DEPARTMENT OF EDUCATION

EXAMINING THE CONTRIBUTION OF A PROFESSIONAL DEVELOPMENT PROGRAM TO GENERALIST TEACHERS' CONTENT KNOWLEDGE AND STUDENT ACHIEVEMENT: THE CASE OF BASKETBALL

DOCTOR OF PHILOSOPHY DISSERTATION

LAMBROS S. STEFANOU

2018

DEPARTMENT OF EDUCATION

EXAMINING THE CONTRIBUTION OF A PROFESSIONAL DEVELOPMENT PROGRAM TO GENERALIST TEACHERS' CONTENT KNOWLEDGE AND STUDENT ACHIEVEMENT: THE CASE OF BASKETBALL

LAMBROS S. STEFANOU

A Dissertation Submitted to the University of Cyprus in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

April 2018

Validation Page

Doctoral Candidate: Lambros S. Stefanou

Doctoral Thesis Title: Examining the Contribution of a Professional Development Program to Generalist Teachers' Content Knowledge and Student Achievement: The Case of Basketball

The present Doctoral Dissertation was submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy at the ***Department of Education*** *and was approved on the ……………………. by the members of the* ***Examination Committee.***

Examination Committee

Research Supervisor: Niki Tsangaridou, Professor ....

Committee Member: Leonidas Kyriakides, Professor (Chair of the Examination Committee) ....

Committee Member: Charalambos Y. Charalambous, Assistant Professor

....

Committee Member: Mary O'Sullivan, Professor, Department of Physical Education and Sport Sciences, University of Limerick

Committee Member: Phillip Ward, Professor, Department of Human Sciences, Ohio State University

Declaration of Doctoral Candidate

The present doctoral dissertation was submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy of the University of Cyprus. It is a product of original work of my own, unless otherwise mentioned through references, notes, or any other statements.

Lambros S. Stefanou

………………………… [Signature]

Abstract (in Greek language)

Μετά από το πρωτοποριακό έργο του Lee Shulman, οι ερευνητές άρχισαν να αντιλαμβάνονται ολοένα και περισσότερο τη σημασία της γνώσης του εκπαιδευτικού – και ιδιαίτερα αυτήν της γνώσης περιεχομένου (ΓΠ) – στην ποιότητα της διδασκαλίας. Αναγνωρίζοντάς το αυτό, πολλά κράτη επενδύουν στη συνεχή επαγγελματική ανάπτυξη (ΕΑ) των εκπαιδευτικών, στοχεύοντας τόσο στην ενίσχυση της γνώσης των εκπαιδευτικών όσο και στη βελτίωση των μαθησιακών αποτελεσμάτων. Ωστόσο, οι περισσότερες έρευνες που εξετάζουν τη σχέση μεταξύ της γνώσης του εκπαιδευτικού και της επίδοσης του μαθητή, συμπεριλαμβανομένης της σχετικής έρευνας στην περιοχή της Φυσικής Αγωγής (ΦΑ), είτε είχαν θεωρητικό προσανατολισμό είτε στηρίζονταν σε ‘έμμεσες μετρήσεις’ της γνώσης του εκπαιδευτικού (π.χ., αριθμός των μαθημάτων που οι εκπαιδευτικοί παρακολούθησαν στο πανεπιστήμιο ή/και τα πτυχία που απόκτησαν). Παράλληλα, υπάρχει σημαντική έλλειψη έρευνας, που να αξιολογεί την αποτελεσματικότητα προγραμμάτων ΕΑ με τη χρήση ‘άμεσων μετρήσεων’ της γνώσης των εκπαιδευτικών και της επίδοσης των μαθητών. Κατά συνέπεια, εξακολουθούν να είναι αναπάντητα ερωτήματα όπως: Ποια είναι η απαραίτητη ΓΠ για την αποτελεσματική διδασκαλία της ΦΑ; Πώς η ΓΠ συνδέεται με την ΕΑ των εκπαιδευτικών;

Με στόχο την πλήρωση των πιο πάνω ερευνητικών κενών, η παρούσα ερεύνα επιδίωξε να αναπτύξει αξιόπιστες και έγκυρες κλίμακες για τη μέτρηση της ΓΠ του εκπαιδευτικού και της επίδοσης του μαθητή στην καλαθόσφαιρα. Ταυτόχρονα, βασικός στόχος της παρούσας έρευνας υπήρξε η διερεύνηση της συνεισφοράς ενός προγράμματος ΕΑ στη ΓΠ των εκπαιδευτικών και στα μαθησιακά αποτελέσματα. Για την πραγματοποίηση της εν λόγω έρευνας, σχεδιάστηκε συγκεκριμένη παρέμβαση (δηλ., πρόγραμμα ΕΑ για τη ΓΠ της καλαθόσφαιρας). Η ΓΠ των εκπαιδευτικών και τα μαθησιακά αποτελέσματα στην καλαθόσφαιρα μετρήθηκαν πριν και μετά από το τέλος της παρέμβασης. Το τεστ ΓΠ χορηγήθηκε συνολικά σε 52 εκπαιδευτικούς πρωτοβάθμιας

εκπαίδευσης, ενώ το τεστ επίδοσης μαθητή χορηγήθηκε σε 913 μαθητές (Ε΄ και Στ΄ τάξης). Επιπλέον, κατά τη διάρκεια της παρέμβασης χρησιμοποιήθηκαν διάφορες τεχνικές για τη συλλογή ποιοτικών δεδομένων (π.χ., σχέδια μαθήματος, κάρτες αναστοχασμού διδασκαλίας, ομαδικές συνεντεύξεις και φύλλα αναστοχασμού για το πρόγραμμα ΕΑ) με στόχο τη σε βάθος κατανόηση του υπό εξέταση φαινομένου.

Για την ανάλυση των ποσοτικών δεδομένων της έρευνας χρησιμοποιήθηκαν τρεις προχωρημένες στατιστικές μέθοδοι. Αρχικά, για τον έλεγχο των ψυχομετρικών ιδιοτήτων των δύο τεστ (δηλ., τεστ γνώσης εκπαιδευτικού και τεστ επίδοσης μαθητή) χρησιμοποιήθηκαν μοντέλα Item Response Theory. Ακολούθως, πραγματοποιήθηκαν αναλύσεις πολλαπλής γραμμικής παλινδρόμησης (multiple linear regression) για την πρόβλεψη και επεξήγηση της τελικής επίδοσης των εκπαιδευτικών στο τεστ ΓΠ. Σε ένα επόμενο στάδιο, διεξήχθησαν πολυ-επίπεδες αναλύσεις για τη διερεύνηση της συνεισφοράς του προγράμματος ΕΑ στα μαθησιακά αποτελέσματα. Τέλος, για την ανάλυση των ποιοτικών δεδομένων χρησιμοποιήθηκε η μέθοδος συνεχούς σύγκρισης (constant comparative method).

Από την ανάλυση των δεδομένων της έρευνας προέκυψαν βασικά ευρήματα. Αρχικά, τα αποτελέσματα της έρευνας φανέρωσαν πως οι δύο κλίμακες είχαν ικανοποιητικές ψυχομετρικές ιδιότητες (*κλίμακα ΓΠ εκπαιδευτικού*: items' r=0.98 – teachers' r=0.75; *κλίμακα επίδοσης μαθητή*: items' r=0.98 – students' r=0.82) και έτσι μπορούσαν να χρησιμοποιηθούν για έγκυρη και αξιόπιστη μέτρηση της ΓΠ των εκπαιδευτικών και των μαθησιακών αποτελεσμάτων. Επιπλέον, σε συμφωνία με ευρήματα προηγούμενων ερευνών, η συμμετοχή των εκπαιδευτικών στο πρόγραμμα ΕΑ αναδείχθηκε ως στατιστικά σημαντικός παράγοντας πρόβλεψης τόσο των αποτελεσμάτων των εκπαιδευτικών όσο και αυτών των μαθητών. Συγκεκριμένα, η ανάλυση έδειξε ότι η συμμετοχή στο πρόγραμμα ΕΑ ήταν στατιστικά σημαντικός παράγοντας πρόβλεψης της τελικής ΓΠ των εκπαιδευτικών, εξηγώντας το 40% της διακύμανσής της. Αντίστοιχα, τα αποτελέσματα της έρευνας δείχνουν πως η μεταβλητή που αναφέρεται στη συμμετοχή των εκπαιδευτικών στο πρόγραμμα ΕΑ, ήταν ο ισχυρότερος παράγοντας πρόβλεψης της επίδοσης του μαθητή. Ειδικότερα, η συμμετοχή των εκπαιδευτικών στο πρόγραμμα ΕΑ εξήγησε το 10.38% της διακύμανσης που εντοπίστηκε στο επίπεδο του εκπαιδευτικού – η οποία αντιπροσωπεύει το 64.92% της μη εξηγούμενης διακύμανσης στο επίπεδο του εκπαιδευτικού. Επιπρόσθετα, οι διαφορές μεταξύ των ομάδων της έρευνας (δηλ., εκπαιδευτικοί και μαθητές που συμμετείχαν στην πειραματική ομάδα ή στην ομάδα ελέγχου), επιβεβαιώθηκαν υπολογίζοντας το μέγεθος της επίδρασης (effect size) με τη χρήση του κριτηρίου Cohen's *d*. Αναφορικά με την τελική επίδοση των εκπαιδευτικών και των μαθητών, βρήκαμε δυνατό (d=1.60) και μέτριο (d=0.73) μέγεθος επίδρασης αντίστοιχα.

Τα ευρήματά μας ευθυγραμμίζονται επίσης με προηγούμενα ερευνητικά ευρήματα, που υποδηλώνουν ότι η ΓΠ των εκπαιδευτικών είναι κρίσιμης σημασίας για τη βελτίωση των μαθησιακών αποτελεσμάτων. Συγκεκριμένα, η μεταβλητή που αναφέρεται στην τελική επίδοση των εκπαιδευτικών στο τεστ ΓΠ εξήγησε το 3.65% της διακύμανσης που εντοπίστηκε στο επίπεδο του εκπαιδευτικού – η οποία αντιπροσωπεύει το 22.83% της μη εξηγούμενης διακύμανσης στο επίπεδο του εκπαιδευτικού. Τέλος, τα ευρήματα της έρευνας προσέφεραν εμπειρική στήριξη για την αποτελεσματικότητα συγκεκριμένων, υψηλής ποιότητας, χαρακτηριστικών ΕΑ (π.χ. εστίαση στο περιεχόμενο, παρατεταμένη χρονική διάρκεια, ενεργή μάθηση, συνοχή). Τα πιο πάνω αποτελέσματα – για την ερμηνεία των οποίων πρέπει να ληφθούν υπόψη οι περιορισμοί της έρευνας – έχουν θεωρητικές, μεθοδολογικές και πρακτικές προεκτάσεις. Οι προεκτάσεις αυτές συζητούνται διεξοδικά μαζί με προτάσεις για μελλοντική έρευνα.

Abstract (in English language)

After Lee Shulman's pioneering work, researchers have started to increasingly realize the importance of teacher knowledge and, particularly, of content knowledge (CK) as a prerequisite for high-quality teaching. Acknowledging this, many countries around the world are investing in the continuous professional development (PD) of their teachers as a major mechanism for the improvement of both teacher and student outcomes. However, most research on the link between teacher CK and student achievement, including the relative research in the area of physical education (PE), has been either theoretical or based on proxy measures of teachers' knowledge, such as the number of courses taken at university and degrees attained. Moreover, research seeking to examine the efficacy of PD programs using direct measures (e.g., tests) of both teacher and student performance is scarce. Consequently, our understanding concerning the CK a teacher needs to teach PE effectively – and how PD matters for acquiring this type of knowledge – is limited.

Aiming to address these research gaps, the present study sought to develop reliable and valid scales to measure teachers' CK and students' achievement in basketball, and in doing so, to investigate the contribution of a content-focused PD program to both teacher and student outcomes. In order to undertake this exploration, an intervention was designed (i.e., content-focused PD program in basketball). Teachers' CK and students' achievement in basketball were measured before the beginning and after the end of the intervention. The teacher CK test was administered to 52 Cypriot generalist primary school teachers, while the student performance test was administered to 913 students (5^{th} or 6^{th} Grade students). In addition, a set of qualitative data techniques (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection sheets on the PD program) was used to gain a deeper understanding of the phenomenon under study.

For the analysis of the quantitative data, three advanced statistical techniques were utilized. First, Item Response Theory (IRT) models were run to test the psychometric

properties of both the teacher CK test and the student performance test. Second, Multiple Linear Regression analyses were conducted to predict and explain teachers' final performance in the basketball CK test. Third, Multilevel model analyses were conducted in order to investigate the contribution of the PD program to student achievement. Finally, for the analysis of the qualitative data the constant comparative method was used.

This exploration revealed several key findings. To begin, the data analysis indicated that the developed scales had satisfactory psychometric properties (*teacher CK scale*: items' r=0.98 – teachers' r=0.75; *student performance scale*: items' r=0.98 – students' r=0.82) and thus, could provide valid and reliable measurements of teacher CK and student achievement. Moreover, in line with previous research findings, teachers' participation in a content-focused PD program was found to be a significant predictor of both teacher and student outcome. Specifically, the analysis revealed that the participation in the PD program was a significant predictor of teachers' final performance in the CK test explaining 40% of its variance. Correspondingly, we found that the variable pertaining to the teachers' participation in the PD had the strongest effect in predicting student achievement. In particular, teachers' participation in the PD explained 10.38% of the variance attributed to the teacher level –which represents 64.92% of the unexplained variance at the teacher level. Moreover, the differences between the study's groups (i.e., teachers and students participating in the treatment or in the comparison group) were verified using Cohen's *d* for effect size. Concerning teachers' and students' final performance, we found strong (*d*=1.60) and moderate (*d*=0.73) effect sizes, respectively.

Our findings also resonate with previous findings suggesting that teacher CK is of critical importance to student achievement. That is, the variable pertaining to teachers' final performance in the teacher CK test explained 3.65% of the variance attributed to the teacher level – which represents 22.83% of the unexplained variance at the teacher level. Finally, the study's findings provided empirical support for specific high-quality PD features (e.g., focus on content, sustained duration, active learning, coherence). Although several limitations should be considered in interpreting the results of the current study, theoretical, methodological, and practical implications are discussed along with suggestions for future research.

Acknowledgements

What a labyrinth of thought was the doctoral dissertation! Just like those labyrinths, whose walls change shape and layout all the time! A difficult, unpredictable, exhausting and lonely journey! Yet, I found my way out! How lucky I was to have found bright beacons to light up my way and show me the right path! The least I can do is to acknowledge their important contribution to the completion of my doctoral dissertation.

I would like to express my warmest thanks and gratitude to my advisor Professor Niki Tsangaridou. I will never forget the day you asked me to study a book’s chapter on teachers’ subject matter knowledge in physical education. That chapter inspired me and greatly determined the course of my professional life. Professor Tsangaridou, you have helped me take the first steps! Thank you from the bottom of my heart for all your valuable advice and support! Thank you for believing in me and for having high expectations from me until the very last minute. This has pushed me to give the best of myself.

I would also like to thank Professor Leonidas Kyriakides. My appreciation of you dates back to when I was an undergraduate student. I feel very fortunate to have been given the opportunity to attend your classes and discuss with you as an undergraduate student, as a master's student and, of course, as a PhD student. If there is one thing you have instilled in me is your passion for research! Your advice has been of crucial importance! Thank you for lighting up my way.

I would also like to express my profound gratitude to the Assistant Professor Charalambos Charalambous. You have been by my side every step of the way; at every turn of the journey! I bombarded you with questions and concerns and yet you have never given up on me! I no longer see you as just an exceptional professor! I now see you as a very good friend! How lucky your newborn baby is to have a father like you!

My appreciation also goes to the two external members of my examination committee, Professor Mary O’Sullivan and Professor Phillip Ward. Your comments and suggestions have helped me improve important aspects of my dissertation. Your work has been a great source of inspiration for me and has considerably influenced both my way of thinking and my research choices! It was a great honor working with you!

I would also like to thank the 52 teachers and the 913 students for participating in this study. I would like to address special thanks to the 23 teachers who have participated in the afternoon training sessions. These colleagues have sacrificed their free time to support my efforts, without having any real incentive apart from their love for education. My dear colleagues, the moments I have spent with you have been of significant importance! Each one of you has enormously contributed to the successful outcome of the professional development program.

At the same time, I would like to thank all the members of the expert panels of this study. Your suggestions have contributed to the development of valid measurement tools and appropriate training materials. I will always remember our long meetings and interesting discussions.

It would be an omission on my part not to thank the postgraduate students who have participated in the team of scorers of this study. We spent several hours together during your training. You have demonstrated a high level of professionalism and contributed the most to the collection of quality data. You deserve the best!

There is one person that I would like to distinguish, and this person is no other than my fellow PhD student Ermis Kyriakides. Ermis, you have the warmest of hearts and a brilliant mind. We were fortunate to have one another! We were not alone in that labyrinth of thought! The support you have provided me was substantial and diverse. I am certain that we will collaborate in many occasions in the future!

Finally, I can hardly find the words to thank my family enough. Words cannot begin to describe my feelings. First, I would like to thank my parents. Although you were far away, your love and support warmed my heart. I would also like to express my

gratitude toward my beloved wife, who has stood by my side! Antonia, thank you from the bottom of my heart for looking after our children, both as a mother and a father, for such a long period! My sweet love, this journey would have been of no value if I didn't have you by my side! May God bless you and keep you safe!

Finally, I would like to dedicate this dissertation to my two beloved children, Marilia and Stavros. As my inner strength was fading away, I was drawing strength from you two. May your life be guided by the power of your minds! Whatever path you choose to follow or labyrinth you choose to explore, I'll be there by your sides!

Table of Contents

Abstract (in Greek language) iv
Abstract (in English language) vii
Acknowledgements x
List of Figures xvi
List of Tables xvii
List of Appendices xviii
List of Abbreviations xix
CHAPTER 1: INTRODUCTION 1
Abstract 1
The Importance of Teacher CK 1
The Importance of Teacher PD 3
Statement of the Problem 4
Purpose of the Study and Research Questions 5
Significance of the Study 6
Limitations 8
Definition of Terms 11
CHAPTER 2: REVIEW OF LITERATURE 13
Abstract 13
The Historical Evolution of CK in General Education 13
Shulman's Theoretical Framework 14
Grossman's Theoretical Framework 15
Ball's Theoretical Framework 16
The Historical Evolution of CK in PE 18
Siedentop's Definition of CK 18
Ward's Reconceptualization of CK 19
Investigating CK in General Education 22
Investigating CK in PE 34
Teacher Professional Development 44
Holistic Approaches to the Comparison and Classification of PD Models 46
Key Features of Effective PD Programs 48
Features and Findings of Content-Focused PD Programs in General Education 56
Features and Findings of Content-Focused PD Programs in PE 58
Research Results on Generalist Teachers Teaching Physical Education 61
Generalist Teachers' CK in PE 62
PD Programs for Generalist Teachers 63
Chapter Summary and the Theoretical Framework of the Study 66
CHAPTER 3: METHODOLOGY 71
Abstract 71
Research Setting and Participants 71
Research Setting 71

Participants 77
The Formation of the Treatment and Comparison Group 79
Instrumentation..82
Teacher CK Test..82
Student Performance Test...84
Qualitative Data Methods..89
Development of Training Materials 92
The Intervention 94
Data Collection Processes 97
Phase 1: Scorer Recruitment and Training 98
Phase 2: Teacher Recruitment 99
Phase 3: Pre-Test Administration...100
Phase 4: Post-Test Administration 100
Issues of Validity and Reliability 100
Validation of the Teacher CK Test...101
Content Validation of the Student Performance Test (BaST test)............102
Content Validation of the Training Materials..103
Scorer Training and Reliability 103
Trustworthiness of the Qualitative Data 104
Data Analysis 105
Descriptive and Inferential Analyses...106
Item-Response-Theory (IRT) Analyses...106
Multiple Regression Analyses 107
Multilevel Analyses...110
Constant Comparative Method for Analyzing the Qualitative Study Data 111
Justification of the Design and Methods Chosen 113
Chapter Summary...115
CHAPTER 4: RESULTS...116
Abstract 116
Research Question 1 116
Research Question 2..121
Research Question 3..125
Descriptive and Inferential Statistics..125
Multiple Regression Analysis...129
Insights on Teachers' Task Progressions as Depicted in their Lesson Plans 131
Teachers' Views on the PD Program 134
Research Question 4..138
Descriptive and Inferential Statistics..139

Multilevel Regression Analysis 141
Using Elements from the Lesson Plans to Explain Student Performance 144
Using Elements from the Self-Reflection Data to Explain Student Performance 146
Summary of Findings 153
CHAPTER 5: DISCUSSION 156
Abstract 156
Research Question 1 156
Research Question 2 158
Research Question 3 159
Research Question 4 163
Implications of the Study 169
Additional Directions for Future Research 177
Conclusion 181
Appendices 183
References 269

List of Figures

Figure

2.1 Domains of mathematical knowledge for teaching 17
3.1 Scatterplot of standardized residuals 109
3.2 Normal P-P plot of standardized residuals 109
4.1 The one-parameter IRT scale capturing teachers' level of CK in basketball 118
4.2 The one-parameter IRT scale capturing students' achievement in basketball 123
4.3 Percentage of inappropriate task progressions per lesson 133
5.1 Integrated conceptual framework of effective PD 180

List of Tables

Table

2.1 Features of High Quality PD in General and in PE 54
2.2 The Study's PD Features 69
3.1 The Four Principles of Play Practice 92
3.2 The Ten Activities Included in the Training Material 94
3.3 The Objectives of the CK PD Program 95
3.4 The Structure and Content of the PD Program 96
3.5 Psychometric Properties of the Scale Developed to Capture Teacher CK in Basketball...102
4.1 Item and Teacher Parameter Estimates for the Scale Developed to Measure Teacher CK in Basketball 117
4.2 Item Difficulty, Standard Errors and Fit Indices for the Items Included in the Teacher CK Test 120
4.3 Item and Student Parameter Estimates for the Scale Developed to Measure Student Achievement in Basketball 122
4.4 Item Difficulty, Standard Errors and Fit Indices for the Tasks Included in the Student Performance Test 125
4.5 Percentages of Success for the Items of the CK Test: Comparison between the Treatment and the Comparison Group...126
4.6 Percentages of Success in the Four Knowledge Domains: Comparison between the Treatment and the Comparison Group 128
4.7 Comparison of the Pre- and Post-Test Performances between the Teachers of the Treatment and the Comparison Group 129
4.8 Stepwise Multiple Regression Analysis for the Variables Explaining Teachers' Final Performance in the CK Test 130
4.9 Examples of Sequentially Inappropriate Task Progressions found in Teachers' Lesson Plans 131
4.10 Self-Reflection on the PD program: Outline of the Main Themes Emerged 135
4.11 Pre- and Post-Test Means for the 11 Tasks of the Student Performance Test: Comparison between the Treatment and the Comparison Group..............................140
4.12 Comparison of the Pre- and Post-Test Performances between the Students of the Treatment and the Comparison Group 141
4.13 Parameter Estimates and (Standard Errors) for the Analysis of Student Achievement in Basketball..142
4.14 Average Percentage of Lessons Allocated to the Teaching of Each Skill or Tactic ..145
4.15 Self-Reflection on Teaching: Outline of the Main Themes Emerged 147

List of Appendices

Appendix

A Teacher CK Test in Basketball 184

B Student Performance Test in Basketball 193

C Set of Qualitative Techniques 204

D The Training Material Activities 209

E The Structure and Content of the PD program 231

F Examples of Assessment Score Sheet and Evaluation Form 237

G Studies that Investigated CK in General Education and in PE 240

H Features of Content-Based PD Programs in General Education and in PE 261

List of Abbreviations

BaST	Basketball Skills and Tactics (test)
CCK	Common Content Knowledge
CG	Comparison Group
CK	Content Knowledge
CoP	Community of Practice
DSPP	Dribbling-Stopping-Pivoting-Passing (task)
LU	Lay-up (task)
ODeMS	Offensive and Defensive Moves and Skills (task)
PCK	Pedagogical Content Knowledge
PD	Professional Development
PE	Physical Education
SCK	Specialized Content Knowledge
TG	Treatment Group

CHAPTER 1: INTRODUCTION

Abstract

After Lee Shulman's pioneering work, researchers have started to increasingly realize the importance of teacher knowledge, and particularly of content knowledge (CK), as a prerequisite for high-quality teaching. Acknowledging this, many countries around the world are investing in the professional development (PD) of their teachers as a major mechanism for the improvement of both teacher and student outcomes. However, most research on the link between teacher CK and student achievement, including the relative research in the area of physical education (PE), has been either theoretical or based on proxy measures of teachers' knowledge, such as number of courses taken at university and degrees attained. Moreover, research seeking to examine the efficacy of PD programs using direct measures (e.g., tests) of both teacher and student performance is scarce. Consequently, our understanding of the CK a teacher needs to teach PE effectively and how that knowledge matters for PD is limited. Aiming to address this research gap, the present study seeks to develop reliable and valid scales to measure teachers' CK and students' achievement in basketball and to investigate the contribution of a content-focused PD program to both teacher and student outcomes. The significance and uniqueness of the effort undertaken herein is described in detail. Finally, several limitations are provided, which should be considered in interpreting the results of the current study.

The Importance of Teacher CK

The knowledge that teachers must possess to teach effectively has historically been a topic of scholarly interest. This interest stems from the fact that the strength and nature of the relationships between teacher knowledge, instruction, and student achievement, shape both the policies regulating how teachers are prepared, certified, hired, and evaluated, as well as the content of continuous PD programs (Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013b).

In his seminal work Shulman (1986, 1987) was the first to suggest that teachers' effects on student achievement are driven by teachers' ability to understand and use subject matter knowledge (i.e., CK) to carry out the tasks of teaching. Specifically, Shulman argued that knowing a subject matter for teaching requires more than knowing its valid and acceptable facts or concepts. Teachers must also understand how and why these facts or concepts are organized and structured within a disciplinary domain. Given his emphasis on what he called the "missing paradigm," researchers after Shulman have started to increasingly realize the importance of teacher knowledge, and particularly of CK as a necessary foundation for effective teaching (Baumert et al., 2010; Schempp, 1997; Siedentop, 1989/2002).

Building on Shulman's (1986, 1987) conceptualization of teacher knowledge, Deborah Ball, Heather Hill, and their colleagues (e.g., Ball, Thames and Phelps, 2008; Hill, Schilling, & Ball, 2004) designed and empirically tested measures of teachers' CK for teaching elementary mathematics (Hill et al., 2004). Based on the analysis of the mathematical demands of teaching, Hill, Rowan, and Ball (2005) recognized two distinct key elements of CK for teaching mathematics: *common content knowledge* (CCK) and *specialized content knowledge* (SCK). According to Ball and colleagues (2008), CCK refers to the mathematical knowledge and skill used in settings other than teaching. That is, CCK comprises the mathematical knowledge and skill possessed by any well-educated adult (Hill et al., 2005). Whereas, SCK refers to the mathematical knowledge and skill unique to teaching (Ball et al., 2008), which is not generally held by well-educated adults (Hill et al., 2005).

In the field of sport pedagogy, the importance of CK in PE was underlined by Daryl Siedentop, who argued that without the necessary core CK, perspective teachers "will fail as teachers of physical education no matter how well they are eventually prepared in the pedagogical domain" (Siedentop, 1989/2002, p. 372). In Siedentop's (1989/2002) broad view of CK components, a wide range of knowledge, skills, and dispositions within psychomotor, cognitive, and social dimensions that teachers should know, were encompassed.

Drawing on Siedentop's arguments (1989/2002), Phillip Ward (2009) proposed a four-domain CK conceptualization in PE: (a) knowledge of the rules, etiquettes, and safety, (b) knowledge of techniques and tactics, (c) knowledge of errors, and (d) knowledge of instructional representations and tasks (e.g., task progression). In line with Ball and colleagues (2008), Ward (2009) argued that the first two domains can typically be acquired by playing the game (i.e., performing) and as such could be called CCK in PE. Similarly, the next two domains are typically acquired through reflecting and refining teaching performance in PE, and as such could be called SCK in PE.

The Importance of Teacher PD

A vital mechanism for helping teachers understand more deeply the content they teach and the ways students learn that content is continuous PD (Guskey, 2003). According to Knight (2002, p. 230), "continuing professional development is needed because initial teacher education cannot contain all of the prepositional knowledge that is needed and certainly not that procedural, 'how to' knowledge which grows in practice". In fact, there is a general consensus that continuous PD programs should be focused on improving and deepening teachers' CK (Desimone, 2009; Desimone & Pak, 2017; Garet, Porter, Desimone, Birman, & Yoon, 2001; O'Sullivan & Deglau, 2006; Patton & Parker, 2015; Ward, 2009).

A review of the literature reveals that numerous efforts have been made to articulate lists of *key features* of effective PD for teachers (e.g., Armour &Yelling, 2004a; Desimone, 2009; Darling-Hammond & McLaughlin, 2011; Han, 2014; Hunzicker, 2011; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). These lists share common features, and in many cases empirical support is provided. Scholars suggest that effective PD should be sustained, content-focused, coherent, collective, and tailored to meet teachers' needs. At the same time, it should provide opportunities for active learning and feature elements of autonomy and choice (e.g., Armour & Yelling, 2004a; Desimone, 2009; Patton & Parker, 2015).

Taking into consideration that generalist teachers are responsible for teaching primary PE classes in most countries around the world (Hardman, 2005; Hardman & Marshall, 2001, 2009) and that they were found to lack the necessary CK and/or PCK to teach PE effectively (Graber, Locke, Lambdin, & Solmon, 2008; Petrie, 2010), it appears that continuous PD is indispensable in helping generalist teachers enhance students' achievement in PE.

Statement of the Problem

Three decades after Shulman's reconceptualization of teacher knowledge, the field has made little progress in developing a coherent theoretical framework for the necessary CK for teaching. The ideas and concepts remain theoretically scattered, lacking clear definition (Ball et al., 2008). Likewise, in PE Ward (2009) argued that there is "a lack of conceptual clarity relative to what is the subject matter knowledge that best serves a teacher" (p. 346). According to Ward (2009), this lack of conceptual clarity largely explains the use of proxy variables in measuring teachers' CK in PE. Actually, indirect methods of assessing teachers' knowledge, such as courses taken, degrees attained, or results of basic skills tests were commonly used by several researchers (e.g., Begle, 1979; Goldhaber & Brewer, 2001; Monk, 1994) in the early years of research on teacher knowledge and continuing on through the *educational production function* literature (Wilson, Floden, & Ferrini-Mundy, 2001). Such measures of teachers' intellectual resources have been found over time to be poor predictors of student achievement (Ball, Lubienski, & Mewborn, 2001; Begle, 1979; Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; D'Agostino & Powers, 2009).

Moreover, while many countries around the world are investing in the continuous PD of their teachers (Borko, 2004; Darling-Hammond, Chung Wei, & Andree, 2010), research seeking to evaluate the efficacy of PD programs using direct measures (e.g., tests) of both teacher and student performance is more than scarce. To the best of our knowledge, over a period of almost 40 years (i.e., from 1980 to 2017), only four PD studies were conducted in general education (i.e., Diamond, Maerten-Rivera, Rohrer, & Lee, 2014; Garet et al., 2008, 2011; Heller, Daehler, Wong, Shinohara, & Miratrix, 2012) and one in the area of PE (i.e., Hunuk, Ince, & Tannehill, 2013), which used tests to capture teachers'

CK and students' achievement. Ward's (2013) call for CK measures in PE describes in the best way the existing research gap:

> Measures of content knowledge are needed, both in terms of assessing and demonstrating knowledge. Without such measures to serve as dependent variables, we cannot move forward. With such measures, student learning can be compared relative to the content knowledge of their teachers. This may allow us to determine which dimensions of content knowledge are most influential in terms of student achievement. (p. 438)

Purpose of the Study and Research Questions

Aiming to address these gaps in both research areas – that is, teacher knowledge and teacher PD – the present study contributes toward the understanding of the interactive relationships between teacher knowledge, student achievement, and key features of teacher PD. Specifically, the purpose of this study is twofold: to develop reliable and valid scales to measure teachers' CK and students' achievement in basketball and to investigate the contribution of a content-focused PD program to both teacher and student outcomes.

Drawing on Ward's (2009) conceptualization of CK in PE and on evidence-based high-quality PD features described in the literature (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015), the present study seeks to answer the following research questions:

1. Can a scale with good psychometric properties that measures in-service generalist teachers' CK in basketball be developed?
2. Can a scale with good psychometric properties that measures students' performance in basketball be developed?
3. What is the contribution of a content-focused basketball PD program to in-service generalist teachers' level of CK in basketball?

4. What is the contribution of a content-focused basketball PD program to students' achievement in basketball?

Significance of the Study

The present study aims to address a series of gaps identified in the literature. Particularly, this study contributes to the literature in five ways. First, while CK is a widely used term in the educational community, it lacks a clear definition (Ball et al., 2008; Ward, 2009). Ward (2009, 2011) reconceptualized teachers' CK in PE to include apart from the knowledge of rules, etiquettes, safety, techniques, and tactics (i.e., CCK), the knowledge of students' errors and instructional tasks and representations (i.e., SCK). A number of studies directly measuring teachers' CK in PE (e.g., Hunuk et al., 2013; Kim, 1996; Santiago, Disch, & Morales, 2012a) consider CK to include only the knowledge described under the construct of CCK. We suggest that what is measured (or provided in PD programs) as teacher CK is a key aspect in investigating links between teacher CK and student achievement. For the purposes of this study, we draw on Ward's (2009) four-domain CK conceptualization in PE. Our efforts contribute toward the establishment of one common definition of CK in PE.

Second, attempts to directly measure teachers' CK in PE are uncommon, and even then, the majority of the work in this area sought only to assess the level of teachers' CK across the various content areas of PE, without drawing any connections to student achievement (e.g., Castelli & Williams, 2007; Santiago et al., 2012a; Stuhr et al., 2007). Notably, research seeking to evaluate the efficacy of PD programs in PE using direct measures of both teacher and student performance is almost nonexistent (Sinelnikov, Kim, Ward, Curtner-Smith, & Li, 2016). In fact, as fas as we can tell, this is the first PD study in the field of PE that seeks to assess directly both teacher CK (i.e., via a test) and student achievement (i.e., via a performance test) in basketball. Thus, the effort undertaken herein seems to be highly warranted.

Third, despite the widespread recognition of PD's importance (cf. Bautista & Ortega-Ruiz, 2015), the PD currently available to teachers can be described as "woefully inadequate" (Borko, 2004, p. 3). In particular, most PD opportunities remain poorly aligned with curricula and classroom practice, fragmented, and inadequate to meet teachers' needs (Borko, 2004; Creemers, Kyriakides, & Antoniou, 2013; Patton & Parker, 2015). Acknowledging this, Fishman, Marx, Best, and Tal (cited in Armour and Yelling, 2007, p. 182) point out that "to create excellent programs of professional development, it is necessary to build an empirical knowledge base that links different forms of professional development to both teacher and student learning outcomes". Responding to this call, the PD format utilized in the present study draws on features of high-quality teacher PD programs described in the literature (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). By doing so, this study contributes toward the development of effective PD programs.

Fourth, the present study follows a *quasi-experimental* design, which is not particularly common in educational studies, let alone in PD studies in PE examining relationships between teacher knowledge and student achievement. According to Yoon, Duncan, Lee, Scarloss and Shapley (2007), while hundreds of studies addressed the topic of teacher learning and PD (in mathematics, science, and reading and English/language arts), a thorough review of literature identified only 9 out of 1,343 studies of PD that had the types of rigorous designs – randomized control trial or quasi-experimental designs – which allow causal inferences to be made. For the purposes of the present study, we have applied a quasi-experimental design, which includes both a comparison group and pre/post-measurements. In doing so, we provide a series of data concerning the baseline equivalence between the treatment and the comparison group. Thus, to a certain degree, this study's findings can inform the design of support materials for generalist teachers as well as the content and processes of teacher PD programs.

Finally, this study differs from existing pertinent research in PE (e.g., Iserbyt, Ward, & Li, 2017; Iserbyt, Ward, & Martens, 2016; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward, Kim, Ko, & Li, 2015) in another significant way. Rather than focusing on PE specialists, it focuses on generalist teachers, given that in many countries (e.g., Germany, Portugal, Sweden, United Kingdom, Australia, Canada) including Cyprus, it is the job of generalist teachers to teach PE lessons in primary school (Hardman, 2005; Hardman & Marshall, 2001). A comprehensive review of literature revealed only a handful of studies attempting to assess generalist teachers' CK in PE (e.g., Hart, 2005; Stefanou, Tsangaridou, Charalambous, & Kyriakides, 2015). Moreover, from the school year 2010-2011, a new PE curriculum has been introduced in Cypriot primary education, and importantly, from the school year 2015-2016, the Ministry of Education and Culture decided to increase the allocated PE time for 5th and 6th graders from two to three 40-minute periods per week. These recent policy and curricular developments bring into focus the significance of PD for generalist teachers, who were found to lack the necessary CK and/or PCK to teach PE effectively (Graber, Locke, Lambdin, & Solmon, 2008; Petrie, 2010; Stefanou et al., 2015). Generalist teachers' participation in content-focused PD programs in PE, such as the one developed and provided for the purposes of the present study, seems to be indispensable in enhancing teacher knowledge and student achievement in Cypriot primary education.

Limitations

Several limitations should be considered in interpreting the results of the current study. First, although our original intention was to use an experimental design, it was not feasible to randomly allocate the participants to the experimental and control group. Specifically, the allocation to the two groups was based on the participants' availability of free afternoon time (since the PD sessions were held during afternoon time). Consequently, a quasi-experimental research design (Shadish, Cook, & Campbell, 2002) was used to examine the intervention's (i.e., participation in a content-focused PD program) contribution to teacher CK and student achievement. The presence of selection bias was examined in terms of baseline characteristics. The two groups were equal in respect to teachers' background characteristics and teachers' initial level of CK in basketball. Nevertheless, it is acknowledged that the absence of pre-test differences in a quasi-experimental study is never proof that selection bias is absent, since unmeasured variables might cause the selection (Shadish et al., 2002).

Second, non-probability sampling techniques (i.e., convenience and snowball sampling) were employed to build the teacher sample due to budget constraints (e.g., no compensation was given to the participants in the group that received the treatment). Although the sample was not randomly selected, it was found to be representative of the primary school teacher population of Cyprus in terms of teachers' enrollment in urban and suburban/rural schools. In addition, anecdotal evidence suggested that the study's sample was largely representative of the teacher population under consideration in terms of PE teaching experience and gender. However, it is acknowledged that the results obtained from the study's sample should be generalized to the general population with great caution (Strauss & Corbin, 1990).

Third, we acknowledge that teacher quality is more than CK. Therefore, the study could have investigated the contribution of the PD program to the quality of teaching PE and/or to the enacted PCK. That is, this study's design cannot provide answers to the following crucial question: How teachers' CK plays out in teaching? Although the study's qualitative data referring to teachers' perspectives on teaching (e.g., self-reflection on teaching) shed some light to what might have actually happened during the lessons, without classroom observations we cannot fully understand these findings. The use of observation data could provide objective information and prevent many of the biases related to the self-report data (Strong, 2011), that were collected for the purposes of the present study. Yet, due to budget and time limitations this was not feasible.

Fourth, we acknowledge that the CK framework (Ward, 2009) utilized in this study, for the most part, refers to CK of physical activity in PE. In the context of contemporary schooling, the CK needed for teaching PE is more than CK of physical activity. According to Tom and Valli (1990), there are three orientations on CK: positivistic, interpretive, and critical. The focus of the positivistic orientation is on the knowledge and skills of evidence-based teaching, whilst, the interpretive orientation emphasizes the use of theory-laden constructs in studying social life. Finally, the critical theory orientation embraces both a more progressive social vision and a radical critique of schooling (Tsangaridou, 2006).

Fifth, the present study applied a pre-post design, which only allows the investigation of the short-term contribution of the PD program to teacher and student outcomes. This design could have been improved by including more longitudinal measures, such as retention tests (for both teacher CK and student achievement) administered at the start of the next school year. Nevertheless, this was not attainable due to time and budget constraints.

Finally, concerning the qualitative data used in this study, it is acknowledged that the primary researcher functioned as the major instrument of data collection and analysis (Lincoln & Guba, 1985; Patton, 1990). He was also the person who developed and implemented the training materials. However, a variety of techniques were used to support the trustworthiness of the qualitative data (e.g., data triangulation, identification of confirming and disconfirming evidence, peer reviewing of the data), as well as the content validity of the training materials (i.e., content-specific experts and/or teacher educators thoroughly checked the training materials).

Definition of Terms

Common Content Knowledge Knowledge and skills needed to perform an activity (Ball et al., 2008).

Content Knowledge Knowing both how to perform an activity as well as what to teach as the activity (Ward, 2009).

Critical Elements The most important aspects of movement that should be observed when the skill is performed correctly (Laund & Veal, 2013).

Cues Key words or phrases that communicate the critical elements of a movement to the learner (Rink, 2010).

Game-like Activities Activities comprising authentic game challenges, i.e., pressure of time, space, and/or an opponent (proposed).

Generalist Teacher A classroom teacher, who teaches all the curriculum subjects, and not a PE specialist.

High-quality Activities Activities that involve game-like situations and an intentional manipulation (i.e., shaping practices) of one or more game variables (e.g., rules, playing area dimensions, scoring system) to emphasize particular aspects of effective play (proposed).

Pedagogical Content Knowledge "[…] a focal point, a locus, defined as such as an event in time (and therefore specific contextually) where teachers make decisions in terms of content based on their understandings of a number of knowledge bases (e.g., pedagogy, learning, motor development, students, contexts, and curriculum)" (Ward et al., 2015, p. 131).

Specialized Content Knowledge Knowledge and skills needed to teach the content (Ball et al., 2008). This type of knowledge should not be confused with pedagogical content knowledge, which additionally includes knowledge of students, pedagogy, and context (Ward, 2009).

Student Achievement “[...] the status of subject-matter knowledge, understandings, and skills at one point in time” (Linn et al., 2011, p. 9).

Tactics “[…] the ways in which attackers position themselves and combine with teammates to keep possession of the ball, and the way in which defenders manoeuvre to regain the ball” (Launder & Piltz, 2013, p. 20).

Teacher Professional Development “[…] is about teachers learning, learning how to learn, and transforming their knowledge into practice for the benefit of their students’ growth” (Avalos, 2011, p.10).

Technique A set of critical elements describing the correct performance of a skill (proposed).

CHAPTER 2: REVIEW OF LITERATURE

Abstract

Building on Shulman's conceptualization of teacher knowledge, Deborah Ball, Heather Hill, and their colleagues developed a practice-based theory of mathematical knowledge for teaching. Likewise, Phillip Ward drew on the milestone work of Ball and Hill to propose a four-domain CK conceptualization in PE. Ward's CK framework comprises both CCK and SCK domains. However, until today a number of researchers explore and measure CK under different definitions (e.g., exclusively CCK). We suggest that what is measured (or provided through a PD program) as teacher CK is a key aspect in investigating links between teacher CK and student achievement. Moreover, although continuous PD is widely recognized as a major mechanism for the improvement of both teacher knowledge and student achievement, research findings indicate that the PD currently available to teachers can be described as "woefully inadequate". Acknowledging this, many researchers in general education, as well as in PE, described and investigated a series of high-quality PD features. Focus on CK has a prominent place among these features of effective PD. Nevertheless, there has been relatively little systematic research on the contribution of PD to teacher and student outcomes. Finally, content-focused PD has been identified as an area of need for generalist teachers, since they were found to lack the necessary CK to teach PE effectively. Yet, research evidence indicated that few generalist teachers have participated in effective PD programs. Taking into consideration these research gaps, the present study builds on earlier work on teacher CK and teacher PD to propose an effective content-focused PD framework for generalist teachers teaching PE.

The following literature review is organized into seven sections. In the first two sections, the historical evolution of CK in general education and in PE, are explored. The next two sections review studies investigating CK in general education and in PE. The fifth section presents high-quality PD features described in the literature and findings of content-focused PD studies for both general education and PE. Finally, the sixth section reviews research results on classroom teaching, while the last section presents this study's theoretical framework.

The Historical Evolution of CK in General Education

During the last three decades, educational researchers have made efforts to describe the knowledge base for teaching. In this section, Shulman's (1986, 1987) initial definition and conceptualization of CK, Grossman and colleagues' (1990, 2005) view of CK and Ball and colleagues' (2005, 2008) new notion of CK will be reviewed because their work had a significant influence on the particular research area.

Shulman's Theoretical Framework

Much of the discussion about CK in the past three decades has been informed by the work of Shulman (1986, 1987), who defined CK as "the amount and organization of knowledge per se in the mind of the teacher" (p. 9). In Shulman's (1986) initial conceptualization of teacher knowledge, CK refers to a total body of knowledge, which encompasses three knowledge bases for teaching: (a) subject matter content knowledge (i.e., teachers' organization and breadth of knowledge about the subject matter); (b) pedagogical content knowledge (i.e., the ways of representing and formulating content that makes it easy for learners to understand); and (c) curricular knowledge (i.e., a range of topics planned and sequenced for teaching specific content at a given level of learners).

Drawing on Bruner (1960) and on Schwab (1961/1978), Shulman (1986) argued that knowing a subject matter for teaching requires more than knowing its valid and acceptable facts or concepts. Teachers must also understand how and why these facts or concepts are organized and structured within a disciplinary domain. In Shulman's (1986) view "a teacher need not only understand that something is so; the teacher must further understand why it is so" (p. 9).

Shulman (1987) revised his theoretical framework of teacher knowledge base to seven categories: (a) CK; (b) general pedagogical knowledge; (c) curriculum knowledge; (d) pedagogical content knowledge (PCK); (e) knowledge of learners and their characteristics; (f) knowledge of educational contexts; and (g) knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. In this latter conceptualization of teacher knowledge, CK is considered as one of the seven components of teacher knowledge base that is required for teaching and as one distinct component of PCK. In particular, Shulman (1987) argues that "among those categories, pedagogical content knowledge is of special interest because it identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8).

The pioneering work of Shulman (1986, 1987) reframed the study of teacher knowledge in ways that attend to the role of content in teaching (Ball et al., 2008). In 1986, Shulman suggested that research on teaching overemphasized the pedagogical aspects of teaching and underemphasized the role of subject matter in teaching situations (Tsangaridou, 2006). Shulman (1986) referred to the absence of research on subject matter among the various paradigms for the study of teaching as the "missing paradigm" problem. Researchers after Shulman have started to increasingly realize the importance of teacher knowledge, and particularly of CK as a necessary foundation for effective teaching (Baumert et al., 2010; Schempp, 1997; Shulman, 1987; Siedentop, 1989/2002).

Grossman's Theoretical Framework

Grossman (1990) defined CK as "knowledge of content and knowledge of substantive and syntactic structures in subject area" (p. 25) and reorganized Shulman and colleagues' seven knowledge bases into four components as follows: (a) subject matter knowledge; (b) general pedagogical knowledge; (c) PCK; and (d) knowledge of context. Unlike Shulman, Grossman (1990) viewed these four cornerstones of teacher knowledge as interactive. Likewise, Marks (1990) suggested that classifying knowledge into categories was problematic because of the ambiguous boundaries between the types of knowledge.

In 2005, Grossman, Schoenfeld, and Lee argued that the subject matter competence is not sufficient to successfully teach students who have different kinds of errors. Instead, they suggested that a teacher must be able to not only identify such mistakes when they occur, but also to address the sources of the students' errors in an effort to correct them. Grossman et al. (2005) also proposed that learning through the coursework is not sufficient to develop a profound understanding of content. However, they argued that prospective teachers have to construct a solid foundation (i.e., a basic CK) during their content coursework, which will enable them to continue learning within the subject matter throughout their careers.

Ball's Theoretical Framework

In mathematics education, Deborah Ball and Heather Hill built on Shulman's (1986, 1987) conceptualization of teacher knowledge to develop a practice-based theory of mathematical knowledge for teaching. Their efforts were grounded in the argument that Shulman's framework was in need of theoretical development, analytic clarification, and empirical testing (Ball et al., 2008).

Hill and colleagues (2004) argued that scholars had not attempted to measure teachers' knowledge for teaching in a rigorous manner and thus could not track its development or contribution to student achievement. Thus, their work aimed at designing and empirically testing measures of teachers' CK for teaching elementary mathematics (Hill et al., 2004). Their findings provided initial evidence for the conjecture that CK for teaching mathematics consists of more than the knowledge of mathematics held by any well-educated adult.

Based on their analysis of the mathematical demands of teaching, in 2005, Hill, Rowan, and Ball recognized two distinct key elements of CK for teaching mathematics: *common knowledge of content* and *specialized knowledge of content*. In their following work (e.g., Ball et al., 2008; Hill, Ball, & Schilling, 2008; Hill et al., 2008b), these two CK subcategories were termed as *common content knowledge* and *specialized content knowledge*. In other words, Ball, Hill and their colleagues suggested and verified that Shulman's CK construct could be subdivided into CCK and SCK (see Figure 2.1).

According to Ball and colleagues (2008), CCK refers to the mathematical knowledge and skill used in settings other than teaching. That is, CCK comprises the mathematical knowledge and skill possessed by any well-educated adult (Hill et al., 2005).

For teachers to possess CCK it means to know the material they teach, recognize when their students give wrong answers or when the textbook gives an inaccurate definition, and use terms and notation correctly (Ball et al., 2008).

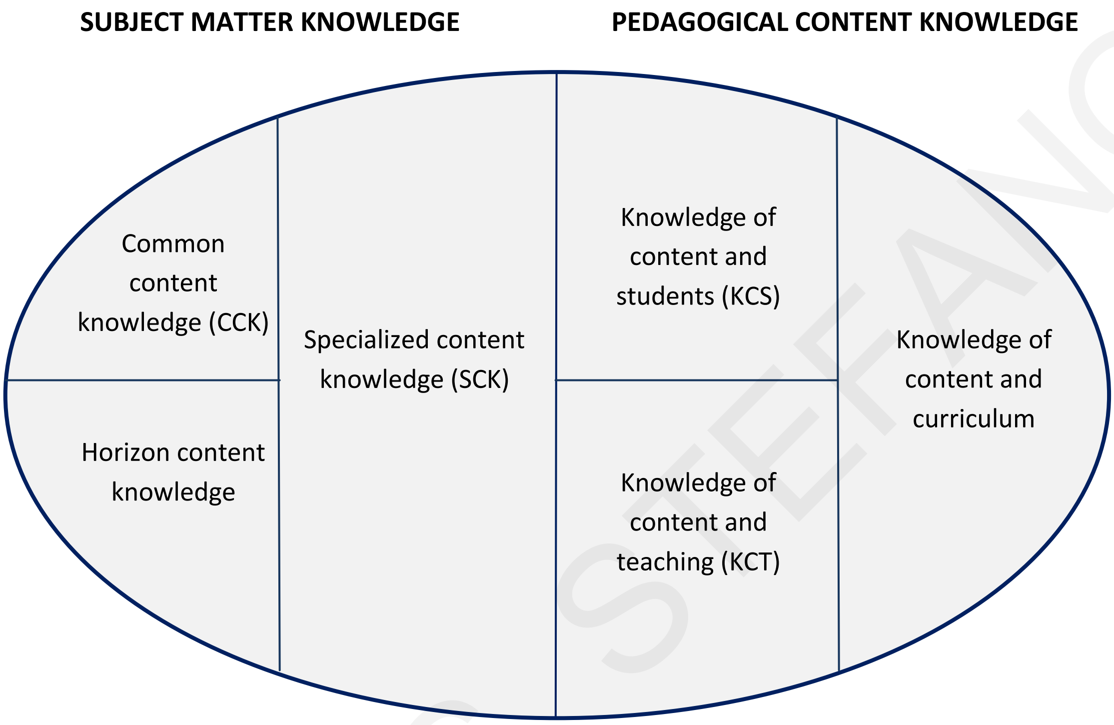


Figure 2.1 Domains of mathematical knowledge for teaching

The second domain, SCK, refers to the mathematical knowledge and skill unique to teaching (Ball et al., 2008), which is not generally held by well-educated adults (Hill et al., 2005). Ball and colleagues consider SCK to be a "pure" form of CK because it is not mixed with knowledge of students or pedagogy and is thus distinct from the PCK identified by Shulman (Ball et al., 2008; Hill et al., 2005). Ball et al. (2008) provide a list of tasks that depend more on mathematical knowledge (i.e., CK) and less (or not at all) on knowledge of students and teaching. For example, SCK includes the knowledge of how to choose and develop useable definitions, how to select and use various representations, how to give or evaluate mathematical explanations, how to size up the sources of mathematical errors, or how to modify tasks to be either easier or harder (Ball et al., 2008; Hill et al., 2005).

In addition, Ball's research group suggested that Shulman's *PCK* could be divided into *knowledge of content and students*, *knowledge of content and teaching*, and *knowledge of content and curriculum* (see Figure 1). Since in-depth discussion of PCK is beyond the scope of this study, we are not going to elaborate further on its subcategories (for more information, see Ball et al., 2008).

Conclusively, the work of Ball, Hill, and their colleagues can be seen as detailing fundamental elements of CK for teaching. They accomplished this by establishing a practice-based conceptualization of CK, by elaborating sub-domains, and by measuring and validating knowledge of those domains. Nevertheless, Ball and colleagues' (2008) framework concerns mathematical knowledge for teaching. Whether or not this framework could be applied in the area of PE, it is a matter that needs to be investigated.

The Historical Evolution of CK in PE

In this section, Siedentop's (1989/2002) initial definition of CK and Ward's (2009, 2011) reconceptualization of CK will be reviewed. Reviewing the work of these two scholars is deemed important not only because they come from the area of PE, but also because this study draws on their research.

Siedentop's Definition of CK

The importance of CK in PE was underlined by Daryl Siedentop in 1989, who argued that without the necessary core CK, perspective teachers "will fail as teachers of physical education no matter how well they are eventually prepared in the pedagogical domain" (Siedentop, 1989/2002, p. 372).

Siedentop (1989/2002) described his strong view of CK using Shulman's (1986) umbrella term of "subject matter content knowledge" in PE. Siedentop (1989/2002) argued that the core subject matter of PE is sport and physical activities that teachers will teach for their students in school. In his broad view of CK components, a wide range of knowledge, skills, and dispositions within psychomotor, cognitive, and social dimensions that teachers or coaches should know in an educational or sport context were encompassed. Specifically, Siedentop (1989/2002, p.374) argues that teachers:

> […] should know the technical aspects of the skills involved, the strengths and weaknesses of various strategic approaches to the sport, the training implications for improved performance in the sport, the developmental considerations, the norms, values, and traditions of the sport, the role it does, and the developing technologies within the sport, the psychosocial considerations associated with individual and group dynamics of players, and the ethnical/moral dilemmas posed by competition. And, they should "know" these things intellectually and as performers, each kind of knowledge having its own meaning.

Regarding the development of the necessary CK for teaching PE, Siedentop (1989/2002) argued that many courses in the discipline of kinesiology were largely irrelevant to the content taught in schools. To support his argument, Siedentop (1989/2002) provided an example of the Ohio State University's dance education program, indicating that more emphasis should be placed in courses comprising opportunities for participation in the sport. According to Siedentop (1989/2002), full engagement in the sport by participating in it (i.e., performing it) is the best way to allow prospective teachers to deeply understand the nature of the content and develop their CK for teaching.

Ward's Reconceptualization of CK

Drawing on Siedentop's arguments (1989/2002), Ward (2009) raised an important question "What is the subject matter knowledge one needs to teach a subject?" and suggested two forms of CK in PE: (a) knowing how to perform an activity; and (b) knowing what to teach as the activity. According to Ward (2009, p. 349), "knowing what to teach should not be confused with pedagogical content knowledge, which, in addition to including knowledge of what to teach, also includes knowledge of students, pedagogy, and context". That is, Ward (2009) challenged the prevalent assumption that teachers must be able to perform the activity to teach the activity. In line with Siedentop (1989/2002), Ward (2009) more forcefully argued that learning through performing is only a part of the knowledge that is needed for someone to teach the activity.

According to Ward (2009), the knowledge that one must possess to simply perform an activity or play a sport includes basic rules, technique, and tactics, whereas the knowledge that is necessary for someone to teach the activity, includes error analysis and proper selection of tasks. For example, there is no doubt that in playing volleyball a player must know basic rules, etiquette, techniques, and tactics. Yet in teaching volleyball, besides knowing the rules, etiquettes, techniques and tactics, a teacher must be able to analyze the source of students' errors, address incorrect students' performances using correct feedback and cues, and provide appropriate tasks (Kim, 2011).

Thus, Ward (2009, 2011) proposed a four-domain CK conceptualization in PE: (a) knowledge of the rules, etiquettes, and safety; (b) knowledge of technique and tactics; (c) knowledge of errors; and (d) knowledge of instructional representations and tasks (e.g., task progression). We briefly explain each domain below.

Knowledge of the rules, etiquettes, and safety. This domain includes knowledge of the rules (e.g., when a travelling violation is committed in basketball or when and where a corner kick occurs in soccer) and knowledge of the etiquette of an activity (e.g., only the playing captain can speak to the referees in volleyball). In addition, this domain includes knowledge of the essential concepts of the activity. For example, a teacher should know the primary rules that define the fundamental character of the game (e.g., the ball must go over the net in volleyball) and secondary rules that can be changed to make the game more developmentally appropriate (e.g., the service is executed behind the end line in volleyball). It also includes knowledge relating to issues of safety and knowing how to set up equipment.

Knowledge of techniques and tactics. This domain includes knowledge of technique of the skills required to perform an activity (e.g., knowing the sequence of steps in a dance or knowing that the lead leg has to be extended over the hurdle during a race) and knowledge of basic tactics (e.g., knowing how to move to open space in order to receive a pass in soccer).

Knowledge of errors. This domain refers to recognizing students' correct and incorrect performances. For example, this would occur when the teacher recognizes that the steps of a specific dance are in incorrect sequence with the music or in volleyball when the teacher recognizes that the student did not contact the ball with the fingers during an overhead pass.

Knowledge of instructional representations and tasks. This domain includes knowledge of different activities and progressions. For example, in gymnastics, it would include using an inclined mat to help students place their hands closer to their feet to facilitate the forward roll before using a flat mat. In hurdling, it would include the use of horizontal obstacles before using vertical obstacles.

Largely in line with Ball and colleagues' (2008) conceptualization of mathematical knowledge for teaching, Ward (2009) argues that the first two domains can typically be acquired by playing the game (i.e., performing) and as such could be called CCK in PE. Similarly, the next two domains are typically acquired through reflecting and refining teaching performance in PE, and as such could be called SCK in PE. In short, SCK is that form of CK that represents a teacher's understanding of the tasks that can be used to teach CCK.

However, we have to note that Ward's (2009) CK framework, for the most part, refers to CK of physical activity in PE. According to Tinning (2004), the traditional role of the PE teacher was to teach for the development of physical activity and sport-related outcomes. However, in the context of contemporary schooling, the CK needed for teaching

PE is more than CK of physical activity (Tinning, 2006; Tsangaridou, 2006). According to Tom and Valli (1990), there are three orientations on CK: positivistic, interpretive, and critical. The focus of the positivistic orientation is on the knowledge and skills of teaching derived from the scientific study of teaching, whereas, the interpretive orientation focuses on the use of theory-laden constructs in studying social life. Finally, the critical theory orientation combines a progressive social vision with a radical critique of teaching and schooling (Tsangaridou, 2006). Moreover, Fernandez-Balboa, Barrett, Solomon, and Silverman (1996) suggest that the different theoretical orientations can find a place beside each other in pre- and in-service programs. Specifically, they noted:

> We see them [the different orientations] as complementary, not as competitive; they all aim at the same target – developing the intellectual and physical acuity of both students in schools and those soon-to-be teachers. Providing students with a sound, multifaceted preparation regarding our content knowledge will most likely ensure their educational success and our future as a profession. (p. 57)

Investigating CK in General Education

This section reviews investigations of CK in general education. Two education databases (ERIC and SCOPUS) were used to locate studies published in peer-reviewed journals and conferences proceedings. Several terms were used including ‘teacher knowledge’, ‘subject matter knowledge’ and ‘content knowledge’. Following the initial search, materials were scanned to eliminate studies (in) which: (a) CK was not the focus of the investigation; (b) did not include measurement of teachers’ CK; and (c) were carried out before 1980. Finally, the reference lists of the included articles were cross-checked to discover additional studies that were not revealed during the initial search; 51 studies were selected for final review.

For the purposes of this section, each article was summarized in a classification scheme including five aspects: (1) the research purpose/questions of the CK studies; (2) the number and nature of participants/level of education; (3) the research method used to capture CK; (4) the specific content that was investigated; and (5) the main research findings. These five aspects are presented in Table G1 (see Appendix G).

Research Purpose/Questions of the CK Studies

An analysis of the research questions of the studies (see column *research purpose* in Table F1) revealed that CK research in general education is organized along eight major research lines: (1) *the nature and level of teacher CK*; (2) *the development of teacher CK*; (3) *the differences in teachers' CK*; (4) *the relationship between CK and PCK*; (5) *the relationship between teacher CK and quality of instruction*; (6) *the relationship between teacher CK and student learning/achievement*; (7) *the contribution of PD programs to teachers' CK and student achievement*; and (8) *the development and validation of teacher CK instruments*.

Studies within the first research line describe teachers' CK based on a pre-defined conceptualization of CK. For the most part, the first research line comprises studies which aim at assessing the level of teachers' CK in a specific subject (e.g., Casey & Wasserman, 2015; Baturo & Nason, 1996; Diamond, Maerten-Rivera, Rohrer, & Lee, 2013; Leinhart & Smith, 1985). The second research line examines the development of teachers' CK during their pre-service training and/or career (e.g., Arzi & White, 2008; Guberman, 2016). The third research line comprises studies that sought to identify differences in teachers' CK by recruiting contrasting populations, e.g., in-service and pre-service teachers (e.g., Aslan-Tutak & Adams, 2015; Auslander, Smith, Smith, Hart, & Carothers, 2016; Bos, Mather, Dickson, Podhajski, & Chard, 2001; Buchholtz et al., 2013; Charalambous, 2016; Hoz, Tomer, & Tamir, 1990; Kleickmann et al., 2013; Krauss, Baumert, & Blum, 2008; Leinhart & Smith, 1985; Rice, 2005), while, the fourth research line investigates the relationship between teachers' CK and PCK (e.g., Capraro, Capraro, Parker, Kulm, & Raulerson, 2005; Even, 1993). The fifth research line addresses the relationship between teachers' CK and quality of instruction (e.g., Bartos & Lederman, 2014; Baumert et al., 2010; Gilbert & Gilbert, 2013; Hill et al., 2008b; Nowicki, Sullivan-Watts, Shim, Young, & Pockalny, 2013; Tatto, Nielsen, Cummings, Kularatna, & Dharmadasa, 1993), whereas, the sixth research line examines the relationship between teachers' CK and student learning/achievement (e.g., Baumert et al., 2010; Carlisle, Correnti, Phelps, & Zeng, 2009; Diamond et al., 2014; Heller et al., 2012; Hill et al., 2005; Lane et al., 2009; Mullens, Murnane, & Willett, 1996; Rowan, Chiang, & Miller, 1997; Sadler et al., 2013b; Tatto et al., 1993; Tchoshanov et al., 2017). Studies within the seventh research line investigate the contribution of PD programs to teachers' CK (Diamond et al., 2014; Garet et al., 2008, 2011; Heller et al., 2012; Faulkner & Cain, 2013; Greene, Lubin, Slater, & Walden, 2013; Hill & Ball, 2004; Khourey-Bowers & Fenk, 2009; Maerten-Rivera, Huggins-Manley, Adamson, Lee, & Llosa, 2015) and student achievement (Diamond et al., 2014; Garet et al., 2008, 2011; Heller et al., 2012; Koellner & Jacobs, 2015). Finally, the eighth research line comprises studies that sought to describe the development and validation procedures of instruments measuring teachers' CK (e.g., Diamond et al., 2013; Duguay, Kenyon, Haynes, August, & Yanosky, 2016; Ekawati, Lin, & Yang, 2015; Groth & Bergner, 2013; Hill et al., 2004; Jüttner, Boone, Park, & Neuhaus, 2013; Maerten-Rivera et al., 2015; Phelps & Schilling, 2004; Sadler et al., 2013a; Steele, 2013).

Surprisingly, research seeking to identify links between improved teacher CK (through a PD intervention) and student achievement is limited. To the best of our knowledge, over a period of almost 40 years (i.e., from 1980 to 2017), only four content-focused PD studies were conducted in general education, which involved measuring both teacher CK and student achievement (i.e., Diamond et al., 2014; Garet et al., 2008, 2011; Heller et al., 2012).

Research Methods Used to Capture CK

The research methods used to capture teachers' CK included: (1) tests; (2) interviews; (3) lesson observations (using videotaped lessons); (4) concept maps; (5) card sorting; and (6) writing prompts. As it can be observed in Table G1 (see Appendix G), six studies used interviews to elicit teachers' CK (Arzi & White, 2008; Baturo & Nason, 1996; Casey & Wasserman. 2015; Even, 1993; Hoz et al., 1990; Leinhart & Smith, 1985). Interviews, as a tool to capture teachers' CK or the change in teachers' CK, included: (a) a sequence of specific tasks, i.e., task-based interviews (Baturo & Nason, 1996; Casey & Wasserman, 2015); (b) stimulated recalls via taped lessons, planning and evaluation of teachers' lessons, and fraction knowledge (Leinhart & Smith, 1985); (c) clarifying questions regarding answers to a questionnaire and gathering more information on questions that were too difficult to answer via a written questionnaire (Even, 1993); and (d) building concept profiles – a word-association method (Arzi & White, 2008) or concept maps (Hoz et al., 1990).

In addition, lesson observations were used in four studies (i.e., Diamond et al., 2013; Diamond et al., 2014; Leinhart & Smith, 1985; Nowicki et al., 2013). Lesson observations were used in three studies in order to measure the extent to which the teacher had an accurate and comprehensive grasp of the science content of the lesson (i.e., Diamond et al., 2013; Diamond et al., 2014; Nowicki et al., 2013), while, in one study lesson observations were used for the development of semantic nets (i.e., concept maps) that reflected teachers' knowledge of fractions (Leinhart & Smith, 1985).

Furthermore, card sorting was used in a single study (Leinhart & Smith, 1985). The card sorts consisted of 40 math problems randomly selected from the computational sections of 4^{th} Grade textbooks. The teachers were asked to sort the problems and give a rationale for their sorts. The data gleaned from the mathematics card sorts were used: (a) to determine patterns of knowledge and understanding as well as confusion and misunderstanding; and (b) to confirm the presence of a particular hypothesized concept or relationship in constructing teachers' semantic nets. To the same end, a recent study (i.e., Groth & Bergner, 2013) utilized 'writing prompts' on assigned teacher-oriented articles to collect data on participants' thinking (as they were in the process of constructing the intended CK and PCK elements for a statistics course). Relationships among knowledge elements held by each participant were displayed through the use of node-link diagrams (e.g., Nesbit & Adesope, 2006).

Moreover, concept maps were used in two studies (Greene et al., 2013; Shymansky et al., 1993). A concept map is a two or three-dimensional spatial or graphic display that makes use of labeled nodes to represent concepts and lines or arcs to represent relationships between pairs of concepts (cf. Novak & Cañav, 2008). Contrary to other studies that used concept maps (Hoz et al., 1990) or variations thereof (i.e., concept profiles: Artzi & White, 2008; node-link diagrams: Groth & Bergner, 2013; semantic nets: Leinhart & Smith, 1985) to display teachers' CK as captured through other methods (i.e., interviews, lesson observations, writing prompts), in these two studies the participating teachers constructed their personal concept maps of targeted science topics.

Importantly, out of 51 CK studies included in this review, the 38 studies used a test to assess the level of teachers' CK. Another four studies used a set of instruments/techniques to capture teachers' CK, including a test. Thus, we can infer that tests comprise the main research method used to directly measure teachers' CK over time and across subjects. This is not surprising, since lesson observation and interviews can be very time-consuming and expensive (cf. Desimone, 2009).

The questions that were used in the CK tests can be classified into three general categories: (1) *objective questions*, i.e., close-ended questions (e.g., multiple-choice questions, true-false questions); (2) *semiobjective questions* (e.g., short-answer questions); and (3) *essay questions*, i.e., open-ended questions (Lacy, 2011; Morrow, Jackson, Disch,

& Mood, 2011). Regarding the use of the above types of questions we observe the following: objective questions were used in 19 studies, whereas, essay questions in eight studies; a combination of two or three different types of questions (i.e., objective questions, semiobjective questions, and/or essay questions) was used in 13 studies; in two studies the type of the questions that were used in the tests was not specified (i.e., Mullens et al., 1996; Strauss & Sawyer, 1986).

Moreover, *multiple-choice* seems to be the main question format used in the CK tests. Specifically, 30 out of the 42 studies that measure teachers' CK with a test use exclusively (16 studies) or mainly (14 studies) multiple-choice questions. Despite the concerns raised in the literature regarding the use of multiple-choice questions to measure teachers' CK (cf., Buchholtz et al. 2013; Charalambous, 2016; Fauskanger, 2015; Hill et al., 2008b; Steele, 2013), multiple-choice tests are used widely and for many purposes: "placement, selection, awards, certification, licensure, course credit (proficiency), grades, diagnosis of what has and has not been learned, and even employment" (Haladyna, 2004, p. ix). If multiple-choice questions are properly written, they discourage guessing more than other objective formats (Lacy, 2011), and can access higher taxonomies of knowledge (cf. Haladyna, 2004; Lacy, 2011). In addition, multiple-choice questions are easier to score than essay and semiobjective questions, since scoring is relatively free of any subjective decision (Lacy, 2011; Morrow et al., 2011). That is, the scorer simply matches the examinee's response to a predetermined correct answer. Finally, it is an issue of debate whether objective questions (and particularly multiple-choice questions) can capture the depth and multi-dimensionality of teachers' knowledge. According to Morrow and his colleagues (2011), although it is often more difficult to construct, a test composed of objective questions can measure depth of achievement as well as a test comprising essay questions. "In short, the type of studying promoted by a test is more a function of the quality of the questions than the type of questions" (Morrow et al., 2011, p. 149).

The Main Research Findings

This section presents research findings which are relevant to the scope of the present study. In particular, we present results concerning: (a) the relationship between teachers' background characteristics and teachers' CK; (b) the relationship between teachers' background characteristics and student achievement; (c) the relationship between participation in CK PD programs and teachers' CK; and (d) the relationship between teachers' CK and student achievement.

The relationship between teachers' background characteristics and teachers' CK. Relevant to the exploration undertaken herein are findings concerning the relationship between teachers' background characteristics and teachers' CK. Specifically, researchers explored variables such as, *gender* (i.e., Carlisle et al., 2009) *teacher certification* (Carlisle et al., 2009; Hill et al., 2005), *teacher qualifications* (Carlisle et al., 2009; Diamond et al., 2014), *teacher coursework* (Diamond et al., 2013, 2014; Hill et al., 2005; Maerten-Rivera et al., 2015; Nowicki et al., 2013; Rice, 2005), and *teaching experience* (Bos et al., 2001; Carlisle et al., 2009; Diamond et al., 2014; Hill et al., 2005; Hoz et al., 1990).

The pertinent research findings, for the most part, converge to suggest that the above teachers' background characteristics are not significantly correlated with teachers' CK (Carlisle et al., 2009; Diamond et al., 2013, 2014; Hill et al., 2005; Hoz et al., 1990; Nowicki et al., 2013; Rice, 2005). Contradictory results were reported by Bos and her colleagues (2001), who found that in-service teachers with more than 11 years of teaching experience demonstrated significantly higher knowledge scores than their counterparts with one to five years of experience.

The relationship between teachers' background characteristics and student achievement. Regarding the relationship between teachers' background characteristics and student achievement, researchers explored variables, such as *teacher certification* (Hill et al., 2005), *teacher qualifications*, i.e., degree level: bachelor, master, doctoral degree

(Monk, 1994; Rowan et al., 1997), *teacher coursework* (Begle, 1979; Diamond et al., 2014; Hill et al., 2005; Monk, 1994), and *teaching experience* (Diamond et al., 2014; Hill et al., 2005; Monk, 1994).

The pertinent results reveal that teacher content preparation (as measured by the number of courses a teacher took in the subject area being taught) significantly correlate to student achievement (Monk, 1994). Particularly, Monk's analysis showed that each undergraduate mathematics course a teacher takes is associated to .04% gain in student achievement. According to a meta-analysis, research findings on mathematics suggest that high school students learn more from teachers with more mathematics-related coursework (Wayne & Youngs, 2003). However, the number of methods courses that teachers had taken were found to relate to student performance more so than the content courses in which they had been enrolled (cf. Begle, 1979; Monk, 1994). In contrast, Diamond et al. (2014) found that the number of science courses taken in college by a teacher was not a statistically significant predictor of student achievement. Likewise, Hill et al. (2005) found that methods and content coursework was unrelated to students' achievement in mathematics.

Furthermore, relevant to the scope of the present study are previous studies' results concerning teaching experience. Two meta-analyses (Rice, 2003; Wayne & Youngs, 2003) found that teaching experience (measured in years) generally had a positive effect on student achievement. However, Wayne and Youngs (2003) suggested that findings concerning teaching experience were too difficult to interpret. Diamond and colleagues' (2014) findings point to the same direction. Specifically, these researchers found that the number of years teaching had a small but positive impact on student science achievement. Additionally, Monk (1994) reported that teaching experience had an inconsistent effect on student achievement, depending on the year. In particular, for sophomores it had no effect, while, for junior level mathematics, the effect was positive. Finally, contradictory findings were also reported by Hill and her colleagues (2005). This study's results indicate that years of teaching experience were not significantly related to Grade 1 student achievement, whereas, they were significantly related (marginally; p=.11) to Grade 3 student achievement.

The relationship between participation in PD programs and teachers' CK. Research findings concerning the contribution of PD programs to teachers' CK, suggest that the participation in a PD program generally had a significant positive effect on teacher CK (Diamond et al., 2014; Garet et al., 2008; Heller et al., 2012; Faulkner & Cain, 2013; Greene et al., 2013; Hill & Ball, 2004; Khourey-Bowers & Fenk, 2009; Maerten-Rivera et al., 2015). These findings were consistent regardless the study design (i.e., randomized controlled trial design or one group pre-test/post-test design), the method used to capture teacher CK (i.e., test or concept map), the method of data analysis (i.e., inferential analysis, hierarchical linear model analysis, IRT analysis) or the subject area (i.e., mathematics, life/physical sciences or early reading).

For example, Heller and colleagues (2012) implemented a randomized experiment to compare three PD models (i.e., 'teaching cases', 'looking at student work', and 'metacognitive analysis'). The three interventions (i.e., courses) comprised identical science content, but differed in the ways they incorporated analysis of learner thinking and of teaching. Results indicated that all three treatment groups had gains in science CK well beyond the control groups. A follow-up indicated that the effects were maintained a year later. Similarly, Diamond and colleagues (2014) found that a curricular and PD intervention had a significant effect on the treatment group teachers' science CK as measured by test scores and self-reported science knowledge. Surprisingly, participation in the PD intervention did not have a significant effect on the classroom observation ratings. The observation scales that were used for the purposes of the specific study measured the extent to which the teacher had an accurate and comprehensive grasp of the science content of the lesson. In fact, the teacher science test scores predicted 6% of the variance found between teachers' mean student science test scores (see the following section), while, the classroom observations did not predict student science achievement outcomes. Based on these findings, Diamond et al. (2014) suggested that classroom observations are less effective for measuring teachers' CK than more cost-effective, easier methods such as knowledge tests.

Contradictory results were reported by Garet and colleagues (2011) concerning the impact of a two-year PD program on teacher knowledge. Specifically, at the end of the second year of implementation, there were no statistically significant impacts on teachers' total score on a specially constructed teacher knowledge test. However, exploratory analyses based on a pooled sample, which combined data from the first and second year of the study, suggested that on average, each year of the PD had a statistically significant positive effect on teachers' specialized knowledge for teaching mathematics (i.e., SCK). No statistically significant effects were found regarding teachers' common knowledge of mathematics (i.e., CCK).

The relationship between teachers' CK and student achievement. Fifteen studies included in this review of literature sought to investigate the relationship between teacher CK and student achievement (Baumert et al., 2010; Carlisle et al., 2009; Diamond et al., 2014; Garet et al., 2008, 2011; Heller et al., 2012; Hill et al., 2005; Lane et al., 2009; Mullens et al., 1996; Rowan et al., 1997; Sadler et al., 2013a, 2013b; Strauss & Sawyer, 1986; Tatto et al., 1993; Tchoshanov et al., 2017). The majority of these studies (i.e., 9 out of 15) found that teacher CK is critical for student achievement.

For example, by applying multilevel analysis, Hill et al. (2005) showed that elementary teachers' mathematical knowledge for teaching predicted students' learning gains in two different grades; in fact, the effect was practically linear. This result was obtained via a measure focusing on the specialized mathematical knowledge and skills used in teaching mathematics. Moreover, Heller et al. (2012) used a PD intervention in which teachers learned about circuits through hands-on inquiry-based investigations. Participation in the PD resulted in a test score gain (i.e., from pre-test to post-test) of 22% for treatment group teachers, compared to 2.4% for control group teachers. Significantly, teachers' CK gains were maintained a year after the PD. Likewise, treatment group students showed an improvement of about 7% over the control group students. Actually, a hierarchical linear model analysis was conducted to reveal that teacher CK was a significant predictor of student test scores.

However, the findings of six studies (i.e., Baumert et al., 2010; Carlisle et al., 2009; Garet et al., 2008, 2011; Sadler et al., 2013a, 2013b) raise doubts on the contribution of teacher's CK to student achievement. Particularly, Baumert et al. (2010) concluded that the correlation between teachers' PCK and their instructional approaches as well as students' learning outcomes was significantly higher than the correlation with teachers' CK. Similarly, Sadler et al. (2013a, 2013b) found that on items that students exhibit misconceptions, the teachers who could identify the specific misconceptions (which they term as PCK) had larger classroom gains, much larger than if the teachers knew only the correct answers (i.e., CK). In addition, Carlisle and her colleagues' (2009) findings indicated that performance on a teacher knowledge test did not significantly explain students' improvement on two reading subtests. Finally, Garet and colleagues (2008, 2011) found that teachers' participation in content-based PD programs did not have a statistically significant impact on student achievement, although in one case positive impacts were found on teacher's knowledge (Garet et al., 2008).

Interestingly, five out of these six studies define, and thus measure, teacher CK in the same manner. First, the test used by Baumert et al. (2010) to assess teacher CK consisted of 13 items covering arithmetic (including functions), measurement, algebra, geometry, and probability. All items required complex mathematical argumentation or proofs. Second, Carlisle et al. (2009) and Garet et al. (2008) used tests which measured teachers' phonemic awareness, phonics, fluency, vocabulary, and reading comprehension. Finally, Sadler and colleagues (2013a, 2013b) captured teacher's CK using a middle school classroom assessment. This assessment was designed to measure the understanding of physical science concepts and related common misconceptions. In this study, teachers' PCK was captured by using teachers' prediction of the most common wrong answers of their students.

In other words, these studies consider CK to include only the knowledge described under the construct of CCK. As described in a previous section, Ball et al. (2008) and Ward (2009) reconceptualized teachers' CK to include apart from the CCK – which in the case of PE includes the knowledge of rules, etiquettes, safety, techniques, and tactics – SCK (i.e., knowledge of students' errors and instructional tasks). Actually, Carlisle and her colleagues (2009) acknowledge that "the content of the measure might not capture the knowledge that teachers use to teach reading to their students; this might explain why performance on the measure was not related to students' gains in reading" (p. 475). Furthermore, Sadler et al. (2013a, 2013b) termed the knowledge of students' misconceptions as PCK. Instead, Ball and Ward's research teams consider this type of knowledge to be SCK, which for them is a component of CK.

Thus, we suggest that what is measured (or provided) as teacher CK is a key aspect in investigating links between teacher CK and student acchievement. In other words, it seems that CCK is not as good predictor of student achievement as SCK. For the purposes of this study, we draw on Ward's (2009) four-domain CK conceptualization in PE. By doing so, we sought to develop a scale to directly measure in-service teachers CK in basketball, which includes both CCK and SCK in basketball.

Moreover, in Garet and colleagues' (2011) study, although teacher CK was measured and provided under both dimensions of CCK and SCK, the participation in a content-based PD program was not found to have statistically significant impact on student achievement. While it is unclear what the researchers define as SCK, Desimone and Garet (2015) provide a possible explanation concerning the above unexpected finding. In particular, they suggest that the specific PD program might not have helped teachers to translate the knowledge or strategies into daily instructional routines and lessons. Taking this into consideration, the PD program designed for the purposes of this study provided a series of opportunities regarding the transfer of the knowledge gained to classroom practice (e.g., development of task progressions, development of lesson plans, reflection on teaching).

Investigating CK in PE

This section reviews investigations of CK in PE. Three education databases (ERIC, SCOPUS and SPORT DISCUS) were used to locate studies published in peer-reviewed journals, conferences proceedings and dissertation databases. Several terms were used including 'teacher knowledge', 'subject matter knowledge', 'content knowledge' combined with 'physical education', 'physical activity' and 'sport'. Following the same procedure as in general education CK studies, after the initial search, materials were scanned to eliminate studies (in) which: (a) CK was not the focus of the investigation; (b) did not include measurement or manipulation of teachers' CK (i.e., through a PD program or a university course); and (c) were carried out before1980. Finally, the reference lists of the included articles were cross-checked to discover additional studies that were not revealed during the initial search; 22 studies were selected for final review.

For the purposes of this section, each article was summarized in a classification scheme including seven aspects: (1) the research purpose/questions of the CK studies; (2) the definition of CK; (3) the number and nature of participants/level of education; (4) the research method that was used to capture or manipulate CK and/or student achievement; (5)

the techniques used to analyze the data; (6) the PE content that was investigated; and (7) the main research findings. All these aspects are presented in Table G2 (see Appendix G).

Research Purpose/Questions of the CK Studies

An analysis of the research questions of the studies revealed that CK research in PE is organized along seven major research lines: (1) *the nature and level of teacher CK*; (2) *the development of teacher CK*; (3) *the differences in teachers' CK*; (4) *the relationship between teacher CK and background characteristics*; (5) *the relationship between CK and PCK*; (6) *the relationship between teachers' CK* (i.e., CK workshop), *teachers' enacted PCK* (i.e., teaching practices) *and student learning/achievement*; (7) *development and validation of teacher CK instruments*.

Studies within the first research line describe teachers' CK based on a pre-defined conceptualization of CK. For the most part, the first research line comprises studies which aim at assessing the level of teachers' CK in PE and/or in physical activity (PA) and health-related fitness (HRF), e.g., Castelli & Williams, 2007; Kim & Ko, 2017; Santiago et al, 2009, 2012a; Stefanou, 2014; Stefanou et al., 2015. The second research line examines the development of teachers' CK during their pre-service training and/or career (e.g., Hart, 2005; Hunuk et al., 2013; Webster, 2017), whereas, the third research line aims to identify differences in teachers' CK by recruiting contrasting populations, e.g., in-service and pre-service teachers (Miller & Housner, 1998; Santiago, Morales, & Disch, 2012b). The fourth research line investigates the relationship(s) between teachers' background characteristics (e.g., gender, course work, teaching experience, prior playing or league-playing experience) and CK (e.g., Li et al., 2013; Santiago et al., 2009, 2012a; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007). Studies within the fifth research line seek to investigate the relationship between teachers' CK and PCK (e.g., Hunuk et al., 2013; Kim, 1996), while, the sixth research line addresses the relationship between teachers' CK, quality of instruction and student learning/achievement by manipulating the level of teachers' CK through a PD intervention, i.e., CK workshop (e.g., Iserbyt et al., 2017; Iserbyt et al., 2016; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015). Finally, studies within the seventh research line describe the development and/or validation procedures of instruments measuring teachers' CK (e.g., Li et al., 2013; Stefanou et al., 2015; Ward et al., 2017).

The Definition of CK

More than half of the studies (13 out of 22) included in this review, build on Ball and colleagues' (2008) conceptualization of mathematical knowledge for teaching and on Ward's (2009) definition of CK in PE. Two studies (Castelli & Williams, 2007; Hunuk et al., 2013) refer to Shulman's (1986, 1987) definition of CK, one study (Kim, 1996) draws on Siedentop's (1989/2002) broad definition of CK in PE, and remarkably, in six studies CK is not defined at all (i.e., explanation of what is meant by the concept is not given). As mentioned in the previous section, Ward (2009) extended the definition of CK in PE to include, apart from the knowledge of rules, etiquettes, safety, techniques, and tactics (i.e., CCK), the knowledge of students' errors and instructional tasks (i.e., SCK). A number of studies measuring teachers' CK in PE (e.g., Hunuk et al., 2013; Kim, 1996; Santiago et al., 2012a) consider CK to include only the knowledge described under the construct of CCK.

Participants – Level of Education

In 19 out of the 22 CK studies, the participants were PE specialists. In only three studies (Hart, 2005; Stefanou, 2014; Stefanou et al., 2015) the participants were generalist teachers. Furthermore, in-service teachers participated in 12 studies, and pre-service teachers in six studies. Four studies included both pre-service and in-service teachers. Moreover, ten studies were conducted within secondary school settings, six studies within elementary school settings and two studies in both settings. In four studies the educational level is not specified.

What is striking is the lack of CK studies in PE concerning generalist teachers. Taking into consideration that in many countries, including Cyprus, it is the job of generalist teachers to offer PE in elementary schools (Hardman, 2005; Hardman & Marshall, 2001), the lack of CK studies regarding generalist teachers is deemed as a significant research gap. Moreover, as it can be observed in the participants' column (see Table F2), the teachers sample sizes that were used in the intervention CK studies range from one to four participants. With these sample sizes per study, generalizations and interpretations of findings should be evaluated with care. Importantly, this limitation is acknowledged by the researchers who conducted the specific studies (e.g., Iserbyt et al., 2017; Kim, 2016; Sinelnikov et al., 2016; Ward et al., 2015). In fact, Iserbyt and colleagues (2017) suggested that future studies might increase the number of classes and teachers in their analysis.

Research Methods Used to Capture CK

The research methods used to capture teachers' CK included: (a) close-ended tests with multiple-choice questions (e.g., Kim, 1996; Li et al., 2013; Miller & Housner, 1998; Santiago et al., 2012a; Stefanou et al., 2015; Stuhr et al., 2007); (b) open-ended tests (Castelli & Williams, 2007; Hart, 2005; Hunuk et al., 2013); (c) instructional tasks assessment forms (Kim & Ko, 2017); and (d) content maps (Ward et al., 2017).

As it can be observed, the majority of CK studies in PE used a test (close- or open-ended) to assess teachers' level of CK in various content areas. The instructional tasks assessment form that was used by Kim and Ko (2017) comprised four tasks: (1) listing as many instructional tasks as possible to teach three manipulative skills; (2) clarifying each task's intention (i.e., what to do – content; where to do – context; and how well to do – criteria); (3) listing the tasks in an appropriate sequence ranging from simple (easy) to complex (difficult); and (4) specifying a grade level for each task to be taught. In addition, Ward et al. (2015) introduced content maps as a teaching and assessment tool for CK (particularly SCK). In a recently published article, Ward and colleagues (2017) described the methods for establishing the reliability and validity of content maps as a measurement tool. A content map, which is a concept map's modification (Novak & Gowin, 1984), is a graphic organizer of SCK that describes: (a) the instructional task progressions for teaching basic skills and tactics for a particular sport or activity; and (b) the relationships between skills (e.g., when the forearm pass and the set are to be combined) and/or tactics (Ward et al., 2017).

Finally, in the intervention PD studies, teachers' CK was not assessed (with the exception of Hunuk et al., 2013). In these studies, middle and high school physical educators were first observed teaching their standard units in soccer, badminton, volley or swimming. After that, they were taught relative CK (i.e., CCK and SCK) in PD workshops. The teachers were observed teaching new classes, this time using the CK that they had gained in the workshops.

Research Methods Used to Capture Student Achievement

In most of the studies, student achievement was measured in terms of students' practice trials (e.g., correct trials). Although students' correct trials were found to have a strong and positive relationship with student achievement (Ashy, Lee, & Landin, 1988; Buck, Harrisson, & Bryce, 1990; Silverman, 1985), they constitute a measure of student engagement with specific skills (Silverman, 1985) and can therefore be considered as a proxy variable of student achievement.

However, different approaches were used by Kim (2016) and Iserbyt et al. (2016) to capture student achievement. Specifically, Kim (2016) used the Game Performance Assessment Instrument (Griffin, Mitchell, & Oslin, 1997) to collect students' game performance data during the last 10–15 minutes of game play in each videotaped lesson. Student daily content quizzes (comprising two or three multiple choice or short answer questions regarding on- and off-the ball skills and movements) were also provided to students at the end of every class.

Moreover, Iserbyt et al. (2016) used the following swimming performance indices: (a) students' number of strokes over 50 m in lesson 1 and 10; (b) 50 m sprint time in lessons 1 and 10; and (c) the number of laps swum per student in all the lessons. For example, the researches argue that 'a reduction in stroke rate for the same speed represents an increase in effectiveness of the swimming technique because the swimmer covers more distance per stroke' (Iserbyt et al., 2016, p. 546). The specific performance indices can be described as *product-oriented.* That is, they only measure the product of the task (e.g., the speed at which a performer completes a task) and not the correct form (i.e., critical elements) of the observed skill (Morrow et al., 2011).

The Techniques Used to Analyze the Quantitative Data in CK Studies

For the analysis of data, most of the studies used descriptive statistics and inferential analysis. In addition to descriptive statistics and inferential analysis, two studies used correlational analysis (Castelli & Williams, 2007; Kim, 1996). Only five studies used the following advanced techniques for the analysis of data: repeated ANOVA (Hunuk et al., 2013), IRT analysis (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015) and multiple regression analysis (Kim, 1996).

The PE Content that was Investigated

The 22 CK studies included in this review were conducted within or in relation to the following content areas: (1) PA and/or HRF (Castelli & Williams, 2007; Hunuk et al., 2013; Miller & Housner, 1998; Santiago et al., 2009, 2012a, 2012b); (2) basketball (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007); (3) soccer (Lee, 2011; Stuhr et al., 2007); (4) volleyball (Kim, 1996; Kim, 2016); (5) badminton (Iserbyt et al., 2017; Kim, 2011; Ko et al., 2013; Sinelnikov et al., 2016; Ward et al., 2015); (6)

swimming (Iserbyt et al., 2016); (7) educational gymnastics (Webster, 2017); (8) manipulative skills (Kim & Ko, 2017); and (9) movement skills (Hart, 2005).

The Main Research Findings

This section presents research findings relevant to the focus of the present study. In particular, it presents results concerning: (a) the level of teachers' CK in PE; (b) the relationship between CK and background characteristics; and (c) results of CK intervention studies in PE.

The level of teachers' CK in PE. Findings concerning the level of in-service and pre-service teachers' CK in PE indicate deficiencies in HRF CK (Castelli and Williams, 2007; Miller & Housner, 1998), in PA and HRF CK (Santiago et al., 2009, 2012a, 2012b), in basketball CK (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007), in soccer CK (Stuhr et al., 2007), and in task knowledge for teaching elementary content (Kim & Ko, 2017). For example, Castelli and Williams (2007) studied 73 middle school PE teachers who were very confident in their knowledge of HRF, yet they did not meet the standards expected of 9th Grade students. Not surprisingly, the largest amount and variety of teachers' errors appertained to a part of the test that required the design of a 9-week physical activity program.

The relationship between teachers' background characteristics and teachers' CK in PE. In the last two decades, researchers sought to identify possible teachers' background variables that could explain variation in teachers' CK in PE. In particular, background information was collected on in-service and pre-service teachers including variables such as: (a) *gender* (Castelli & Williams, 2012; Li et al., 2013; Santiago et al., 2009, 2012a; Stefanou, 2014; Stefanou et al., 2015); (b) *coursework,* i.e., the number of PE methods and content courses taken during their studies (Stefanou, 2014; Stefanou et al., 2015); (c) *qualifications*, i.e., degree level: bachelor, master, doctoral degree (Miller & Housner, 1998; Santiago et al., 2012a); (d) *prior playing or league-playing experience* (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007); and (e) *teaching experience* (Castelli & Williams, 2012; Santiago, et al., 2009, 2012a; Stefanou et al., 2015).

In PA and HRF studies, gender was found to be unrelated to CK of PA and/or HRF (Castelli & Williams, 2007; Santiago et al., 2009; 2012a). On the contrary, Stefanou (2014) and Stefanou and colleagues (2015) found that male pre-service and in-service generalist teachers scored significantly higher in a basketball CK test when compared to their female counterparts. Likewise, Li and colleagues (2013) found that men scored better in three out of four knowledge domains comprised in a basketball CK test.

Concerning teachers' coursework, Stefanou (2014) found that the group of pre-service generalist teachers who had taken two or more PE methods courses scored higher in basketball CK than those who took one course or no courses at all. However, the number of PE content courses that pre-service teachers had taken during their studies were not found to contribute significantly to the level of basketball CK. Nevertheless, when Stefanou and his colleagues submitted the same test to in-service generalist teachers, they found that the number of both PE methods courses and PE content courses that the teachers had taken during their studies, contributed to the teachers' level of CK in basketball (Stefanou et al., 2015).

Contradictory results were reported concerning the years of teaching experience. Specifically, Castelli and Williams (2012) and Santiago and colleagues (2009) found that PA and/or HRF CK was not significantly correlated with the years of teaching experience. In contrast, Santiago and colleagues (2012a) found that years of teaching experience significantly influenced CK of PA and HRF. Their analysis revealed that PE teachers with 6 to 19 years of teaching experience scored significantly higher than teachers with more than 19 years of teaching experience. Likewise, Stefanou and colleagues (2015) found that generalist teachers with 6 or more years of PE teaching experience exhibit a significantly higher level of basketball CK than the teachers with 5 or less years of PE teaching experience.

Contradictory results were also reported concerning teachers' qualifications. In particular, Santiago and colleagues (2012a) found that the level of education was not related to CK of PA and HRF. Yet, Miller and Housner (1998) found that Masters' students performed significantly better than postgraduate students. A trend analysis also indicated that knowledge increased significantly as a function of progressing through the teacher education program (Miller & Housner, 1998).

Finally, all the studies investigating the contribution of prior playing or league-playing experience to teachers' CK (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007) converge to the same conclusion: the teachers with more playing experience in a content area possess a higher CK level in the specific content area. For example, Stefanou (2014) found that the pre-service generalist teachers, who reported playing basketball in a team or playing regularly pick-up games for amusement/exercise, scored higher in CK compared to those who reported little or no prior playing experience.

Results of intervention CK studies. Hunuk and colleagues (2013) primarily sought to examine the effects of a community of practice (CoP) on physical educators' and their students' HRF CK. According to Lave and Wenger (1991), a CoP is formed by people who engage in a process of collective learning in a domain of interest. Through CoPs teachers share experiences, resources, and work related to their shared interest (Wenger, 1998). Using Wenger's framework of a CoP, Hunuk et al. (2013) found that teachers' participation in a CoP increased both their CK and their students' HRF CK. More insights concerning the structure and content of the specific CoP are presented in a following section.

Furthermore, recent interventional studies (i.e., Iserbyt et al., 2017; Iserbyt et al., 2016; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015) provide the first evidence in PE that improving a teacher's CK and especially SCK contributes to gains in student learning. In those studies, middle and high school physical educators were first observed teaching their standard PE units in soccer, badminton, volley or swimming. Then, they were taught CK for the specific content areas in PD workshops using knowledge packets. A knowledge packet constitutes a body of knowledge, in specific PE content, that contains both CCK and SCK that is appropriate for a particular grade context, such as upper elementary or middle school (Iserbyt et al., 2016). Following the workshops, the teachers were observed teaching new classes, this time using the CK that they had gained in the workshops.

The results of the intervention studies indicated that the CK workshops affected the teachers' CK and enacted PCK. That is, the improved teachers' CK lead to improvement in teachers' enacted PCK in terms of: (a) maturity of task representations (i.e., verbal task representations: instructions, descriptions, analogies/metaphors, cues, and congruent feedback; visual task representations: correct demonstrations, partially correct demonstrations, incorrect demonstrations, the use of task cards); (b) appropriateness of the tasks (i.e., developmental appropriate: suitable for students' age and individual capabilities; principle appropriate: using fundamental principles of play practice); and (c) appropriateness of task adaptations (i.e., inter-task adaptations and intra-task adaptations). For more details on these variables, see Ayvazo and Ward (2011) and Kim (2011).

In addition, Kim (2016), who used a mixed-method design, found that a 3-hour CK workshop changed a teacher's enacted teaching practices in the following manner: (a) from less content progression to more content progressions; (b) from fewer content adaptations to more content adaptations; (c) from isolated practices to integrated practices; (d) from full-sided games to small-sided games; and (e) from less diverse verbal repertoires to more diverse verbal repertoires. The specific themes that demonstrate the teacher's quality of instruction emerged by analyzing the pre-and post-intervention teacher qualitative data (e.g. interview transcripts, lesson transcripts, and field notes).

Finally, the intervention studies' findings showed that the improved teachers' enacted PCK positively influenced student learning. Specifically, it was consistently found that the students in the experimental classes had a higher percentage of correct trials than those in the comparison classes, and conversely, students in the comparison groups had a higher percentage of incorrect trials than those in the experimental groups. These findings are deemed important since correct trials are associated with student achievement in PE (e.g., Ashy et al., 1988; Buck et al., 1990; Silverman, 1985). Kim's (2016) and Iserbyt and colleagues' (2016) findings point to the same direction. In particular, Kim (2016) reported gains in student learning in terms of: (a) appropriate decision-making, skill execution, and support movements during volleyball game play; and (b) a better cognitive understanding of techniques and tactics. Likewise, Iserbyt and colleagues (2016) found that the students in the experimental classes demonstrated a significant reduction of their number of strokes on 50 m, which indicates an increase in effectiveness of the swimming technique, and swam significantly more laps than the students in the comparison classes.

Teacher Professional Development

In this section, research work on teacher PD is reviewed, since this study aims at investigating the contribution of a content-focused PD program to teacher CK and student achievement. Specifically, the following are presented: definition of teacher PD; importance of teacher PD; holistic approaches to the comparison and classification of PD models; and features and findings of high-quality PD in both general education and PE.

> […] professional development is about teachers learning, learning how to learn, and transforming their knowledge into practice for the benefit of their students' growth. Teacher professional learning is a complex process, which requires cognitive and emotional involvement of teachers individually and collectively, the capacity and

willingness to examine where each one stands in terms of convictions and beliefs and the perusal and enactment of appropriate alternatives for improvement or change. (Avalos, 2011, p.10)

PD refers to a variety of educational experiences designed to enhance teacher knowledge and skills, quality of instruction and student achievement (Darling-Hammond & McLaughlin, 2011; Guskey, 2000; Patton & Parker, 2015; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Pointing to the importance of PD for teachers Darling-Hammond (2000) indicated that "the effects of well-prepared teachers on student achievement can be stronger than the influences of student background factors, such as poverty, language background, and minority status" (p. 33). Currently, there is a general consensus among policymakers, scholars, and educators that improving the quality of teachers' career-long professional learning is pivotal in enhancing the quality of instruction, and thus, student achievement (Bautista & Ortega-Ruiz, 2015). Acknowledging this, many countries around the world are investing in the continuous PD of their teachers as a major mechanism for the improvement of both teacher and student outcomes (Borko, 2004; Darling-Hammond et al., 2010).

Despite the widespread recognition of its importance, the PD programs currently available to teachers can be described as "woefully inadequate" (Borko, 2004, p. 3). In particular, most PD opportunities remain poorly aligned with curricula and classroom practice, fragmented, and inadequate to meet teachers' needs (Borko, 2004; Creemers et al., 2013; Patton & Parker, 2015). A particular target for criticism is the prevalence of *one-shot* PD – one-day workshops, seminars, or conferences, in which teachers tend to be passive recipients of knowledge, having no opportunities to collaborate with others or receive feedback (Armour & Yelling, 2007; Ball & Cohen, 1999; Bautista & Ortega-Ruiz, 2015; Garet et al., 2001; Yoon et al., 2007). Darling-Hammond (2010) referred to these models of PD as the "spray and pray approach", and Ball and Cohen (1999) described them as "intellectually superficial". Likewise, Patton and Parker (2015) argued that one-day PD models "most often fall short of having any lasting influence on teaching practices and reduce teachers to the status of technicians who deliver the thoughts of others" (p. 24).

Taking into account the above, it is deemed important to identify in the literature features of "high-quality PD programs" (e.g., Desimone, 2009; Desimone & Pak, 2017; Garet et al., 2001) or features of "effective PD" (e.g., Guskey, 2003; Patton & Parker, 2015) – that is, PD features that are based on empirical evidence and linked to both teacher and student learning outcomes (Armour & Yelling, 2007). These features can provide a starting point for designing and judging the effectiveness of PD programs (Patton & Parker, 2015). To this end, features of high-quality PD for both general education and PE are presented in the following sections. However, before elaborating on the above aspects, we briefly present in the next section some recent holistic approaches to the comparison and classification of PD models.

Holistic Approaches to the Comparison and Classification of PD Models

Several PD models exist (e.g., Armour & Yelling, 2004a; Darling-Hammond & McLaughlin, 2011; Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015) outlining the features of effective PD. However, while there is a growing body of literature concerning particular aspects of teacher PD, there is a dearth of literature addressing the spectrum of PD models in a comparative manner (Kennedy, 2014). Below, we briefly present some holistic approaches to the comparison of PD models.

One of the first scholars who described representative paradigms in teacher education and PD was Kenneth Zeichner (Creemers et al., 2013). Specifically, Zeichner (1983) identified the following four PD paradigms: the *craft paradigm*, which is based on the field experiences of teaching involving the trial and error of practitioners; the *expending the repertoire paradigm*, which focuses on the acquisition of comprehensive instructional models of teaching (e.g., direct instruction, inductive inquiry); the *competency-based paradigm*, which focuses on mastery of knowledge and teaching skills identified by expert academics and researchers; and the *holistic or reflective paradigm*, which emphasizes the development of teachers' capacity for reflective action. Moreover, Antoniou and Kyriakides (2011) proposed a PD approach – the *dynamic integrated approach* – which according to them, lies between the competency-based approach and the reflective approach. The *dynamic approach* to teacher PD emphasizes the acquisition of teaching skills that were found to be positively related with student achievement, and at the same time, the engagement into systematic critical reflection on teaching practices.

In addition, Park Rogers and colleagues (2010) suggested that PD models can be classified according to their orientation (i.e., orientation is comprised of project characteristics that drive the PD design and implementation for that project) and that there is a link between PD orientation and participant outcomes. In particular, the following five PD models were identified and described: the *activity-driven* model, which mainly engages teachers in hands-on activities intended for use with students; the *content-driven* model, which helps teachers learn new content and enhances teachers' understanding of selected concepts; the *pedagogy-driven* model, which encourages and models particular instructional strategies that would help teachers promote students learning; the *curriculum materials-driven* model, which focuses on helping teachers learn specific curriculum materials in order to use them in their classes; and the *needs-driven* model, in which teachers collaboratively assess their needs, and design and implement instruction (Mara et al., 2011).

Finally, Kennedy (2014) proposed a framework built around key characteristics of individual models of PD. The framework identifies a number of PD models, which are then classified according to their capacity for supporting professional autonomy and transformative practice. Specifically, Kennedy (2014) proposed the following nine PD models: *training* (i.e., a PD that emphasizes the acquisition of teaching skills); *award-bearing* (i.e., a PD that emphasizes the completion of award-bearing programs of study); *deficit* (i.e., a PD that is designed specifically to address a perceived deficit in teacher performance); *cascade* (i.e., a PD that involves individual teachers attending training events and then cascading the information obtained to colleagues); *standards-based* (i.e., a PD that emphasizes the empirical connections between teacher effectiveness and student learning); *coaching/mentoring* (i.e., a PD that acknowledges the importance of the one-to-one relationship, generally between two teachers, which is designed to support continuing PD); *community of practice,* i.e., CoPs can be described as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger, 2006, p. 1); *action research*, i.e., a PD that is driven by participants, collaborative at every stage, intending to result to some action, change or improvement on the issue being researched (Pain, Whitman, & Milledge, 2011); and *transformative* (i.e., a PD model that combines practices and conditions that support a transformative agenda).

The approach that we followed in designing the PD under investigation was more akin to the transformative model described by Kennedy (2014) – that is, we incorporated specific features in the PD's design that are based on empirical evidence and linked to both teacher and student outcomes. Thus, in the next section, features of high-quality PD both in general education and in PE are presented.

Key Features of Effective PD Programs

A review of the literature reveals that numerous efforts have been made to articulate lists of *key features* of effective PD for teachers (e.g., Armour &Yelling, 2004a; Darling-Hammond & McLaughlin, 2011; Desimone, 2009; Han, 2014; Hunzicker, 2011; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). These lists share common features to a high degree, and in many cases convincing empirical support is provided. However, we are going to present three prominent frameworks that are most relevant to the effort undertaken herein; the first framework comes from teacher PD in general education (Desimone, 2009), while the second and third, from teacher PD in PE (O'Sullivan & Deglau, 2006; Patton & Parker, 2015).

To start, Desimone (2009) described five core features of high-quality PD synthesized from cross-sectional studies, longitudinal studies, and literature reviews of experimental (i.e., randomized controlled trial) and quasi-experimental studies; i.e., *content focus, active learning, coherence, sustained duration*, and *collective participation* (Desimone & Pak, 2017). The specific framework was first presented by Birman, Desimone, Porter, and Garet (2000) and included *format* as a sixth feature (i.e., whether the PD was reform type, such as a study group or network, in contrast to a traditional workshop or conference). Based on insights gained from recent research that tested the specific features, a refined version of the original framework was proposed (Desimone, 2009; Desimone & Pak, 2017). As it was noted above, Desimone (2009) proposed the following five key features that make PD effective:

- ***content focus***: activities that are focused on subject matter content and how students learn that content;
- ***active learning:*** opportunities for teachers to observe and be observed, plan classroom implementation, receive feedback, analyze student work, or make presentations, as opposed to passively listening to lectures;
- ***coherence***: content, goals, and activities that are consistent with the school curriculum and goals, teachers' knowledge and beliefs, the needs of students, and school, district, and state reforms and policies;
- ***sustained duration***: PD activities that are ongoing throughout the school year and include 20 hours or more of contact time (i.e., of importance are both span of time over which the activity is spread and the number of contact hours spent in the activity);
- ***collective participation****:* groups of teachers from the same grade, subject, or school participate in PD activities together to build an interactive learning community.

Importantly, Desimone’s (2009) teacher PD framework incorporates both a theory of teacher change (e.g., that PD alters teacher knowledge, beliefs, or practice) and a theory of instruction (e.g., that changed practice influences student achievement).

Moreover, O’Sullivan and Deglau (2006) proposed a framework for designing PD programs. Specifically, based on findings of a 4-year-long PD initiative and on their reflections on experiences and understandings of the PD literature, O’Sullivan and Deglau (2006) suggested the following principles for the design and delivery of high-quality PD programs:

- ***Teachers should be treated as active learners*****:** Teachers should be treated as learners who construct their own meanings and understandings from active participation in the PD program rather than acting as passive recipients of ideas and curricula.
- ***Teachers should be empowered and treated as professionals and leaders:*** Teachers should be in a position to share their ideas, learn from each other, and challenge the purposes and underlying assumptions of educational change efforts. In other words, teacher educators should create a supportive climate in which teachers know that their views are encouraged and valued.
- ***Professional development must be situated in classroom practice****:* PD programs should take into account the contexts in which teachers work and the phases of teachers’ careers and personal lives. The phases of teachers’ careers and personal lives may affect what they can and are willing to do at certain points in time.
- ***Focus on content knowledge:*** Teachers should be engaged with specific meaningful tasks related to their daily work as teachers, some of which relate to the specific content they offer their students and how and why that content is organized and delivered as it is.
- ***Follow-up should be on site and sustained over time:*** The fact that most PE teachers work alone in a gymnasium does not encourage critical dialogue of their

own or others' teaching. The dialogue between teachers is a vital aspect of quality PD, and thus, it should be supported and nurtured.

- ***Pay attention to teacher and student teaching–learning contexts:*** The work of PD should be done in the setting closest to the real work of teachers (i.e., schools) rather than at the university. To create an authentic PD experience, the equipment and facilities available to teachers in the local school contexts should be used when revisiting approaches to assessment and instructional strategies or presenting new curriculum models.
- ***Balance the teachers' needs with a program vision for the PD initiative:*** PD programs should address teachers' needs while pushing forward on their goals. Presenting ideas to teachers that are feasible in their setting should be a key first step, but they should also see how this new "work" shall better their program, how they teach, and/or the experiences of their students.

Finally, based on PE research findings (e.g., O'Sullivan & Deglau, 2006; Parker, Patton, & Tannehill, 2012), Paton and Parker (2015) suggested specific core features of effective PD for PE. These features have been associated with changes in teacher knowledge, practice, and, in some cases, student achievement. Specifically, Patton and Parker (2015) presented the following eight features of effective PD:

- ***Core feature 1 - Effective PD is based on teachers' needs and interests*:** Providing opportunities for teachers to participate in decision-making regarding what they will learn, how they will learn, and how they will use what they learn has led to increased ownership of and commitment to PD's success (Armour & Yelling, 2007a; Deglau & O'Sullivan, 2006; Han, 2014).
- ***Core feature 2 - Effective PD acknowledges that learning is a social process*:** Participating in informal social events as an element of PD enhances trust among the stakeholders and strengthens collegial relationships. A PD, as a social environment, is

enhanced through collaborative learning and joint practice that encourage interactive feedback and discussion.

- ***Core feature 3 - Effective PD includes collaborative opportunities within learning communities*****:** Belonging to a learning community that extends beyond classrooms and school buildings, provides opportunities for collaboration and collective learning.
- ***Core feature 4 - Effective PD is ongoing and sustained*****:** Most PD targets in eliciting specific changes in teacher knowledge and instruction. To support this complex type of change, effective PD must be ongoing and sustained over time. Long-term PD is accompanied by an opportunity to practice the change (i.e., in-class implementation), subsequently bringing experiences back to the group for discussion.
- ***Core feature 5 - Effective PD treats teachers as active learners*****:** Effective PD gives opportunities to teachers to construct their own meaning and understanding from active participation – with a focus on inquiry and reflection - rather than acting as passive recipients of ideas and curricula (O'Sullivan & Deglau, 2006). Opportunities to engage in PD activities, such as observing and receiving feedback, and making presentations and/or writing a report are the essence of active learning. These opportunities can take a number of forms, including group discussions, hands-on activity sessions, observing expert teachers and/or being observed teaching, and curriculum development.
- ***Core feature 6 - Effective PD enhances teachers' pedagogical skills and CK*****:** Content – and pedagogy – specific PD opportunities provide meaningful learning experiences, some of which relate to the specific content teachers offer their students and how and why that content is organized and delivered (O'Sullivan & Deglau, 2006).
- ***Core feature 7 - Effective PD is facilitated with care*****:** Successful facilitation acknowledges how teachers actively construct new meaning based on prior

knowledge and experiences, and recognizes the influences of others in a nonjudgmental and social environment. Effective facilitators encourage teacher capacity building through engagement in self-improvement and student learning. A variety of pedagogical strategies are used by facilitators to aid teachers in becoming independent and lifelong learners.

- ***Core feature 8 - Effective PD focuses on improving learning outcomes for students*****:** An effective PD in PE should comprise activities which are designed and delivered to enhance both teacher and student learning. However, there is a dearth of sound, trustworthy, and scientifically valid evidence describing how PD affects pupil learning (Armour & Yelling, 2007; Guskey & Yoon, 2009; Yoon et al., 2007).

Importantly, the above core features are presented under three categories of effectiveness. In particular, features one to four refer to teachers' engagement, features five to seven to teaching practices, and feature eight to student learning (Patton, Parker, & Tannehill, 2015).

Table 2.1 summarizes Desimone's (2009), O'Sullivan and Deglau's (2006), and Patton & Parker's (2015) proposed features of high-quality PD. The specific table can be conceived as a map reflecting how a high-quality PD should look like. As it can be observed, the proposed PD features are supported by a wide range of research in the area of teachers' PD in general education and in PE. At the same time, one can instantly notice that high-quality PD in PE is no different than high-quality PD in general education. On the contrary, high-quality PD in both general education and PE share common features. We are not suggesting that these features are exhaustive in describing high-quality PD. They only represent a starting point for designing PD programs and judging whether they are effective (Patton & Parker, 2015).

Table 2.1

Features of High Quality PD in General and in PE

Features	Meaning/Sub-features	General education	Physical education
Content focus	Activities that are focused on subject matter content and how students learn that content	Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Capps, Crawford and Constas (2012)[a]; Desimone (2009); Guskey (2003)[a]	Coulter and Woods (2017); O’Sullivan and Deglau (2006); Patton and Parker (2015)
Active learning	Practicum (hands-on activities)	Birman et al. (2000); Desimone (2009)	Armour and Yelling (2004b); Patton and Parker (2015)
	Meaningful discussion (e.g., how they might transfer PD materials or experiences into their classrooms)	Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Capps et al. (2012)[a]; Desimone (2009)	O’Sullivan and Deglau (2006); Patton and Parker (2015)
	Reflection through discussion or journaling	Antoniou and Kyriakides (2011); Bautista and Ortega-Ruiz (2015)[a]; Capps et al. (2012)[a]; Darling-Hammond and McLaughlin (2011); Han (2014)	Armour and Yelling (2004b); O’Sullivan and Deglau (2006); Patton and Parker (2015)
	Planning (e.g., developing lesson plans)	Birman et al. (2000); Capps et al. (2012)[a]; Desimone (2009)	Patton and Parker (2015)
	Opportunities to observe and be observed teaching	Avalos (2011); Birman et al. (2000); Darling-Hammond and McLaughlin (2011); Desimone (2009)	Patton and Parker (2015)
	Meaningful analysis of learning (e.g., review student work, student misconceptions or common errors)	Antoniou and Kyriakides (2011); Birman et al. (2000); Desimone (2009)	Patton and Parker (2015)
	Meaningful analysis of teaching (e.g., receiving feedback on the implementation)	Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Desimone (2009); Han (2014)	Patton and Parker (2015)
	Present, lead or write (e.g., present a demonstration, lead a discussion, or write a report).	Birman et al. (2000); Desimone (2009)	Patton and Parker (2015)

Table 2.1 Continued

Features	Meaning/Sub-features	General education	Physical education
Coherence	Content, goals, and activities that are aligned to practice (e.g., the material the teacher is teaching), to the curriculum, and/or to teachers' knowledge and beliefs	Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Capps et al. (2012)[a]; Desimone (2009); Desimone and Garet (2015)	Armour and Duncombe (2004); Armour and Yelling (2004b); O'Sullivan and Deglau (2006)
Sustained duration	Providing teachers with sufficient opportunities for in-depth study, interaction, and reflection	Avalos (2011)[a]; Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Capps et al. (2012)[a]; Darling-Hammond and McLaughlin (2011); Desimone (2009); Guskey (2003)[a]	Armour and Yelling (2004a); Lee and Choi (2015); O'Sullivan and Deglau (2006); Patton and Parker (2015)
Collective participation	Groups of teachers from the same grade, subject, or school participate in PD activities together to build an interactive learning community	Avalos (2011)[a]; Bautista and Ortega-Ruiz (2015)[a]; Birman et al. (2000); Darling-Hammond and McLaughlin (2011); Desimone (2009)	Armour and Yelling (2004a); Coulter and Woods (2017); O'Sullivan and Deglau (2006); Patton and Parker (2015)
Addressing participants needs	Identifying PD content based on participants' contextual needs	Antoniou and Kyriakides (2011); Bautista and Ortega-Ruiz (2015)[a]; Darling-Hammond and McLaughlin (2011); Han (2014)	Armour and Yelling (2004a, 2007); Coulter and Woods (2017); O'Sullivan and Deglau (2006); Patton and Parker (2015); Petrie and McGee (2012)
Autonomy	Supporting teachers in becoming independent and lifelong learners	Bautista and Ortega-Ruiz (2015)[a]	Patton and Parker (2015); Lee and Choi (2015)

Notes.[a] Review articles.

Features and Findings of Content-Focused PD Programs in General Education

In this section, we discuss the content-focused PD studies that were reviewed earlier (i.e., investigating CK in general education and in PE); that is, we examine them in terms of alignment with high-quality PD features described in the literature. At the same time, in this section we elaborate on key findings of relevant content-focused PD studies.

Features of content-focused PD programs in general education. The eight content-focused PD programs presented in Table H1 (see Appendix H) share common features, but they also have differences. First of all, we observe various study designs: *randomized controlled trial design* (i.e., Diamond et al., 2014; Garet et al., 2008, 2011; Heller et al., 2012); *quasi-experimental design* (i.e., Faulkner & Cain, 2013); and *one group pre-test/post-test design* (Greene et al., 2013; Hill & Ball, 2004; Khourey-Bowers & Fenk, 2009). The studies that have utilized a *one group pre-test/post-test design* lack a control group. This design can yield strong causal inferences only by reducing the plausibility of alternative explanations (i.e., maturation or history) for the treatment effect (Shadish et al., 2002). However, the utilization of the specific design in two studies (Greene et al., 2013; Hill & Ball, 2004) can be considered as appropriate since the emphasis was not on the evaluation of PD programs, but rather on the specific measures that were used to capture teacher knowledge (i.e., multiple-choice test and concept map).

In the case of the study utilizing a *quasi-experimental design* (i.e., Faulkner & Cain, 2013), of special importance is the provision of data concerning the baseline equivalence of the treatment and comparison groups (Yoon et al., 2007). By a thorough examination of the specific PD study, we concluded that the reported baseline data regarding the equivalence between treatment and comparison groups were not adequate.

Moving to the CK provided in the PD programs under investigation, we conclude that in most cases the CK provided is not thoroughly specified. The reader has to 'dig' through the lines to pull out information concerning the CK aspects that were addressed. In some cases, the researchers report that the CK provided comprised both CCK and SCK, though the actual components of these knowledge categories are not specified. Only in two studies (Garet et al., 2011; Heller et al., 2012) are specific components of SCK described (i.e., identifying and addressing student misconceptions, using representations). It is important to note that this is not a criticism of the methodology used by the specific researchers or of the CK provided in each case. However, we cannot draw absolute conclusions concerning the type of CK that matters most in enhancing both teacher and student outcomes.

Regarding the rest of the PD features (i.e., active learning, coherence, sustained duration and collective participation), one can observe that, in most of the studies, the researchers designed the PD programs taking into consideration the PD evidence base. Of considerable importance are the opportunities given to teachers for active participation in most of the PD programs included in this review. Six out of the eight programs provide a plethora of components to foster teachers' active participation (e.g., practicum, observe or being observed teaching, receiving feedback in implementation, developing lesson plans).

Finally, another important aspect that is worth mentioning pertains to the ongoing and sustained duration of the specific PD programs. Specifically, the six PD programs that specify their exact duration include 20 hours or more of contact time. In fact, in four cases the contact time ranges from 40 to 120 hours (over one or two years).

Findings of content-focused PD programs in general education. We shall now proceed to examine the findings of content-focused PD studies in general education. The results of studies that fall in this category (i.e., the studies included in Table G2), which used a direct measure to access teacher CK (i.e., CK test), were thoroughly discussed in a previous section (i.e., investigating CK in general education). Thus, in this section we are going to briefly review other relevant findings presented in literature reviews and/or relevant PD studies (i.e., Appleton, 2008; Borko, 2004; Garet et al., 2001; Kennedy, 1998;

Mara et al. 2011; Shallcross, Spink, Stephenson, & Warwick, 2002; Yoon et al., 2007). These studies did not use a direct measure (e.g., a test) to capture teacher CK, and thus, they were not included in the review of CK studies in general education.

In summary, key findings from the relevant research that has been undertaken concerning the effects of content-focused PD programs include the following: PD integrating CK and pedagogy increase teachers' confidence in teaching the specific content (Shallcross et al., 2002); PD programs that focus on CK can help teachers deepen their knowledge (Borko, 2004; Garet et al., 2001; Mara et al., 2011); planning for and implementing teaching was considered to be the most effective strategy for acquiring and developing CK and understanding (Shallcross et al., 2002); performing PD activities as learners (i.e., hands-on activities) improves teachers' CK (Appleton, 2008, Diamond et al., 2014; Shallcross et al., 2002); emphasis on CK in PD improves classroom instruction (Borko, 2004; Mara et al., 2011); PD programs that include an explicit focus on subject matter can help teachers foster students' conceptual understanding (Borko, 2004); PD programs that include analysis of student thinking (e.g., students' common conceptions and misconceptions) can help teachers guide student thinking (Borko, 2004); PD programs, whose content mainly focused on teachers' behaviors, demonstrated smaller influences on student learning than did programs whose content focused on teachers' CK, on the curriculum, or on how students learn the subject (Kennedy, 1998). These findings confirm the significance of PD that focuses on CK and stress its profound importance in designing high-quality PD.

Features and Findings of Content-Focused PD Programs in PE

Features of content-focused PD programs in PE. By examining the features of content-based PD programs in PE (see Table H2 in Appendix H), we infer that these programs – unlike the corresponding programs in general education – include fewer key features of effective PD as proposed in the literature (e.g., sustained duration, collective participation) with the exception of Hunuk and colleagues' (2013) study. More specifically, Hunuk et al. (2013) designed a study to examine the effects of a CoP on teacher and student CK. CoPs, by definition, provide opportunities for ongoing, active and collegial learning. Another interesting feature of the specific study was the presence of a facilitator in all the teachers' meetings. The role of the facilitator was to present key topics to the discussion groups, listen to participants' voices and keep the discussions focused.

Nevertheless, all the other studies included in this review (i.e., Iserbyt et al., 2017; Iserbyt et al., 2016; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015) contribute to the PD literature in a different way; they explicitly describe the nature and components of the CK provided. This is not surprising, since the specific studies build on Ward's (2009) CK conceptualization in PE. In all the studies following Phillip Wards' CK framework, the participating teachers were taught CK for specific content areas in PD workshops using knowledge packets. A knowledge packet constitutes a body of knowledge in specific PE content that contains both CCK and SCK that is appropriate for a particular grade context, such as upper elementary or middle school (Iserbyt et al., 2016).

In each case, the content of the knowledge packet included the following: (a) a set of task progressions for teaching particular skills (SCK); (b) a list of critical elements of each skill and tactic (CCK); (c) a list of student common errors and error corrections (SCK); and (d) a recommendation on how to sequence tasks in a teaching unit (SCK) (Ward et al., 2015).

During the workshops, the researchers (and/or their assistants) modeled each task in the knowledge packet – in some cases this procedure involved watching a video developed by the researchers (Kim, 2016; Sinelnikov et al. 2016; Ward et al., 2015). During the modeling, the following were presented: (a) the objective of each task; (b) examples of developmentally and principally appropriate tasks (SCK); (c) specific and sequenced task progressions for teaching particular content (SCK); (d) critical elements of each skill and tactic (CCK); (e) examples of visual (e.g., demonstration) and verbal (e.g., cues) representations of the tasks (SCK); and (f) task adaptations of the content sequence for students who had lower abilities and skill levels (SCK).

Findings of content-focused PD programs in PE. The above studies' findings were thoroughly discussed in a previous section (i.e., investigating CK in PE). Thus, in this section we are going to briefly review other relevant findings presented in content-focused PD studies in PE (i.e., Braga, Jones, Bulger, & Elliott, 2017; Sinelnikov, 2009), which did not include direct measures of teacher CK.

To begin with, Sinelnikov (2009) investigated the effectiveness of an on-site PD program regarding the Sport Education model. Participants were two PE teachers who were teaching different PE classes in the same school. Data sources included the researcher's log, informal discussions, briefing/debriefing sessions and semi-structured interviews. The results of the study demonstrated that collective participation encouraged sharing knowledge, provided the basis for peer support, and stimulated teacher reflection.

Moreover, in a recent study Braga and colleagues (2017) examined teacher perceptions regarding their experiences in a continuous PD initiative and its influence on their professional readiness to implement innovative content in PE. Participants were four PE teachers who engaged in a series of hands-on workshops and collaborative activities related to the design and implementation of a mountain biking unit. Qualitative data were collected through post-workshop surveys, semi-structured interviews, and a focus group. Key findings included the following: teachers' CK was enhanced through the hands-on experiences, the unit planning, and the piloting of the unit (i.e., the three-week unit was pilot tested with students at school setting and, based on lessons learned, the teachers reconvened to make revisions to the instructional materials); participants valued the fact that they were encouraged to choose how to best manage their classes and deliver the content to their learners; acquiring the biking skills and knowledge was essential to ignite changes in the teachers' attitudes toward the content and to enable them to transfer it to the classroom; the teachers frequently addressed how the biking lessons impacted their students' learning and engagement, which enhanced their levels of motivation toward the unit.

Research Results on Generalist Teachers Teaching Physical Education

In most countries around the world, including Cyprus, primary PE classes are taught by generalist teachers rather than by PE specialists (Hardman & Marshall, 2009). Specifically, primary PE classes globally are taught as follows: exclusively by generalist teachers in almost half of the countries (i.e., 47%); exclusively by PE specialists in about one fifth of the countries (i.e., 21%); and by both generalist teachers and PE specialists in almost one third of the countries (i.e., 32%). Thus, we can infer that in 79% of the countries worldwide generalist teachers are exclusively or partially responsible for teaching PE in primary schools (Hardman, Murphy, Routen, & Tones, 2013). Taking into consideration the above, and since the participants of this study were in-service generalist teachers, it is important to review relevant research results.

In a recent review of literature on classroom teaching, Fletcher and Mandigo (2012) classified the research focusing on classroom teachers into the following seven categories: (1) descriptive profiles of classroom teachers and their practices; (2) comparative studies of effectiveness between specialist and non-specialist teachers; (3) barriers to implementing PE programs; (4) teachers' knowledge, attitudes, and beliefs; (5) teachers' socializing experiences; (6) pre-service PE teacher education programs and interventions; and (7) PD programs and initiatives. While there seems to be a growing body of literature on classroom teaching, especially in the last decade (cf. Fletcher & Mandigo, 2012), we present below the research results that are related to the focus of the present study. These results are categorized as follows: (a) generalist teachers' CK in PE; and (b) PD programs for generalist teachers.

Generalist Teachers' CK in PE

Research findings indicated that generalist teachers (pre-service and in-service) believe that they lack the necessary CK to teach PE effectively (Decorby, Halas, Dixon, Wintrup, & Janzen, 2005; Elliot, Atencio, Campbell, & Jess, 2013; Morgan & Hansen, 2007; Xiang, Lowy, & McBride, 2002). Moreover, the examination of pre-service (Ashy & Humphries, 2000) and beginning generalist teachers' (Ní Chróinín & O'Sullivan, 2016) reflective insights, showed that they did not have a strong enough CK base to support student learning in PE. However, in a series of studies, Tsangaridou and her colleagues found that pre-service generalist teachers: could learn to reflect about different aspects of teaching, including CK and PCK (Tsangaridou, 2005; Tsangaridou & Polemitou, 2015); reflected on the content and PCK aspects of their practices, and the results of their reflections guided their teaching actions to satisfactory outcomes (Tsangaridou, 2005); and, based on documentary and observational data, were able to transform their CK and deliver it to students in ways that helped them learn (Tsangaridou, 2002).

Nevertheless, the above findings for the most part are based on teachers' beliefs and reflections. None of the above studies used an instrument (e.g., test) or a technique (e.g., task-based interview) to directly assess teachers' CK. Concerning research on generalist teachers' knowledge, we were able to trace only three studies that have used a measurement tool to directly assess teachers' CK (i.e., Hart, 2005; Stefanou, 2014; Stefanou et al., 2015). The pertinent results are briefly presented below.

To begin, Stefanou (2014) applied Ward's (2009) CK conceptualization in PE to develop a test and measure generalist teachers' CK in basketball. The test was administered to 249 pre-service generalist teachers, who were studying at the four main universities of Cyprus. The results showed that the pre-service teachers' CK in basketball was to some extent inadequate. Specifically, the mean percentage of success was far below 50% (i.e., 36%). The same test, with minor amendments, was then administered to 254 in-service generalist teachers (Stefanou et al., 2015). In this case also, the teachers were found to possess a low level of CK in basketball (mean percentage of success: 41%). In both studies, the results revealed that SCK items (i.e., knowledge of students' common errors and task progression) were more difficult than the CCK items (i.e., knowledge of rules, techniques and tactics), though, this difference was statically significant only in the latter study.

Moreover, Hart (2005) sought to investigate the influence of a PE method course on elementary education majors' CK of fundamental movement skills. To this end, 98 students (i.e., 65 students participating in two PE methods courses served as the treatment group, and 33 students participating in a health methods course served as the control group) were asked to complete an open-ended questionnaire on the first and last day of the course. The questionnaire instructed students to list as many fundamental movement skills as possible and explain their importance. Findings indicated that the students participating in the treatment group exhibited an increased CK level of fundamental movement skills (i.e., more fundamental movement skills were correctly identified), after the completion of the PE methods course.

PD Programs for Generalist Teachers

Continuing PD has been identified as an area of need for generalist teachers (Morgan & Hansen, 2007; Sloan, 2010), since they appear to have limited CK and/or PCK in PE (Graber et al., 2008; Ní Chróinín & O'Sullivan, 2016; Petrie, 2010; Stefanou et al., 2015). Generalist teachers' limited knowledge in PE is mainly attributed to their insufficient preparation during initial teacher education (Elliot & Campbell, 2015; Kirk, 2005; Tsangaridou, 2016). This is not surprising given that, typically, teacher education programs for generalist teachers include only one PE course[1] (Morgan & Bourke, 2008; Tsangaridou, 2016). Thus, we can infer that during their initial teacher education generalist teachers are only given a basic starting point, which is inadequate for teaching PE effectively (Elliot et al., 2013).

Nevertheless, while continuous PD is obviously important for generalist teachers, it has been reported in the literature that only a minority of them have participated in effective PD programs after the completion of their initial training (Armour & Duncombe 2004; Coulter & Woods 2012; Murphy & O'Leary, 2012; Sloan, 2010). Taking into consideration the above, it is important to review studies regarding the participation of generalist teachers in PD programs in PE.

To begin, a study describing the experiences and views of primary teachers to a specific in-service health-related PD program was conducted by Faucette, Nugent, Sallis, and McKenzie (2002). The particular PD program was part of the well-known Project SPARK (Sports, Play, and Active Recreation for Kids), a 5-year federally funded grant from the National Institutes of Health. Results indicated the following: the PD program increased generalist teachers' confidence to teach PE; the participating teachers believed that students benefited from their enhanced knowledge teaching practices; and, opportunities to collaborate and discuss concerns were among the PD features most appreciated by the participants.

Moreover, Petrie (2010) used interviews, questionnaires, lesson observations and document analysis to investigate the impact of a nationwide, one-year PD program on teachers' knowledge and practices in PE. The specific PD program focused predominantly on general pedagogical knowledge and skills. Findings suggested that the PD program

[1] Recently Tsangaridou (2016) reported that a new revised PE teacher education program has been developed and delivered at the University of Cyprus. Within this revised program, students who choose to acquire specialization in PE are required to take a total of four PE courses during their initial teacher education. While this practice seems promising, it constitutes the exception rather than the rule.

helped the participating teachers to feel more confident and motivated as teachers of PE. However, the findings also showed that having sound general pedagogical knowledge and skills alone does not ensure effective teaching in PE. Teachers' ability to fully and effectively incorporate specific general pedagogical approaches was hindered by limited CK in PE. Thus, Petrie (2010) suggested that PD programs for generalist teachers should include – besides pedagogical knowledge – opportunities for developing CK.

In another study, Murphy & O' Leary (2012) described tutors' and teachers' perspectives concerning the effectiveness of a national in-service PD program in PE. Some key findings of the specific study regarding teachers' perspectives were: the active engagement with the content (i.e., hands-on activities) was a key factor in teachers' learning; the PD enhanced teachers' understanding of PE and PE curriculum; after participation in the program most of the teachers reported that they would teach elements of strands that they had not taught previously; and, more attention needed to be given to helping teachers differentiate their instruction.

In addition, Coulter and Woods (2012) employed a single school case study to explore generalist teachers' experiences of a 6-week PD program in PE. For the collection of data, teachers and a sample of students participated in group interviews. Findings indicated that the participation in the PD program enhanced teachers' CK in PE and this encouraged them to use existing classroom pedagogical strategies in the PE context. Teachers' enhanced CK led to increased confidence in teaching PE and to a greater understanding of the PE curriculum and its purpose. Though students' learning was not quantified, there was perceived evidence of learning through the students' interviews. Furthermore, the study showed that a successful PD program in PE involves the following features: learning through collective participation; PD programs should focus on increasing teachers' CK; pedagogical content knowing is best learned while working directly with pupils in the classroom; and PD programs in PE should include time for discussion around PE.

Finally, in a recent study, Miller and colleagues (2017) using a cluster randomized controlled trial design, investigated the efficacy of a continuous PD program in producing changes in generalist teachers' quality of teaching. The PD, which addressed the use of a game-centered approach, comprised an information session and in-class mentoring. Teaching quality was assessed at baseline and follow-up (weeks 6 and 7) via observation of two consecutive PE lessons using a particular observation scale. Findings showed that the PD intervention resulted in a significant positive treatment effect on generalist teachers' quality of teaching.

In conclusion, it seems that there is a growing body of PD evaluation studies within primary PE (e.g., Coulter & Woods 2012; Faucette et al., 2002; Miller et al., 2017; Murphy & O'Leary, 2012; Petrie, 2010). However, these studies' reported outcomes are typically changes in teachers' perceptions or in observed teaching behaviors rather than directly measured teacher and student performance.

Chapter Summary and the Theoretical Framework of the Study

Building on Shulman's (1986, 1987) conceptualization of teacher knowledge, Deborah Ball, Heather Hill, and their colleagues (e.g., Ball et al., 2008; Hill et al., 2004) developed a practice-based theory of mathematical knowledge for teaching. Likewise, Ward (2009), drawing on Siedentop's arguments (1989/2002) and on the milestone work of Ball and Hill (Ball et al., 2008; Hill et al., 2004), proposed a four-domain CK conceptualization in PE: (a) knowledge of the rules, etiquettes, and safety; (b) knowledge of technique and tactics; (c) knowledge of errors; and (d) knowledge of instructional representations and tasks (e.g., task progression).Ward (2009) argues that the first two domains can typically be acquired by playing the game (i.e., performing) and as such could be called CCK in PE. Similarly, the next two domains are typically acquired through reflecting and refining teaching performance in PE, and as such could be called SCK in PE.

A number of studies directly measuring teachers' CK in PE (e.g., Hunuk et al., 2013; Kim, 1996; Santiago, Disch, & Morales, 2012a) consider CK to include only the knowledge described under the construct of CCK. Likewise, research findings in general education (i.e., Baumert et al., 2010; Carlisle et al., 2009; Garet et al., 2008; Sadler et al., 2013a, 2013b) indicated that teacher CK – when measured exclusively under the construct of CCK – is a poor predictor of student achievement. We suggest that what is measured (or provided through a PD program) as teacher CK is a key aspect in investigating links between teacher CK and student achievement.

Moreover, although continuous PD is widely recognized as a major mechanism for the improvement of both teacher knowledge and student achievement, research findings indicate that the PD currently available to teachers can be described as "woefully inadequate" (Armour & Yelling, 2007; Borko, 2004; Creemers et al., 2013; Darling-Hammond, 2010; Patton & Parker, 2015). Acknowledging this, many researchers in general education (e.g., Darling-Hammond & McLaughlin, 2011; Desimone, 2009; Han, 2014; Hunzicker, 2011), as well as in PE (Armour &Yelling, 2004a; O'Sullivan & Deglau, 2006; Patton & Parker, 2015), described and investigated a series of high-quality PD features. Focus on CK has a prominent place among these features of effective PD. Nevertheless, there has been relatively little systematic research on the contribution of PD to teacher and student outcomes.

Turning to the research concerning generalist teachers teaching PE, content-focused PD has been identified as an area of need for generalist teachers (Morgan & Hansen, 2007; Sloan, 2010), since they were found to lack the necessary CK to teach PE effectively (Graber et al., 2008; Ní Chróinín & O'Sullivan, 2016; Petrie, 2010; Stefanou et al., 2015). Yet, research evidence indicated that few generalist teachers have participated in effective

PD programs (Armour & Duncombe 2004; Coulter & Woods 2012; Murphy & O'Leary, 2012; Sloan, 2010).

Taking into consideration these research gaps, the present study builds on earlier work on teacher CK and teacher PD to propose an effective content-focused PD framework for generalist teachers teaching PE. Specifically, in this study we draw on Ward's conceptualization of CK in PE to develop a scale to directly measure teachers' CK in PE. Of special interest in this section is the proposed knowledge of errors domain.

According to Ward (2009), the knowledge of errors requires knowledge of the correct performance to discriminate students' errors of technique and tactic. Ward (2009) suggests that this kind of knowledge is typically acquired through reflecting and refining teaching performance in PE, and as such can be classified as SCK in PE, i.e., knowledge and skill unique to teaching (Ward, 2011). The ability to observe and identify errors during a PE lesson cannot be equated to the ability of recognizing students' errors during classroom teaching (e.g., through students' written work). The observation of a skill performed in PE occurs in an open space in which students are constantly moving (Lindsay, 2014). Hence, PE teachers need to be keen observers of movement (Jensen, 1980).

However, the knowledge of identifying an error of technique or tactic within a *paper-and-pencil* test (multiple-choice format) cannot be discriminated from the knowledge of correct technique or tactic. Specifically, in the items referring to knowledge of errors domain, the four responses (i.e., the correct answer and the three distractors) comprise cases of correct or incorrect technique/tactic. Hence, one has to know the correct technique or tactic of a specific skill in order to figure out the correct answer. It is suggested that this kind of knowledge overlaps with the knowledge measured in the knowledge of technique and tactics domain.

To overcome this measurement limitation, we propose a modification to Wards' (2009) framework. That is, the incorporation of *error discrimination* into the knowledge of technique and tactics domain. The knowledge of errors domain will include items assessing the *knowledge of students' common errors*, i.e., errors that students might make while learning a specific skill (Ward, Ayvazo, & Lehwald, 2014).

Consequently, for the purposes of the present study, the following modified version of Ward's (2009) theoretical framework will be used to assess in-service teachers' level of CK in basketball: (a) knowledge of the rules, etiquettes, and safety; (b) knowledge of technique and tactics, and discrimination of errors of technique and tactical performance; (c) knowledge of student common errors; and (d) knowledge of instructional tasks (e.g., task progression for beginners). It is strongly noted, however, that the suggested modification is applicable only within the context of a *paper-and-pencil* test, comprising multiple-choice questions.

Finally, Ward's (2009) CK framework and Launder's principles of Play Practice (Launder & Piltz, 2013) guided the development of the training materials used within the PD program. At the same time, features of high-quality teacher PD described in the literature (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006, Patton & Parker, 2015) informed the PD's format (i.e., structure and processes). Table 2.2 summarizes this study's PD features and their exact content.

Table 2.2

The Study's PD Features

High-quality PD features	**The study's PD features**
Content focus	Common Content Knowledge • *Knowledge of rules and etiquettes* • *Knowledge of techniques and tactics* (i.e., critical elements) Specialized Content Knowledge • *Knowledge of errors* (i.e., students' common errors, error corrections, recognition of students' correct and incorrect performances) • *Knowledge of instructional tasks and representations* (e.g., task progressions, cues, demonstrations)

Table 2.2 Continued

High-quality PD features	The study's PD features
Active learning	• Practicum (hands-on activities) in each session • In each session, teachers developed their own task progressions for teaching specific skills and/or tactics (based on the principles of Play Practice and their students' skill level) • The teachers were assigned to develop their own basketball unit (i.e., lesson plans) • Meaningful discussions in each session (e.g., how they might transfer PD materials or experiences into their classrooms) • Reflection on teaching through discussions and in written form for each implemented lesson plan (i.e., self-reflection cards on teaching) • In each session, teachers were watching video clips of students performing selected skills, in order to practice in error recognition • In each session, teachers were reviewing students' common errors and relevant error corrections • During the five sessions, teachers were receiving feedback concerning their demonstrations of specific basketball skills • The teachers received feedback concerning the content of their lesson plans (e.g., task progressions, emphasis on activities comprising game-like situations)
Coherence	The PDs goals, content, and activities were aligned to the PE curriculum
Sustained duration	Five 2,5-hour afternoon sessions – 12+ contact hours over two months
Collective participation	Groups of teachers teaching PE to the same grades (i.e., 5th and/or 6th Grade) collaborated in PD activities and participated in interactive discussions
Addressing teachers' needs	The PD's structure was gradually modified (based on the participants' suggestions) in an effort to meet the participants' needs
Autonomy	The participating teachers developed their own units for teaching basketball (based on the PD's training material, and their students' needs/skill level), and were encouraged to decide how to best manage their classes to deliver the specific content to their students

CHAPTER 3: METHODOLOGY

Abstract

The main research question of this study was: What is the contribution of a CK PD program to in-service generalist teachers' level of CK and to student achievement? To answer this question an intervention was designed (i.e., content-focused PD program in basketball). Teachers' CK and students' achievement in basketball were measured before the beginning and after the end of the intervention. The teacher CK test was administered to 52 Cypriot generalist primary school teachers, while the student performance test was administered to 913 students (5^{th} or 6^{th} Grade students). Each performance test administration was carried out by two scorers. Scorers were carefully selected and underwent intensive training before entering the study. In addition, a set of qualitative data techniques (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection sheets on the PD program) was used during the intervention to gain a deeper understanding of the phenomenon under study. For the analysis of the quantitative data, three advanced statistical techniques were utilized. First, Item Response Theory (IRT) models were run to test the psychometric properties of both the teacher CK test and the student performance test. Second, Multiple Linear Regression analyses were conducted to predict and explain teachers' final performance in the basketball CK test. Third, Multilevel model analyses were conducted in order to investigate the contribution of the PD program to student achievement. Finally, for the analysis of the qualitative data the constant comparative method was used.

Research Setting and Participants

Research Setting

The study was conducted in Cyprus, an island country in the Eastern Mediterranean. Although Cyprus is considered to be a small country, it is a comparatively large island (i.e., the third largest and third most populous island in the Mediterranean Sea). Specifically, out of a total of 843.300 inhabitants the estimated composition of the population at the end of 2015 was 701.000 Greek Cypriots and 147.300 foreign residents[2] (Statistical Service of the Republic of Cyprus, 2015).

Since the study presented here was concerned with primary school teachers' CK and student achievement in basketball, the following information is provided below: (a) the broader educational system in Cyprus; (b) qualifications for teaching PE in Cypriot

[2] The given composition of population refers to the Government controlled area.

primary schools; (c) PE in the primary school timetable; (d) PE and basketball in the primary school curriculum; (e) PE facilities and resources; and (f) teacher PD in PE.

The broader educational system in Cyprus. High centralization is one of the main characteristics of the educational system in Cyprus. Pre-primary, primary and secondary schools are considered as government institutions (not as community institutions) and thus, are under the authority of the Ministry of Education and Culture. Major policy and administrative decisions concerning curricula, staffing, textbook selection, and teacher training are made by the Ministry of Education and Culture (Antoniou & Kyriakides, 2013). In addition, teachers' appointments, secondments, transfers, and promotions are being done by an independent five-member body, the Educational Service Commission, which is appointed by the President of the Republic. Finally, local school committees are responsible for issues of construction, maintenance and equipping of school buildings (Kyriakides & Tsangaridou, 2008).

Qualifications for teaching PE in Cypriot primary schools. In Cyprus, the 332 public primary schools[3] provide a six-year compulsory schooling for children from 6 to 12 years old. Public primary education is free of charge and with no entrance requirements. Primary schools are co-educational and provide mixed ability teaching. A university degree in general educational studies for the primary school makes a teacher eligible for inclusion in the official register of candidates for appointment (Antoniou & Kyriakides, 2013). Once appointed, generalist teachers are responsible to teach all the curriculum subjects in Cypriot primary schools, including PE. In other words, the teachers that teach PE in Cypriot primary schools do not hold a PE degree, but are considered qualified by the authorities to teach PE since they have other qualifications, such as certificates from postgraduate studies, seminars and PD programs relevant to PE (Tsangaridou & Yiallourides, 2008).

[3] The total number of primary schools (i.e., 332) refers to the school year 2015-2016.

Furthermore, according to Kyriakides and Tsangaridou (2008), generalist teachers who teach PE in Cypriot primary schools can be classified into three groups. The first group refers to classroom teachers who are responsible for teaching PE only to their own class along with other subjects (e.g., mathematics, Greek language). The second group comprises teachers who teach PE not only to their own class, but also to some other classes. Like the teachers of the first group, the teachers of the second group are responsible for teaching a number of other subjects to the students of their class besides PE. Finally, the third group refers to PE coordinators who teach only PE to students of one or more primary schools.

PE in the primary school timetable. In Cyprus, the school year begins in early September and ends in late June. The actual amount of teaching time per school year ranges from 35 to 37 weeks depending on the distribution of holidays across the year[4].

PE is a compulsory subject in primary education. From the school year 2015-2016 (i.e., the year of this study's data collection), the Ministry of Education and Culture decided to increase the allocated PE time for 5th and 6th graders from two to three 40-minute periods per week. All the other primary school students (Grade 1-4) participate in two 40-minute periods of PE weekly.

PE and basketball in the primary school curriculum. From the school year 2010-2011, a new PE curriculum has been introduced in primary education. According to the new curriculum, the mission of primary PE in Cyprus is to provide all students with equal opportunities to develop, improve and perform various psychomotor skills within the context of five areas of activities (i.e., educational gymnastics, dance, games, track and field, and life activities) and to simultaneously form an integrated personality through the development of fair-play principles, and the cultivation of a positive stance toward

[4] Some holidays (e.g., Easter) are related to flexible calendar dates, thus, their timing changes slightly from year to year. This influences the total number of teaching days/weeks per school year.

accepting and respecting rules, moral and social values (Ministry of Education and Culture, 2010).

In order to carry out the above mission, primary PE curriculum is organized around six main aims, which cover the essential knowledge, skills, values, attitudes, and behaviors that students are expected to develop through their participation in PE lessons. According to the six main aims, the students should: (a) develop and competently perform specific psychomotor skills; (b) acquire essential PE-related knowledge (how and why) and apply it, in order to adequately participate in present and future opportunities of physical activity; (c) acquire knowledge related to the development of a health-enhancing level of physical fitness; (d) obtain positive experience through participating in physical activity opportunities and develop self-expression and social interaction; (e) understand and respect diversity and cooperate with all the students; and (f) demonstrate responsible athletic and social behavior while participating in physical activities (Ministry of Education and Culture, 2010).

Moreover, the PE curriculum for primary schools can be divided into two levels. In the lower-primary level (Grade1-3) teachers introduce, cultivate and develop the basic motor skills and concepts, within the context of three areas of activities (i.e., educational gymnastics, dance and games). Particularly, during Grades 2 and 3, students are encouraged to develop basic skills, follow simple rules, and perform basic tactics in modified game-like situations. In the upper-primary level (Grade 4-6), the focus shifts to the development of more advanced skills through all five areas of activities (i.e., educational gymnastics, dance, games, track and field, and life activities). Specifically, students in Grades 4, 5 and 6 are expected to perform more advanced skills with greater control, coordination and precision, and use them in modified individual and team activities, by applying more complex rules and tactics (Ministry of Education and Culture, 2010).

In addition, as stated above, in lower primary level much of the emphasis is placed on the development of fundamental manipulative skills (e.g., receiving, passing, dribbling, shooting on a target), and on the introduction of some basic offensive and defensive strategies (e.g., passing and moving into open space, trying to steal the ball). All these fundamental skills and strategies constitute the basis for the development of the skills and tactics required for participation in games, including basketball. Progressively (from Grade 1-6), teachers seek to improve the quality of performance, concerning the execution of the various skills and tactics (i.e., inclusion of more critical elements per skill/tactic from grade to grade). For example, during the *initial stages* of *teaching* students how to *dribble* a ball with the hand (Grade 1), the focus of teaching is on critical elements like: *'fingers spread on the ball', 'use the fingers to push the ball to the floor', 'dribble the ball at waist level'.* Subsequently, in Grades 2 and 3, teachers emphasize more critical elements when teaching dribbling (e.g., *'elbow extension and wrist/fingers flexion to push the ball to the floor'*), and finally, from Grade 4 onwards the teaching of dribbling comprises more advanced critical elements (e.g., '*dribble without watching the ball*'). In addition, some advanced basketball skills/tactics (e.g., *set-shot*, *lay-up*, '*person to person' defense*, '*give and go'*) are not introduced before Grade 4 (Ministry of Education and Culture, 2010).

Furthermore, the PE curriculum encourages teachers to develop and cultivate all the basketball skills/tactics within the context of modified invasion games (e.g., games of equal number of opponents: 1vs1, 2vs2, 3vs3; games of unequal number of opponents: 2vs1, 3vs2; modification of various game aspects: the dimensions of the playing area, the scoring system, the rules, the equipment) (Ministry of Education and Culture, 2010).

PE facilities and recourses. In most primary schools in Cyprus, the PE facilities and resources are moderate to adequate. Since a large number of schools have no multipurpose halls/gymnasiums, PE lessons are usually conducted in outdoor facilities, which typically comprise a soccer ground and one or two open-air basketball grounds, which also serve as volleyball, handball, and multi-activity grounds. Even in the case of primary schools that do have multipurpose halls, these are often used for other purposes (e.g., rehearsals for various celebrations). Thus, during bad weather conditions (e.g., rain, extreme cold or heat), PE lessons either are cancelled or take place in the classroom, where simple games can be practiced or a relevant PE topic can be discussed (Tsangaridou & Yiallourides, 2008).

In addition, PE equipment (e.g., balls of all kinds, tennis or badminton rackets, exercise mats, hurdles of different height) is provided and distributed to all primary schools by the Ministry of Education and Culture. Besides the aforementioned equipment, each primary school has its own fund for purchasing PE equipment, which is renewed every year. Local school committees hold these funds and allocate them to the interested schools.

Teacher PD. Regarding teacher PD, primary school teachers are encouraged to attend, on a voluntary basis, courses of PD run by the Pedagogical Institute of Cyprus. For this purpose, the Pedagogical Institute publishes a program of seminars available, and teachers are invited to apply (Antoniou & Kyriakides, 2013). Unfortunately, seminars that are directly related to PE are almost nonexistent.

Furthermore, a few years ago the Ministry of Education and Culture attempted to establish PE professional learning communities (i.e., CoPs), since there has been a growing body of literature highlighting the values and benefits of being a member of a PE CoP (e.g., Deglau & O’Sullivan, 2006; Hunuk et al., 2013; Parker et al., 2010). Wenger (2006) described CoPs as ‘groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly’ (p. 1). Nevertheless, to the best of our knowledge, the established CoPs no longer exist due to practical reasons (e.g., the teachers’ meetings were held during school hours which created problems with substituting teachers).

Finally, a new educational policy concerning teachers' PD has been introduced in public education from the school year 2012-2013. Specifically, at the beginning of each school year, teachers have the opportunity to participate in a two-day PD program. This two-day PD program comprises seminars on different educational matters organized either by the Ministry of Education and Culture or by the schools themselves (Republic of Cyprus, 2012). The specific educational policy has been evaluated through an electronic survey conducted by the Pedagogical Institute of Cyprus during the culmination of the school year 2015-2016. The data collected from the survey were also used to improve the alignment between the offered seminars and the actual needs of teachers (Pedagogical Institute of Cyprus, 2016).

Participants

Convenience and snowball sampling techniques were used to invite prospective participants (Maykut & Morehouse, 2005). Prospective participants had to be generalist primary school teachers, who would probably teach the subject of PE to 5th or 6th Grade the next school year (i.e., school year 2015-2016). In total, 60 teachers were reached and invited to participate in the study. Although, a sample of 50 teachers would provide enough power to run the multilevel analyses described below (Cools, Fraine, Van den Noortgate, & Onghena, 2009), it was reasonable to target a higher sample size because it was expected that there would be some withdrawals (i.e, attrition). Specifically, two teachers refused to participate in the study due to personal reasons. The rest of the teachers (i.e., 58 teachers) were willing to participate in the study. At the beginning of the next school year (i.e., September 2015), another six teachers had to withdraw from the study for different reasons; three teachers were not assigned to teach PE to 5th or 6th Grade and another three were transferred to schools which were located outside the predefined research area[5].

[5] For practical reasons it was decided to sample teachers who were enrolled in primary schools located in the two major educational districts of Cyprus, Nicosia and Limassol.

Eventually, a total number of 52 Cypriot generalist primary school teachers volunteered to participate in the study and signed a related informed-consent form.

From those teachers, 47 (90%) were male teachers. In regard to the PE teaching experience, the mean in the overall sample was 9.6 years (range: 1 up to 26 years). Specifically, 29.4% had up to 5 years of PE teaching experience, 27.4% had 6 to 10 years of experience, 29.3% had 11 to 15 years of experience, and 13.9% had more than 15 years of experience. Although no official data were obtained on the gender composition or the PE teaching experience of the teacher population teaching PE, anecdotal evidence[6] suggests that the study's sample largely represents the teacher population under consideration, given that female teachers and more seasoned teachers typically opt to not teach PE[7].

At this point, it is important to indicate that during the school year 2015-2016 (i.e., the year of this study's data collection) the general primary teacher population comprised 82% female teachers and 18% male teachers (Educational Service Commission, 2016). Taking this into account, questions are raised concerning the underrepresentation of female teachers in the teaching of PE in primary education. Nevertheless, as it was described above, we have no reasons to believe that this aspect affects the representativeness of the study's sample. The composition of the study's sample with respect to participants' gender largely reflects the actual composition of the teachers teaching PE in primary education.

The sampled teachers were enrolled in 43 primary schools which were located in the two major educational districts of Cyprus. The distribution in urban (55.8%) and suburban/rural (44.2%) schools, was representative of these types of primary schools in the

[6] Unofficial reports suggest that the percentage of male teachers that teach PE in primary education is around 85%.

[7] At the beginning of each school year the principle of each primary school is responsible for allocating the subjects to the teaching personnel. Teachers fill out a form indicating their preferences, which the principle takes under consideration for the allotment of subjects. Female teachers typically opt not to teach PE and if "forced" opt to teach PE only to their own class. Thus, for the most part, PE is taught by male teachers.

two districts (x^2=2.54, df=1, p=0.11). In correspondence to the number of the participating teachers, students from 52 PE classes participated in the study. Moreover, the average PE class size was 19.5 students, ranging from 11 to 25 students.

Like what we did with teachers, informed-consent letters were also sent to students' parents/guardians. One hundred (10%) parents/guardians did not give consent for their children to participate in the study. Thus, 913 students in total participated in the study. The final student sample consisted of 460 (50.4%) girls and 453 (49.6%) boys, from which 572 (62.7%) were 5th graders and 341 (37.3%) were 6th graders. The student sample was representative of the population in terms of gender (x^2=0.002, df=1, p=0.96). The percentage of fifth-grade participants in comparison to the sixth-grade participants was higher due to the fact that teachers who were teaching to multiple grades opted to participate in the study with their 5th Grade rather than their 6th Grade classes, since 6th graders – as the older primary school students – are often involved in several school activities.

Although this study also collected data concerning students' left-handedness (7.9% were left-handed), no official data were available about this characteristic of the population of primary school students. As a consequence, it was not possible to examine whether the sample was representative in terms of left-handedness, but we have no reasons to believe that this was not the case.

The Formation of the Treatment and Comparison Group

Our original intension was to randomly allocate the study's participants into two equal groups. The teachers participating in the first group (i.e., experimental group) would attend afternoon CK PD sessions, while the teachers of the second group (i.e., control group) would not receive any training. However, after the first contact with all the participants it became obvious that a significant number of the participants (i.e., 27 out of 52) were unable to attend PD sessions in the afternoons. Hence, the allocation to the two groups (i.e., treatment and comparison group) was based on the participants' availability of free afternoon time. Specifically, 25 teachers volunteered to participate in the treatment group (TG). The rest of the participants (i.e., 27 teachers) formed the comparison group (CG). Nevertheless, during the preparation of the training schedule it became obvious that another two teachers were unable to participate in the PD program, since their availability to participate in afternoon PD sessions was extremely limited[8] (i.e., only a certain day and certain hours). Thus, these two teachers were transferred to the CG. Consequent to the above, the final allocation of the participants to the two groups was as follows: 23 teachers participated in the TG, and 29 in the CG. For practical reasons (i.e., geographical distances) the teachers participating in the TG were divided into two different training groups, according to their place of residence (i.e., participants living in the first educational district formed one training group, whilst, participants living in the second educational district formed the other training group).

Since teachers were not randomly allocated to the two groups, we have checked for differences between the two groups in respect of teachers' background characteristics (i.e., gender, coursework: number of content and methods PE courses the participants had taken during their studies, PE teaching experience measured in years, PE teaching experience measured in number of PE classes taught per year, PE teaching experience measured in grade levels taught, other experiences concerning basketball, frequency of watching professional basketball games, and prior experience in playing basketball) and teachers' initial level of CK in basketball. The *t*-test revealed no statistically significant difference between the two groups in respect of teachers' background characteristics and teachers' initial level of CK in basketball.

To further ensure that the two groups were equivalent at the beginning, we administered a survey asking the teachers to explain the reasons for which they decided to

[8] Information of each participant's availability of free afternoon time was gathered from a small survey.

participate or not in the TG. Twenty six out of the 29 teachers, who decided not to participate in the TG, stated that the main reason for their decision was the lack of free afternoon time, due to family obligations. Mr. John's and Mr. George's[9] explanations are representative of this dominant trend. Mr. John explained:

> The main reason [for not participating in the PD program] is lack of time. Each of my two children has four afternoon activities [per week]. I also have training hours during the afternoons and games on Saturdays. It was practically impossible to participate in training sessions during the afternoon.

Mr. George echoed Mr. John:

> [I did not participate] purely due to lack of time. I wanted to attend in the training program and I believe in its importance. However, during the afternoons I look like a taxi driver, since I have to drive my children to their various afternoon activities.

Three teachers among the above 26, recorded a second reason for deciding not to participate in the TG (besides lack of free afternoon time). These three felt that they did not need any further training in basketball, since they had already participated in a series of basketball courses or seminars and obtained related certificates. Finally, the remaining three teachers (out of 29) stated that basketball and/or PE was not one of their main interests.

In contrast, 22 out of the 23 teachers who decided to participate in the TG stated that the main reason for their decision was the need for acquiring more knowledge and/or teaching skills, concerning basketball. Particularly, Mr. Andrew explained: "I chose to participate in the afternoon training program because I wanted to enhance my knowledge in teaching basketball. I was right in my decision". Likewise, Mr. Jim stated the following:

[9] All the participants' names presented are pseudonyms.

> The fact that in the last few years I only teach PE leads to the need for continuous PD and improvement of my teaching practices. I think that PD and especially the specialized PD in an area, promotes significantly the quality of teaching.

Finally, five teachers recorded a second reason which led them to participate in the TG. They claimed that they wanted to support the research in the field of PE. For example, Mr. Christopher gave the following explanation: “I wanted to help the researchers, since they are seeking to improve teaching quality in PE”.

In conclusion, although the teachers were not randomly assigned into the two groups, the above results suggest that the two groups were not different at the beginning in respect to teachers’ background characteristics and teachers’ initial level of CK in basketball. Furthermore, it seems that the main reason that determined teachers’ willingness to participate in the TG (i.e., participation in afternoon PD sessions), was the availability of free afternoon time.

Instrumentation

To combine the strengths of quantitative and qualitative methods (Creswell & Plano Clark, 2007) two sets of quantitative data instruments (i.e., teacher CK test, student performance test), and one set of qualitative data techniques were developed. This approach provides more breadth, depth, and richness in understanding the complex phenomena of teaching and learning (McKim, 2017; Schulze, 2003). All the study’s instruments and techniques are described below.

Teacher CK Test

For the development of the teacher CK test’s items, the researcher developed a specification table (i.e., a double entrance matrix) (Hill et al., 2004) comprising the content area of basketball (as it is described in the national PE curriculum for 5^{th} and 6^{th} Grade students) and Wards’ (2009) CK knowledge domains. The items were then allocated to individual cells of the matrix on the basis of a priori theoretical considerations. By crossing the content area of basketball (e.g., dribbling, passing, shooting, defensive principles, offensive principles) with the four knowledge domains, an attempt was made to cover the basketball content taught in primary schools and all knowledge domains included in Ward's theoretical framework. For the development of the required test items, a variety of materials was used including: (a) FIBA's official basketball rules (2014); (b) scholarly work on basketball techniques, tactics and common student errors (e.g., Li et al., 2013; Stuhr et al., 2007); and (c) teacher manuals and guidebooks for teaching basketball (e.g., Krause, Meyer, & Meyer, 2008; Paye & Paye, 2013).

More specifically, the teacher test comprised four sets of questions related to: (a) knowledge of the rules, etiquettes, and safety (five items, e.g., Which of the following statements states how a basketball game starts?); (b) knowledge of technique and tactics (six items, e.g., Which of the following statements constitutes incorrect technique when performing the control dribble?); (c) knowledge of errors (six items, e.g., Which of the following statements represents a common error made by students when playing 'person-to-person' off-the-ball defense?); and (d) knowledge of instructional representations and tasks (seven items, e.g., Suppose you observe that beginners have mastered the technique of stationary dribbling. Which of the following statements represents an appropriate extension task? Or, Which is an appropriate sequence of task progressions to teach quick stop and pivot to beginners in 5th and 6th grade?). Nineteen out of the 24 items were multiple-choice with four options; the remaining five items were also closed-ended and asked participants to sequence four options in such a way so that a reasonable progression of PE tasks be developed (see Appendix A).

The construction of the multiple-choice items was based on the following recommendations: (1) the stems were written in positive terms to the highest possible extent (i.e., 17 out of the 19 multiple-choice items were stated in positive terms; in the two negatively stated items, the negative words were underlined and capitalized); (2) the distractors were related to the stem in a plausible way; (3) distractors such as 'none of the above', 'all of the above' were used sparingly (i.e., in 2 out of the 19 multiple-choice items) and were not the correct answers; (4) the distractors and the correct answer of each item were about the same length; (5) the correct answers were listed with near-equal frequency in each of the possible positions of a, b, c and d; (6) patterns that would help the examinees guess the correct answers were avoided; (7) no clues were given in the stems of the items that would help the examinees select the correct answer of other items; and (8) layout issues were considered, i.e., each response was listed starting on a new line; letters instead of numbers were used to identify the responses for each item; all the responses to an item were kept on the same page (Lacy, 2011; Morrow et al., 2011).

In addition to the knowledge items, the test comprised questions eliciting teachers' background information including: (1) *gender*; (2) *coursework*: number of content and methods PE courses the participants had taken during their studies; (3) *PE teaching experience* measured in: (a) years; (b) number of PE classes taught per year; and (c) grade levels taught; (4) *other experiences concerning basketball* (e.g., participation in basketball professional development programs); (5) *frequency of watching professional basketball games*; and (6) *prior experience in playing basketball*.

Student Performance Test

The American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) provides PE teachers, coaches and researchers with a battery of reliable and valid basketball tests (Hopkins, Shick, & Plack, 1984) that measure a range of skills (i.e., speed spot shooting, passing, control dribble, defensive movement). However, all the above mentioned tests are *product-oriented.* That is, they only measure the product of the task (e.g., the speed at which a performer completes a task or the number of successful shots) (Morrow, Jackson, Disch, & Mood, 2011).

In this study, emphasis is placed on evaluating the correct form (i.e., critical elements) of the selected skills. Thus, to measure 5th and 6th grade students' achievement in basketball, a *process-oriented* test was developed and used (i.e., the Basketball Skills and Tactics Test: BaST test). Specifically, the BaST test comprises the following three tasks: (a) the *lay-up task* (LU task); (b) the *dribbling-stopping-pivoting-passing task* (DSPP task); and (c) the *offensive/defensive moves and skills task* (ODeMS task) (see Appendix B). The three tasks include skills and tactics that are aligned with the 5th and 6th Grade national PE curriculum.

In the first two tasks (i.e., LU and DSPP), checklists were used to assess the process criteria (the correct form of the skill executed). In other words, the developed checklists mark the presence or absence of selected critical elements, which "represent the most important components that are absolutely necessary for correct performance" (Lund & Veal, 2013, pp. 92-93). For each of the five skills (i.e., dribble, quick stop, pivot, pass, lay-up) included in the first two tasks, three critical elements were identified (e.g., dribbling: dribble using the fingers and the pads of the hands, keep the ball below waist level, not looking at the ball). In the third task, a simple tally system was used to measure the number of appropriate or efficient and inappropriate or inefficient performances (Griffin, Mitchell, & Oslin, 1997).

The lay-up task. The LU task asked performers to execute lay-ups from the side of the basket they preferred (left or right side of the basket). A practice trial was followed by three evaluated trials. The practice trial gave performers the opportunity to become familiar with the task (Lacy, 2011). In this way, "the measures are accurate estimates of the actual amount of learning that has taken place rather than of the students' abilities to perform in an unfamiliar situation" (Morrow et al., 2011, p. 282). In the case of the LU task, besides the checklist used to assess selected critical elements of the skill (i.e., taking two steps without dribbling before the jump; jumping from the left foot when shooting right-handed and from the right foot when shooting left-handed; shooting right-handed when approaching the basket from the right side and left-handed when approaching the basket from the left side), an objective-accuracy-based measure was used (Morrow et al., 2011); that was the number of successful shots made. Two points were awarded for each successful shot and one point for each shot that was not successful, but the ball hit the hoop on its downward flight. The specific scoring procedure was derived from AAHPERD's speed spot shooting test (1984).

Moreover, as previously described, the LU task included three evaluated trials for each student. Hence, the three selected process criteria (i.e., critical elements) describing the correct execution of a lay-up, were coded in each of the three trials. For a critical element to be considered as present, and thus included in the calculation of the overall student lay-up performance, it should have been coded as present in at least two of the three evaluated trials.

Finally, no critical element was considered to be present and no points were awarded regarding the successful shots made, if the shot was coded as '*non-lay-up*'. For a shot to be considered as a lay-up, it had to meet two basic criteria: (a) steps without dribbling the ball (not necessarily two steps) before the jump; and (b) shot from a jump (not necessarily from a high jump). It is important to stress that these two criteria were used to distinguish a lay-up from a non-lay-up. When a shot was coded as a lay-up, the three selected process criteria (i.e., critical elements) were used to assess the student lay-up performance.

The dribbling-stopping-pivoting-passing task. The DSPP task comprised four skills that the performer had to execute in sequence. Specifically, the task involved dribbling around a course of cones with both hands (change between dominant and non-dominant hand at each cone), executing a quick stop, pivoting left or right and passing (using a chest pass or a bounce pass) to a stationary receiver. The performer could freely choose the direction of the pivot (left or right) and hence where to pass the ball (to a receiver standing to the left side or to a receiver standing to the right side of the stopping point). As in the LU task, a practice trial was given to each performer. In this case, the practice trial was followed by one trial that was evaluated (Kolovelonis, Goudas, & Dermitzaki, 2012).

It is important to note that dribbling around cones approximates the game performance. In basketball, even on the fast break, there must be some degree of controlled speed to allow for control of the ball (Morrow et al., 2011). Other tests measuring dribbling skill, also involve dribbling around a course of cones (e.g., Hopkins et al., 1984; Kolovelonis et al., 2012; Stöckel, Weigelt, & Krug, 2011).

The offensive/defensive moves and skills task. The ODeMS task was based on parts of the Game Performance Assessment Instrument (GPAI, Griffin et al., 1997). The GPAI was developed to assess game performance within its context. Specifically, GPAI includes seven components that demonstrate the ability to solve tactical problems during authentic game situations: (a) return to base; (b) adjust movement; (c) decision making; (d) selected skills execution; (e) support; (f) cover; and (g) guard or mark (Griffin et al., 1997). In the ODeMS task, four components were included (three components from GPAI and a component developed for the purposes of this study). In particular, the ODeMS task comprised the following components: (a) *pass*: the ball reaches the intended target (offensive skill); (b) *support*: off-the ball movement to a position to receive a pass (offensive move); (c) *guard or mark*: defending against an opponent who may or may not have the ball (defensive move); and (d) stealing the ball (defensive skill).

Regarding steals, it is suggested that the number of steals could serve as a good indicator of students' basketball sense and judgment triggered by vision. According to Krause et al. (2008, pp.156-157) '*players should see the ball at all times and use their eyes to anticipate (mind). For example, they should see a careless pass instantly and decide to* *act quickly. Quickness is based on physical readiness and mental anticipation'.* We claim that students may guard or mark correctly by being in the right place at the right moment, but, they may not try to actually gain possession of the ball through steals. Thus, guard or mark together with the number of steals, give a more complete picture of the student's defense performance. In addition, for a student's action to be coded as a 'steal' it had to comply with FIBA's (2012) definition of the term. According to FIBA (2012) a *steal* is credited to a defensive player when his positive, aggressive action causes a turnover by an opponent. This can be done by: (a) legally taking the ball away from an opponent; (b) intercepting an opponent's pass; (c) tipping the ball away from an offensive player in control of the ball such that the ball is loose and a team-mate retrieves the ball, and (d) deflecting an opponent's pass such that the ball is loose and a team-mate retrieves the ball. Steals are credited to the defensive player who first causes the turnover, even if he does not end up with possession of the live ball.

For the purposes of this study, ODeMS task was used to assess game performance (per skill or movement) and game involvement in a three-minutes modified game of basketball (i.e., 2vs2 dribbling and passing in a delimited area without shooting). The game was separated in four segments (45 seconds each). During the first two segments (total duration: 1,5 minutes) the one pair had the ball in its possession. If the other pair managed to steal the ball, the ball was returned and the game was continued. During the first 45-second segment, the two scorers coded the offensive moves/skills of the pair that had the ball in its possession (one scorer – one performer), while, during the second 45-second segment, the scorers coded the defensive moves/skills of the pair that was trying to steal the ball. After the first two segments were over, the ball was given to the other pair and the same procedure was followed for another 1,5 minutes.

To calculate *student performance* for each skill or movement comprised in the task, we divided the number of efficient/appropriate performances by the number of the corresponding inefficient/inappropriate performances (e.g., support performance = number of appropriate supporting movements ÷ number of inappropriate supporting movements). We did not follow the specific approach (i.e., performance = number of appropriate executions ÷ number of inappropriate executions) for the calculation of stealing performance, since in that case we only coded the number of steals per student. Furthermore, for the calculation of the overall *game involvement* we used the sum of the following: (a) number of efficient and inefficient executions of passes; (b) number of appropriate supporting movements; (c) number of appropriate guarding/marking movements; and (d) number of steals. It is important to note that we included the number of inefficient skill executions (i.e., number of inefficient executions of passes) in the calculation of game involvement. According to Griffin and colleagues (1997, pp. 220-221) '*this recognizes that lower ability students, who may not make appropriate decisions or execute skills efficiently, can still be highly involved in a game*'. However, the number of inappropriate supporting and guarding/marking movements was not included in the calculation of game involvement since these parameters clearly indicate lack of involvement in the game.

Qualitative Data Methods

A set of qualitative techniques (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection sheets on the PD program) was used to gain a deeper understanding of the phenomenon under study (from the perspectives of the study's participants). The qualitative techniques are described below.

Lesson plans. As part of the training program, the 23 participants developed and submitted 10 to 12 lesson plans for teaching a basketball unit. Lesson plans were also used in other pertinent studies (e.g., Barrett, Sebren, & Sheehan, 1991) as a technique for gathering evidence on changes in teachers' CK. A simple format of a lesson plan was given to the participants. In each lesson plan, the participants had to record the following:

(a) the expected learning outcomes (i.e., the objectives) of the lesson; (b) the activities (i.e., a set of task progressions) of the lesson; and (c) the amount of time (i.e., number of minutes) allocated to each activity (see Appendix C).

It is indicated, however, that the data drawn out of teachers' lesson plans were, for the most part, related to teachers' SCK (i.e., appropriateness of the sequence of task progressions and of time allocation to the lesson's activities) and not to teachers' PCK (e.g., how the tasks and/or task progressions were adapted to the diverse characteristics of students). That is, we examined context and individual free aspects, which were related to teachers' knowledge of instructional tasks (e.g., tasks involving game-like situations) and to teachers' knowledge of how to appropriately sequence tasks (e.g., from simple to complex or from easy to difficult), regardless of students' interests and abilities.

Self-reflection cards on teaching. The participants in the TG were asked to keep a self-reflection card for every lesson they taught (see Appendix C). More specifically, they were asked to describe: (a) *any positive aspects of the lesson;* and (b) *any difficulties encountered during the lesson.* This type of reflection is referred to by Schon (1983) as *reflection on action*, since it takes place after the instruction. Specifically, 'reflection on action takes place when the practitioner has left the arena of endeavor and mentally reconstructs that arena to analyze actions and events' (Tsangaridou & Siedentop, 1995, p. 213). The development of critically reflective practitioners is actually one of the benefits of the Play Practice model (Launder & Piltz, 2013), which guided the development of this study's training material. According to Launder and Piltz (2013), the ongoing interaction between teacher and student promotes the development of critically reflective practitioners who learn from every experience and every student.

Group interviews. For the purposes of this study, two group interviews (i.e., one interview per training group) were conducted by the researcher. Maykut and Morehouse (2005) define a group interview as a '*group conversation with a purpose'*. Our purpose of doing the group interviews was to bring several different perspectives into contact (Morgan, 1988) through a process that is open, dynamic and emergent. We wanted to find out teachers' thoughts, concerning their two or three first basketball lessons. The interviews provided more time to participants to give meaning to their actions and decisions. Each training group was interviewed in the beginning of the 3rd training session for about 20 minutes. Two main topics were used to guide the discussion during the interviews: (a) *positive aspects of the lessons;* and, (b) *difficulties encountered during the lessons.* Finally, the two interviews were audio-taped, after getting the permission from all the participants.

Self-reflection cards and sheets on the PD program. At the end of the first two PD sessions, the participants were asked to fill out a self-reflection card (see Appendix C). The card comprised three reflection topics: (a) *positive aspects of today's PD session*; (b) *difficulties encountered during today's PD session;* and (c) *suggestions for changes/improvements on the content of the PD.* Based on the participants' suggestions, we gradually modified the content and structure of the PD sessions in an effort to meet the participants' needs. Thus, we decided to omit the completion of the reflection card from the 3rd session onwards for practical reasons (i.e., lack of time).

In the final part of the 5th PD session, the participants were asked to fill out a self-reflection sheet (see Appendix C). The self-reflection sheet included the following topics: (a) *general comments on the content of the PD program (critical elements, cues, videotaped student performances for error recognition, task progression etc.)*; (b) *general comments on the activities included in the training material*; (c) *general comments on the hands-on-activities part* (i.e., the participants practiced in the selected skills and activities) *which was included in the PD program*; and (d) *other general impressions/comments concerning the PD program.*

Development of Training Materials

For the development of the required training materials for the PD program, two key book recourses, among others, were used: (a) "*Play Practice*" (Launder & Piltz, 2013); and (b) "*Basketball Skills & Drills*" (Krause et al., 2008). The four basic principles of Play Practice (Launder & Piltz, 2013) and Ward's (2009, 2011) conceptualization of CK in PE, were employed as a conceptual framework for developing the training materials. The four basic principles of the Play Practice are described in Table 3.1.

Table 3.1

The Four Principles of Play Practice

Principle	Description
Simplifying activities	Simplifying play is about creating learning environments that enable children to experience success. This can be achieved in many ways (e.g., minimizing the technical and/or tactical demands of a game, minimizing the agility and/or endurance demands of a game).
Shaping practices	Shaping play is about *teaching through the game*; it involves manipulating one or more of the variables that form the game (e.g., primary and secondary rules, playing area dimensions, the nature of the goal, the number of players, attacker-to-defender ratio, differential scoring system) in order to create a variety of learning situations that emphasize particular aspects of effective play.
Focusing practices	Focusing play is about *teaching in the game*. Teachers can focus the play by emphasizing the important concepts or cues of the play practice, and then repeating them in various ways to ensure quality and transfer of learning. The *freeze replay* is an important tool for focusing the play.
Enhancing play experiences	The process of enhancing the play is associated with various motivational strategies that can be applied to induce learner interest and maintain an engaged learning state. *Controlled playing time* and *action fantasy games* are examples of ways to enhance the play.

The Play Practice framework (Launder & Piltz, 2013) was chosen to guide the development of the PD training materials since "it is easy to understand and relatively easy to employ" (p. 39). The same approach was used in other pertinent studies (Iserbyt et al., 2017; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015) aiming to develop ‘knowledge packets’. In addition, we suggest that Launder’s principles of Play Practice (Launder & Piltz, 2013) are aligned with Ward’s (2009) CK domains. For example, ‘*shaping play’* is a critical feature in the selection and development of appropriate tasks and/or task progressions (i.e., knowledge of instructional tasks); in addition, ‘*focusing play*’ emphasizes the use of critical elements (i.e., knowledge of technique and tactic) and cues (i.e., knowledge of instructional representations).

Ten primary activities based on specific basketball techniques and tactics comprised the training materials used in this study. These ten activities were sequentially organized based on their level of difficulty and their objectives (e.g., “*end zone*” is a lead-up game). The ten activities included in the training material are described in Table 3.2. In addition to the description of the ten activities, the training material comprised the following components for each given activity: (a) the organizing arrangement using diagrams; (b) a list of critical elements for each skill/tactic; (c) a list of cues for each skill/tactic; (d) a list of common errors and error corrections; and (e) a set of task progressions related to each primary activity (see Appendix D).

For the visual representation of each skill/tactic selected video clips were used (e.g., “Krause,” 2000; “Krause,” 2008). The visual model was important because it provided an ideal model of the performance that the teachers were going to teach (Ward et al., 2014). Video clips of students performing various selected skills were also used. Through the observation and analysis of video clips, teachers were able to develop a critical eye and become familiar with various types of student performances and typical errors made by beginners (Ayvazo, Ward, & Stuhr, 2010).

Finally, the training materials included descriptions of five main basketball rules (FIBA, 2014): (a) jump ball and alternating possession; (b) violations: player/ball out-of-bounds; (c) violations: travelling; (d) fouls: personal foul; and (e) general provisions: free throws.

Table 3.2

The Ten Activities Included in the Training Material

Activities	Skills (technique)	Offensive tactic	Defensive tactic
End zone: lead-up game (e.g., 5vs5, 6vs6)	• Passing principles • Catching principles	• Support: moving to an open space to receive a pass	• Protect your basket: moving between the opponent and the basket/target
Passing game in open space (e.g., 2vs1, 3vs2)	• Types of passes	• Faking a cut and changing direction • Selection of the appropriate type of pass	• Marking/guarding one opponent
Dribbling game: dribble-freeze-tag (e.g., 6vs6, 7vs7)	• Control (low) dribble • Speed dribble	• Moving away from pressure	
Dribbling, stopping and pivoting drill/game in groups of three	• Control and speed dribble • Quick stop • Pivot	• Moving away from pressure	
Dribbling, passing and possession game in delimited space (e.g., 2vs2, 3vs3)	• All the previous	• All the previous	• All the previous • Defensive stance • Defensive movement (sliding)
Shooting game in half-court (e.g., 3vs2)	• All the previous • Set-shot	• All the previous • Keeping distance from teammates • Passing the ball to a teammate who is in a better shooting position	• All the previous
Shooting game in delimited space (1vs1)	• All the previous except passing • Lay-up	• All the previous except supporting and passing	• All the previous • On-the-ball defense (live or dead ball)
Shooting game (e.g., 2vs1)	• All the previous	• All the previous • Give and go	• All the previous
Mini game in half-court (3vs3)	• All the previous	• All the previous • Continuous movement	• All the previous • Off-the-ball defense
Modified basketball game in full-court: two zones (e.g., 6vs6, 8vs8)	• All the previous	• All the previous	• All the previous

The Intervention

As mentioned above, the teachers of the TG had to attend to a number of afternoon training sessions. Specifically, the teachers had to participate in five 2,5-hour sessions which were held biweekly. At the beginning of the first training session, the instructor (i.e., the researcher) provided an overview of the program, including: (a) the purpose and objectives of the PD program (see Table 3.3), (b) the structure and content of each training session (see Table 3.4 and/or Appendix E for a detailed description of the structure and content of each PD session), and (c) the basic principles of Play Practice (Launder & Piltz, 2013) (see Table 3.1).

Table 3.3

The Objectives of the CK PD Program

Objectives
Concerning the selected basketball skills and tactics the teachers will: 1. be familiarized with the critical elements for the execution of each skill/tactic, 2. discriminate between correct and incorrect performances, 3. identify common errors made by the students and recommend appropriate corrections, 4. represent the tasks by using visual (e.g., appropriate demonstration) and verbal (e.g., cues) representations, 5. develop appropriate sequences of task progressions considering: (a) the students' age and skill level, (b) the principles of Play Practice, 6. be familiarized with the basic rules for playing basketball.

In order to achieve the objectives of the PD program, each training session comprised the following components: (a) *modeling the selected basketball skills/tactics for each activity by the instructor* (i.e., descriptions, demonstrations, presentation of related critical elements and cues); (b) *error recognition* (e.g., through the observation and analysis of video-taped student performances); (c) *participation in the activities* (i.e., the participants practiced in the selected skills/tactics, while, the instructor provided specific congruent feedback); (d) *presentation of related student common errors and error corrections by the instructor*; (e) *developing developmentally appropriate sequences of task progressions* (i.e., the participants developed a sequence of task progressions for each skill/tactic); (f) *presentation of related task progressions by the instructor;* (g) *discussions on the ideas presented* (e.g., how they might transfer PD materials or experiences into their classrooms, reflection on teaching); and (h) *evaluation which occurred both during* *and at the end of each session*[10] [i.e., a set of written questions and an assessment score sheet for each skill/tactic; the assessment score sheet was used by the instructor to access the demonstrations of the participants in each case (see Appendix F)]. If a participant did not meet the criteria, further training occurred.

Table 3.4

The Structure and Content of the PD Program

Session	**Content**
Session 1	• *Overview of the program* (i.e., purpose and objectives, structure and content, Play Practice principles, principles for the development of appropriate sequences of task progressions) • ***Activity 1***: End zone: lead-up game (e.g., 5vs5, 6vs6) • ***Activity 2***: Passing game in open space (e.g., 2vs1, 3vs2)
Session 2	• *Basketball rule*: Jump ball and alternating possession • ***Activity 3***: Dribbling game: dribble-freeze-tag (e.g., 6vs6, 7vs7) • ***Activity 4***: Dribbling, stopping and pivoting drill/game in groups of three
Session 3	• *Basketball rule*: Player/ball out-of-bounds • ***Activity 5***: Dribbling, passing and possession game in delimited space (e.g., 2vs2, 3vs3) • ***Activity 6***: Shooting game in half-court (e.g., 3vs2)
Session 4	• *Basketball rules*: Personal foul – Free throws • ***Activity 7***: Shooting game in delimited space (1vs1) • ***Activity 8***: Shooting game (e.g., 2vs1)
Session 5	• *Basketball rule*: Travelling • ***Activity 9***: Mini game in half-court (3vs3) • ***Activity 10***: Modified basketball game in full-court: two zones (e.g., 6vs6, 8vs8)

Notes. The skills and tactics relevant to each activity are presented in Table 3.2.

At the end of each session, the training material was given to the participating teachers in printed format. In particular, the printed format of the training material comprised the following for each activity: (a) the description of the activity; (b) the organizing arrangement using diagrams; (c) a list of critical elements for each related skill/tactic; (d) a list of cues for each related skill/tactic; (e) a list of related common errors

[10] For practical reasons the written evaluation was administered only at the end of the first two sessions. The reasons are explained in a previous section (see p. 91).

and error corrections; and (f) a set of task progressions related to each primary activity (see Appendix D).

Furthermore, the participants were asked to gradually develop 10-12 lesson plans for teaching a basketball unit. Teachers' lesson plans had to be consistent with the training material (i.e., emphasis had to be placed on the ten primary activities that were included in the training material) and the knowledge they received in each session (e.g., critical elements and cues for each skill/tactic, task progressions, Play Practice' principles). All the lesson plans were gradually collected by the instructor, who provided written feedback to the teachers regarding the content and structure of their first 2 or 3 lesson plans[11]. It should be mentioned that the lesson plans developed were not only used for the purposes of the PD program but also constituted the actual lessons taught to the students.

Finally, throughout the PD program and at its culmination, the participants were asked to reflect on their teaching (i.e., self-reflection card for each basketball lesson, group interview after teachers taught their first 2 or 3 basketball lessons) and on the content of the PD program (i.e., self-reflection card for each training session[12], final self-reflection sheet on the PD program) (see Appendix C).

Data Collection Processes

The data collection was organized into four consecutive phases. Phase 1 comprises the recruitment and training of scorers, while phase 2 refers to the process of teachers' recruitment. Phase 3 involves the procedure of administrating the pre-tests (i.e., student performance test and teacher CK test), and finally, phase 4 comprises the administration of post-tests.

[11] The developed lesson plans were gradually submitted to the researcher. The researcher provided written feedback to the participating teachers after the submission of the first series of lesson plans (two or three lesson plans per teacher).
[12] For practical reasons the self-reflection card was administered only at the end of the first two sessions. The reasons are explained in a previous section (see p. 91).

Phase 1: Scorer Recruitment and Training

For the purposes of this study, six performance scorers were carefully recruited. Four out of six scorers were master's students in a post-graduate degree in PE and sport pedagogy. The other two scorers were master's students in post-graduate degrees in the education department and had a background in PE (i.e., specialization in PE during their under-graduate studies).

After expressing their willingness to participate in the study, the scorers underwent an intensive training program during September 2015. The training program comprised four three-hour training sessions. In the first training session, scorers were informed about the general purpose of the study and their specific role. Moreover, the performance test and the relative assessment scoring rubrics/sheets (see Appendix B) were thoroughly described and discussed. During the discussion, the selected critical elements of each skill were specified and clarified. After the discussion, scorers used the assessment rubrics/sheets to code the videotaped student performances relevant to the skills under consideration. The scores were discussed and whole-group feedback was given to the scorers.

In the second session, particular emphasis was placed on the coding procedure. The scorers had the chance to code multiple videotaped student performances. Their scores were then compared with the master codes, and individualized feedback was given to them. At the end of the second session, scorers took an inter-rater test, based on a different set of videotaped student performances. The six scorers' general percentages of agreement (i.e., the average percentage of agreement to the three tasks included in the performance test) with master-codes did not meet the minimum acceptable threshold of 80% agreement[13]. Therefore, scorers were assigned to code those tasks for which they had high percentages of agreement (i.e., two scorers were assigned to code the ODeMS task and the DSPP task, and the other two, the ODeMS task and the LU task). In doing so, all the

---

[13] The general percentages of agreement for each scorer were the following: Scorer A: 82%; Scorer B: 84%; Scorer C: 80%; Scorer D: 75%; Scorer E: 74%; Scorer F: 77%.

scorers achieved satisfactory percentages of agreement with the master-coder ratings and were thus certified. Specifically, the final percentages of agreement for each scorer were the following: Scorer A: 83%; Scorer B: 88%; Scorer C: 90%; Scorer D: 80%; Scorer E: 85%; Scorer F: 81%.

The last two sessions took place at a school setting and their aim was two-fold: first, to inform scorers on how to set up the test's materials, and second, to get the scorers familiarized with the live-conditions of the test administration. The test administration, besides the live coding of students' performances, included the instructions and the demonstration of the desired movement skills for each task (i.e., LU task, DSPP task, and ODeMS task). For the purposes of these two sessions, the six scorers were divided into two groups. Each group pilot coded the live performances of students from two different classes (5th and 6th grade).

After the four training sessions, four out of the six scorers were divided into two groups (i.e., two scorers per group). The first group was responsible for coding students' performance in the one educational district, and the second group was responsible for the other educational district. The remaining two trained scorers, whenever necessary, substituted the four main scorers (e.g., in case of illness). These initial groups were maintained during the administration of the pre-test. During the administration of the post-test, one of the four main scorers left the scorers' group for personal reasons, thus, one of the substitute scorers took her place. Finally, all the scorers attended a two-hour retraining session due to the extended break between the administration of the pre- and the post-tests (McKenzie & van der Mars, 2015).

Phase 2: Teacher Recruitment

After obtaining the relevant permission for conducting the study in public primary schools from the Centre of Educational Research and Evaluation of Cyprus, all the volunteer teachers were contacted via phone and were informed about the aim and the procedures of the study. As described in a previous section, 23 out of the 52 teachers volunteered to participate in the TG, while, 29 teachers agreed to participate in the CG. After each phone conversation an email was sent to each principal enclosing a letter which informed participants about the aim and the procedures of the study, the written permission for conducting the study, and the teacher and students' parents/guardians consent forms.

Phase 3: Pre-Test Administration

Once the study sample was recruited, data on student achievement were collected by administering the BaST test to the students whose parents had consented to participate in the study. During each administration, the performance of the students was coded by a pair of scorers. In addition, in order to minimize waiting time, students of each class were split into two groups (according to their serial number in the class roster) while taking the test: the first group was performing the LU task, while, the second group was performing the DSPP task; then the two groups alternated. After the completion of the first two tasks, the two groups were reunited and the students, as one group this time, were performing the ODeMS task. At the same time, the participating teachers' level of CK in basketball was assessed by administering the teacher CK test described previously; it was administered as an untimed test.

Phase 4: Post-Test Administration

After the completion of the basketball unit in all the participating classes (around mid-March), the participating teachers' level of CK in basketball and their student achievement in basketball were measured again following the same procedure as in pre-test administration.

Issues of Validity and Reliability

The following section describes how issues of validity and reliability were addressed in this study. Specifically, this section summarizes the following: (a) teacher CK test validation; (b) student performance test validation; (c) training material validation; (d) trustworthiness of the qualitative data; and (e) scorer training and reliability.

Validation of the Teacher CK Test

The test items were content-validated by an expert panel consisting of three practicing teachers, three content-specific experts and two teacher educators. The experts were asked to answer the following questions regarding the test items: (a) To which extent the items cover the breadth of basketball content taught in elementary schools? (b) Are there any items that include developmentally inappropriate skills/principles? (c) Are there any incomprehensible items/terms? (d) Are there any extremely difficult/easy items? Based on the experts' suggestions (e.g., clarification of some items/terms, omission of an easy item, reduction of the given tasks from five to four in the task progression items), the instrument was refined and finalized for the purposes of the study.

In addition, the CK test has been pilot-tested in a previous study (cf. Stefanou et al., 2015) conducted in Cyprus between April and May 2015. Specifically, the teacher test was administered to a convenience sample of 238 in-service generalist teachers from 21 different schools, during formal personnel meetings. The Rasch analysis revealed that the instrument has satisfactory psychometric properties (Bond & Fox, 2007); namely, construct validity and reliability.

Table 3.5 provides a summary of the scale statistics that emerged based on the performance of the 238 teachers to the items of the CK test. The entire sample scale was found to have high reliability for test items (r=0.97) and moderate reliability for teachers (r=0.64), infit and outfit mean squares close to one, and infit and outfit t's close to zero. The methods which were used to analyze the data of the main study are described in a following section.

Table 3.5

Psychometric Properties of the Scale Developed to Capture Teacher CK in Basketball

Statistical Indicators		**Scale (N=238)**
Means	(items)	0.00
	(subjects)	-0.40
Standard deviations	(items)	0.89
	(subjects)	0.65
Reliability	(items)	0.97
	(subjects)	0.64
Mean infit mean square	(items)	1.00
	(subjects)	1.01
Mean outfit mean square	(items)	0.99
	(subjects)	0.99
Infit *t*	(items)	-0.04
	(subjects)	0.02
Outfit *t*	(items)	-0.07
	(subjects)	0.03

Content Validation of the Student Performance Test (BaST test)

The BaST test was content-validated by four experts (i.e., content-specific experts/teacher educators). To establish content validity of the performance test, experts made an in-depth study and confirmed that the test included developmentally appropriate skills/tactics and appropriate critical elements for assessing the correct form of all the selected skills/tactics.

In addition, the performance test was administered to 5th and 6th grade students of six classes (three classes per grade), during May 2015. Based on the information gleaned, the test was refined and finalized for use in the main study. The following major amendments were made: (a) *DSPP task*: it was decided to increase the distance of the pass from 3 to 4 meters (4 meters are more developmentally appropriate); (b) *LU task*: it was decided to reduce the number of critical elements from 4 to 3 to facilitate the coding procedure; and (c) *ODeMS task*: it was decided to separate the three-minute game in four segments (45 seconds each) and to omit two skills (one offensive and one defensive) in an effort to facilitate the live coding procedure.

Content Validation of the Training Materials

To ensure the content validity of the ten activities included in the training materials, four experts (i.e., content-specific experts/teacher educators) were asked to thoroughly check the following: (a) the extent to which the activities cover the breadth of basketball content taught in elementary schools; (b) the appropriateness of the sequence of the activities (i.e., progressive content development, that has the potential to facilitate student learning); (c) the developmental appropriateness of the content (i.e., practices and content that are suitable for 5^{th} and 6^{th} grade students); and (d) the appropriateness of the critical elements, cues, common errors and related set of task progressions for each activity. In light of their comments, minor amendments were made as follows: (a) inclusion of some additional cues (e.g., offensive tactic regarding movement without the ball: '*create passing lanes*'); (b) inclusion of some additional challenges (e.g., '*how many balls can you touch in one minute*' in the '*dribble-freeze-tag game*'; (c) clarification of some activities' descriptions (e.g., '*end zone'*, '*passing game in open space 2vs1 or 3vs2*', '*shooting game 2vs1*'); (d) improvements on the diagrams presenting the organizing arrangements of each activity (i.e., '*passing game in open space 2vs1 or 3vs2*', '*shooting game 2vs1*'); (e) inclusion of some more activities in the given sets of task progressions (e.g., the '*end zone*' to be played with a different attacker-to-defender ratio); and (f) inclusion of some alternative activities to minimize students' waiting time in the case of certain activities (e.g., '*shooting game in delimited space 1vs1*').

Scorer Training and Reliability

To support the reliability of the collected data, as previously described, the scorers were carefully selected, underwent intensive and comprehensive training, and were certified only when their ratings met the minimum acceptable threshold of 80% agreement with the master-coder ratings. Moreover, all the scorers attended a two-hour retraining session due to the extended break between the administration of the pre- and the post-tests (McKenzie & van der Mars, 2015).

Trustworthiness of the Qualitative Data

A variety of techniques were used to support the trustworthiness of the qualitative data. Initially, it is acknowledged that the primary researcher of this study functions as the major instrument of data collection and analysis (Lincoln & Guba, 1985; Patton, 1990). He was also the person who developed and implemented the training materials. Thus, to support the researcher's credibility, an autobiographical report relevant to the phenomenon under study is provided next (Maxwell, 2013; Maykut & Morehouse, 2005; Shenton, 2004). Specifically, the researcher is himself an in-service generalist teacher with 14 years of experience in teaching PE. In fact, during the last 8 years, the researcher has been specialized in teaching PE (i.e., he only teaches PE to all primary school grade levels). The researcher also has experience concerning research on teaching PE (e.g., he was a member of a scorer team and a member of an expert panel for the purposes of previous PE studies).

To further ensure the conformability (i.e., objectivity: the study's findings are the result of the experiences and ideas of the participants, rather than the characteristics and preferences of the researcher; see Shenton, 2004) and credibility of this study's findings, additional techniques were used. First, all four sources of qualitative data (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection sheets on the PD program) were considered in the process of theme identification (i.e., data triangulation). Convergence of a major theme or pattern in the data from the different sources lends strong credibility to the findings (Brewer & Hunter, 1989; Guba, 1981; Maykut & Morehouse, 2005). Second, the researcher thoroughly examined the data for both confirming and disconfirming evidence, i.e., negative cases (Erickson, 1986; Lincoln & Guba, 1985; Miles & Huberman, 1994).

Finally, a peer reviewer examined the data independently (Mertens, 2014). Once generated, the themes (i.e., categories) that emerged were passed to the reviewer, who was asked to code a significant part of the data. Specifically, the peer reviewer coded 40% of the interview data (14 out of 35 excerpts; 93% agreement with the researcher); 15% of the self-reflection cards on teaching (21 out of 143 excerpts; 90% agreement with the researcher); 11% of the self-reflection sheets on the PD program (10 out of 88 excerpts; 100% agreement with the researcher); and 10% of the data referring to the lesson plans (15 out of 151 lesson plans). Concerning the lesson plans the reviewer was asked to code the data in regard to three aspects: (a) sequentially appropriate/inappropriate task progressions (87% agreement with the researcher); (b) appropriate/inappropriate allocation of time to the various activities (100% agreement with the researcher); and (c) relevance between lesson's objectives and activities (100% agreement with the researcher).

Data Analysis

Quantitative and qualitative analyses were undertaken to analyze the data. Specifically, apart from descriptive and inferential analysis, three advanced statistical techniques (i.e., item-response-theory analysis, multiple regression analysis, and multilevel regression analysis) were utilized for the analysis of the quantitative data. Furthermore, for the analysis of the qualitative data, an inductive method (i.e., constant comparative method) was used. It is important to note, that the qualitative data was collected and analyzed in conjunction with the quantitative data, so as to increase the study's internal validity. Internal validity refers to the degree to which observed changes in the study's dependent variables (i.e., teacher CK and student achievement) can be ascribed to changes in specific independent variables facilitating trustworthy interpretations about causal relationships (Halperin, Pyne, & Martin, 2015; Shadish et al., 2002). The techniques and methods that were used for the purposes of this study are described below.

Descriptive and Inferential Analyses

A series of descriptive (i.e., percentages, means, standard deviations) and inferential analyses (i.e., independent samples *t*-test) were carried out, in order to compare the teachers and students of the TG to those of the CG. Specifically, we compared teachers' initial (i.e., pre-test) and final (i.e., post-test) performance in the basketball CK test, and their students' initial and final performance in the basketball performance test (i.e., DSPS task, LU task, and ODeMS task). Descriptive statistics enabled us to explore teachers' performance in each item of the teacher CK test, and students' performance in each skill (e.g., dribbling, stopping, pivoting, passing) or principle (e.g., supporting, guarding) included in the performance test.

Item-Response-Theory (IRT) Analyses

The psychometric properties of both the teacher CK test and the student performance test were tested by developing two IRT scales[14]. In particular, the extended logistic model of Rasch (Andrich, 1988) was applied using the computer program Quest (Adams & Khoo, 1996). IRT was preferred over Classical Test Theory since in IRT models, the difficulty level of each item or task can be estimated and placed on the same scale as the ability of the participants (i.e., teachers or students). This information enables the researcher to determine the ability levels at which the test functions best (Charalambous, Kyriakides, & Philippou, 2012; Safrit, Cohen, & Costa, 1989; Thomas, Nelson, & Silverman, 2015), and thus, to identify possible gaps in construct coverage (Green & Frantom, 2002; Reise & Revicki, 2015).

[14] A limitation of the Rasch analysis pertains to the fact that it considers the items included in the teacher CK test as forming just one scale. Although from analyses run it seems that the different sub-scales (i.e., CCK items and SCK items) are moderately related ($r=.66$, $p<.001$), it is possible that a multidimensional scale could also describe the data. Although separate Rasch models could be run for each single sub-scale we opted for the option presented above, because we did not have enough items (and hence enough power) to run separate scales.

Specifically, by applying Rasch analysis we tested the following: (a) the extent to which the 24 items[15] included in the basketball CK test and the 11 performance indices[16] included in the basketball performance test (i.e., BaST test), could be reducible to a common unidimensional scale (Reise & Revicki, 2015) in each case; (b) whether the items/tasks could be ordered according to their difficulty degree, and the persons (i.e., teachers or students) according to their performance in the construct under investigation (cf. Antoniou & Kyriakides, 2013; Kyriakides, Creemers & Antoniou, 2009); and (c) how well the two scales could discriminate among persons (i.e., teachers or students) based on their estimated performance in the corresponding tests (i.e., teacher CK test or student performance test), and at the same time, how well the items/tasks could be discriminated from one another on the basis of their difficulty (Andrich, 1988). To this end, a number of item and person fit statistics was calculated for both scales. The examination of the fit statistics included the following: (a) whether fit mean squares (i.e., outfit and infit) of the emerging scales were close to 1; (b) whether the normalized infit-*t* and outfit-*t* values had a mean of zero; (c) whether the separability for test items/tasks and students/teachers was higher than 0.75; and (d) whether the person estimates were well targeted against the item fit estimates (Bond & Fox, 2007).

Multiple Regression Analyses

The general goal of a multiple regression analysis is to quantify the relationships among a set of independent or predictor variables and a single dependent or criterion variable (Beckstead, 2012). This goal is sometimes pursued from a predictive perspective and at other times from an explanatory perspective (Kerlinger & Pedhazur, 1973;

[15] The 24 items included in the basketball CK test are based on Ward's (2009) four knowledge domains: (a) knowledge of the rules, etiquettes, and safety; (b) knowledge of technique and tactics; (c) knowledge of errors; and (d) knowledge of instructional representations and tasks (e.g., task progression).
[16] The 11 performance indices comprise six basketball *skills* (i.e., dribbling, quick stop, pivoting, passing, shooting layups, and shooting accuracy in layups) and five *elements of game performance* (i.e., passing in game, supporting, guarding/marking, stealing the ball, and game involvement) .

Pedhazur, 1997; Pedhazur & Schmelkin, 1991). In this study, both perspectives (i.e., predictive and explanatory) are of primary interest. Thus, we sought to maximize the predictive ability of the regression equation (i.e., adding predictor variables based on their ability to increase R^2), and at the same time, to gain theoretical insight or substantive understanding of each predictor's relationship to the criterion (i.e., interpreting the sign and size of regression weights).

More specifically, we conducted a multiple linear regression analysis aiming to predict and explain teachers' final performance in the basketball CK test, based on three independent variables: *teachers' initial performance* in the basketball CK test, *participation in the PD program* (i.e., participation in the TG or CG), and *teaching experience in PE measured in classes taught per year*[17]. The third independent variable (i.e., teaching experience measured in classes taught per year) was excluded from the analysis. The number of the independent variables, which were initially included in the analysis (i.e., three variables), was determined by the size of the sample (i.e., 52 participants). In order to gain the necessary statistical power to run the specific analysis, we followed the subject to predictor ratio threshold of '15 subjects to 1 predictor' (Cohen et al., 2003; Shavelson, 1996). In doing so, we wanted to avoid the problems associated with underpowered studies and their corresponding Type II errors, which can yield misleading results (Cohen, 1994; Rossi, 1990; Sedlmeier & Gigerenzer, 1989).

Furthermore, to strengthen the trustworthiness of our results we have tested a series of assumptions of multiple linear regression. Specifically, we have checked the following assumptions: (a) *outliers* (i.e., extreme scores should be deleted from the data set); (b) *multicollinearity* (i.e., independent variables should not be highly correlated, $r \geq .90$), and

[17] The three independent variables included in the multiple regression analysis were chosen among a set of independent variables related to teachers' background characteristics (i.e., gender, coursework: number of content and methods PE courses the participants had taken during their studies, PE teaching experience measured in years, PE teaching experience measured in grade levels taught, other experiences concerning basketball, frequency of watching professional basketball games, and prior experience in playing basketball). All these independent variables did not contribute significantly to the predictive ability of the regression equation, when included in the analysis and hence were dropped from further analysis.

singularity (i.e., independent variables should not be perfectly correlated); (c) *linearity* (i.e., the residuals should have a linear relationship with the predicted scores of the dependent variable); (d) *homoscedasticity* (i.e., the variance of the residuals should be the same across all levels of the independent variables); (e) *normality* (i.e., the residuals should be normally distributed); and (f) *independence of residuals* (i.e., the residuals should not be correlated) (Cohen, Cohen, West, & Aiken, 2003; Osborne & Waters, 2002).

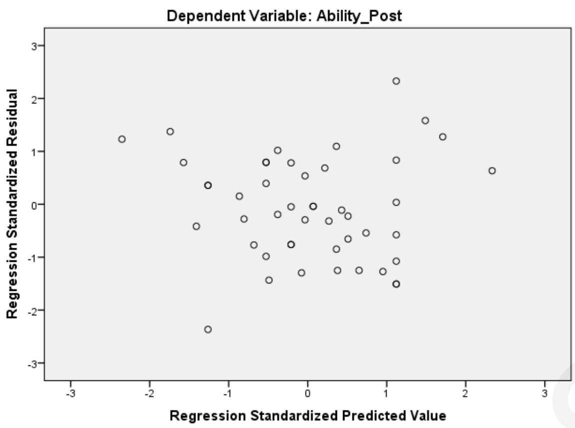


Figure 3.1 Scatterplot of standardized residuals.

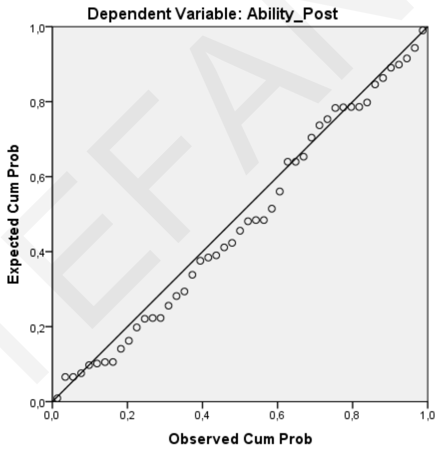


Figure 3.2 Normal P-P plot of standardized residuals.

The emergent model met all the assumptions for multiple linear regression. Initially, an analysis of standard residuals was carried out, which showed that the data contained no outliers (Std. Residual Min = -2.37, Std. Residual Max = 2.33). The specific assumption was also confirmed by checking the values of Mahalanobis distance (i.e., all the values were below the acceptable limit 13.82 for two independent variables, MD: 0.85 – 7.70). The data also met the assumption of multicollinearity and singularity, since the values for tolerance and VIF for the two independent variables were close to 1 (Participation in the PD program, Tolerance = .97, VIF = 1.03; Initial performance, Tolerance = .97, VIF = 1.03). In addition, the scatterplot of standardized residuals showed that the data met the assumption of linearity. As we can see in Figure 3.1, the residuals are randomly scattered around 0 providing a relatively even distribution. The histogram of standardized residuals and the normal P-P plot of standardized residuals (see Figure 3.2) also suggest that the assumption of normality was met. The histogram indicates that the residuals are normally distributed, and the normal P-P plot shows that the points follow the straight line. Finally, the data met the assumption of the independence of residuals, since the Durbin-Watson value was close to 2 (Durbin-Watson value = 1.96).

Multilevel Analyses

After running the above analyses, multilevel analyses were conducted (Luke, 2004) in order to investigate the contribution of the PD program to student achievement. Specifically, a two-level model (i.e., students nested within classes/teachers) was run with students' final performance (i.e., post-test) as the dependent variable and the intervention entered as explanatory variable at the teacher level. This approach is considered appropriate for investigating the contribution of interventions targeted at the teacher level (e.g., Antoniou & Kyriakides, 2013; Creemers, Kyriakides, & Antoniou, 2012; Konstantopoulos, 2011). The omission of the school level was reasonable both because there were several schools in which only one PE teacher was sampled (i.e., 37 out of 43 schools) and because of the present study's interest in exploring the contribution of a CK PD program, which is situated at the teacher rather than at the school level.

Moreover, statistical power was taken into account for applying the multilevel analyses. In order to tap sufficient variance, it is typically recommended to sample at least 40 higher level units (e.g., Cools et al., 2009). For the purposes of this study, the two-level model was considered appropriate, since the study's sample consisted of 913 students enrolled in 52 different classes.

The first model established in the study was the empty model (Model 0). For the estimation of the empty model no explanatory variable was included in the analysis. This was done to investigate how the total variance was allocated to the two levels (i.e., student and teacher level) and, therefore, determine the extent to which it was reasonable to run a multilevel than a single level analysis. Subsequently, explanatory variables were added at the two different levels. Specifically, a number of explanatory variables related to students were introduced into Model 1a (i.e., student initial performance and student background characteristics: grade level, gender, and left-handedness), while, the teacher background variables (e.g., gender, teaching experience in PE, prior experience in playing basketball) were added in Model 1b. Finally, the variables pertaining to teachers' initial and final performance in the CK test, and the variable pertaining to teachers' participation in the PD program (i.e., participation in the TG or CG) were added in Model 2a and Model 2b, respectively.

Constant Comparative Method for Analyzing the Qualitative Study Data

The qualitative data collected for the purposes of this study (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection sheets on the PD program) were analyzed inductively by using the constant comparative method (Maykut & Morehouse, 2005), in order to identify and generate common themes across participants. The researcher first prepared the data by typing all the handwritten documents (i.e., lesson plans, self-reflection cards on teaching, self-reflection sheets on the PD program) and by transcribing the audio-taped group interviews. After typing all the data, the next step was to identify units of meaning in the data; in our case, we selected thematic units since these were considered more appropriate to capture and code significant aspects of the data related to the implementation of the intervention and its effectiveness or lack thereof. This process is referred to by Lincoln and Cuba (1985) as *unitizing* the data, and it was carried out through several, and careful, readings of the data. In order to be useful for analysis, each unit of meaning identified in the data should stand by itself, i.e., it had to be understandable without additional information, except for knowledge of the researcher's focus of inquiry (Lincoln & Cuba, 1985).

Once the unitizing process was completed, the researcher carried out the analysis of the data in three consecutive stages: (a) inductive category coding; (b) refinement of categories; and (c) exploration of relationships and patterns across categories (Maykut & Morehouse, 2005). Inductive category coding involved reviewing the initial concepts and themes (i.e., units of meaning), and combining ideas that overlapped with one another. Each group of similar ideas was considered to be a provisional coding category. Subsequently, the initial coding categories were refined and reorganized by comparing units of meaning across categories. During this second stage of analysis (i.e., refinement of categories), *rules of inclusion* were written, which served as the basis for including (or excluding) subsequent units of meaning in each category. Finally, in the third stage of analysis, the focus was to closely examine all the emerged categories for possible connections and patterns. Through this final stage, some broader categories were developed, which describe important aspects of the phenomenon under study.

Moreover, for analyzing the data from the lesson plans, a specific coding scheme was developed. In particular, the coding scheme included the following categories: (1) *number of lessons allocated to teaching each skill or tactic*: the coding was based on the recorded objectives of each lesson plan; (2) *alignment between the lesson's objectives and activities*: the coding was based on the existence of activities, which were considered to be suitable for the development of the recorded objectives (e.g., objectives related to the development of tactics had to be aligned with activities comprising game-like situations). Thus, a lesson plan could be coded either as 'aligned' or as 'nonaligned'; (3) *appropriateness of the sequence of task progressions*: the coding was based on the existence of sequentially appropriate or inappropriate task progressions. A sequence of task progressions was coded as appropriate if each task was progressed from the prior task in the following manner: from simple to complex, from easy to difficult, or from static to dynamic (Kim & Ko, 2017). Thus, a sequence of task progressions was coded as inappropriate if a task was inappropriately progressed from the prior task; and (4) *appropriateness of time allocation*: the coding was based on the allocation of time (i.e., minutes) to the lesson's activities. Time allocation to the lesson's activities was coded as appropriate if adequate time was devoted to activities comprising game like-situations, (i.e., 10 minutes or more). If inadequate time (i.e., less than 10 minutes), or no time at all, was allocated to activities comprising game-like situations, the time allocation was coded as inappropriate. The 10-minute minimum threshold of game-like situations per lesson was also used in other pertinent studies (e.g., Iserbyt et al., 2017; Kim, 2011; Sinelnikov et al., 2016; Ward et al., 2014).

Justification of the Design and Methods Chosen

A quasi-experimental research design (Shadish et al., 2002) was used to examine the contribution of a CK PD program (i.e., the intervention) to in-service generalist teachers' level of CK and to student achievement, which involved two waves of measurement (i.e., pre- and post-tests). The specific research design is referred to by Shadish and colleagues (2002, p. 136) as '*the untreated control group design with dependent pretest and posttest samples*'. This research design was deemed appropriate, since it allowed the researcher to test the hypothesis that there are relationships between teachers' CK and student achievement by manipulating the level of teachers' CK (through the intervention).

We must, of course, note that our original intension was to use an experimental design. However, it was not feasible to randomly allocate the participants to the experimental and control group, since participation in the experimental group required attending afternoon PD sessions. Particularly, the allocation to the two groups was based on the participants' availability of free afternoon time. Therefore, the presence of selection bias had to be examined in terms of baseline (pre-intervention) characteristics. As described in a previous section, the two groups were equal in respect to teachers' background characteristics[18] and teachers' initial level of CK in basketball. Nevertheless, it is acknowledged that the absence of pre-test differences in a quasi-experimental study is never proof that selection bias is absent, since unmeasured variables might cause the selection (Shadish et al., 2002).

Furthermore, it is acknowledged that the study could have investigated the contribution of the CK PD program (and/or teachers' level of CK) to the quality of teaching PE. For example, data from lesson observations could have been collected and used to measure teaching quality. The use of observation data could provide objective information and prevent many of the biases related to self-report data (Strong, 2011). Yet, due to budget and time limitations this was not feasible.

Finally, non-probability sampling techniques (i.e., convenience and snowball sampling) were employed to build the teacher sample, due to budget constraints (e.g., no compensation was given to the participants in the group that received the treatment). Although the sample was not randomly selected, the chi-square test revealed that the sample was representative of the primary school teacher population of Cyprus in terms of teachers' enrollment in urban and suburban/rural schools (x^2=2.54, df=1, p=0.11). In addition, anecdotal evidence suggested that the study's sample was largely representative to the teacher population under consideration in terms of PE teaching experience (measured in years) and gender[19]. However, it is acknowledged that the results obtained from the study's sample should be generalized to the general population with great caution (Strauss & Corbin, 1990).

[18] The following teachers' background characteristics were compared: (a) gender; (b) coursework: number of content and methods PE courses the participants had taken during their studies; (c) PE teaching experience measured in years; (d) PE teaching experience measured in number of PE classes taught per year; (e) PE teaching experience measured in grade levels taught; (f) other experiences concerning basketball; (g) frequency of watching professional basketball games; and (h) prior experience in playing basketball.

[19] Unofficial reports suggest that the percentage of male teachers that teach PE in primary education is around 85%. The percentage of male teachers in the study's sample was very close to that (i.e., 90%).

Chapter Summary

This chapter outlined the research methods that were followed in the study. First, the research setting was described, with particular emphasis on providing information concerning teaching PE in Cypriot primary schools. Second, information on the participants (i.e., the criteria for inclusion in the study, and the sampling techniques) and their allocation to the TG and CG was provided. Third, the development of the training material and the intervention (i.e., procedures and content of the PD program) were described. Fourth, the instruments and techniques that were used for data collection were also described, along with the procedures that were followed to carry out the study. Fifth, issues of validity and reliability were addressed, regarding all the instruments, techniques and materials that were used in the study. Sixth, the researcher discussed the methods used to analyze the data, and lastly, the justification of the chosen research design and methods was discussed.

CHAPTER 4: RESULTS

Abstract

The present study had two main aims. The first aim concerned the development of two reliable and valid scales (i.e., teacher CK test and student performance test) to measure in-service teachers' CK and students' performance in basketball. The second aim was to investigate the contribution of a basketball CK PD program to in-service generalist teachers' level of CK and to student achievement in basketball. The data analysis regarding the first aim indicated that the two scales had satisfactory psychometric properties. Concerning the second aim, findings revealed that teachers who participated in the PD program exhibited significantly higher performance than those who did not. Likewise, the students whose teachers participated in the PD program exhibited significantly higher gains in performance than those whose teachers did not participated in the PD program. In addition, teacher final CK was found to be a significant predictor of student achievement. The qualitative data indicated that the significant gains in both, teachers' CK and students' achievement in basketball can be (at least partly) attributed to the content and procedures of the PD program.

The results are organized around the four research questions that the study sought to answer:

1. Can a scale with good psychometric properties that measures in-service teachers' CK in basketball be developed?
2. Can a scale with good psychometric properties that measures students' performance in basketball be developed?
3. What is the contribution of a basketball CK PD program to in-service teachers' level of CK in basketball?
4. What is the contribution of a basketball CK PD program to student achievement in basketball?

Research Question 1: Can a scale with good psychometric properties that measures in-service teachers' CK in basketball be developed?

The extended logistic model of Rasch (Andrich, 1988)[20] was utilized in order to test the psychometric properties of the scale developed to measure teacher CK in basketball. The psychometric properties of a scale are crucial for the interpretability and

[20] The Rasch analyses were run by using the computer program Quest (Adams & Khoo, 1996).

generalizability of the construct being measured. Particularly, we tested the following: (a) the extent to which the 24 items[21] included in the basketball CK test, could be reducible to a common unidimensional scale (i.e., unidimensionality); (b) whether the items could be ordered according to their difficulty degree, and the teachers according to their performance in the construct under investigation; and (c) how well the scale could discriminate among teachers based on their estimated performance in the CK test, and at the same time, how well the items could be discriminated from one another on the basis of their difficulty (i.e., reliability).

Table 4.1

Item and Teacher Parameter Estimates for the Scale Developed to Measure Teacher CK in Basketball

Statistical Indicators		**Scale (N=337[a])**
Means	(items)	0.00
	(cases)	-0.13
Standard deviations	(items)	0.92
	(cases)	0.87
Separability[b]	(items)	0.98
	(cases)	0.75
Mean Infit mean square	(items)	1.00
	(cases)	1.00
Mean Outfit mean square	(items)	1.00
	(cases)	1.00
Infit *t*	(items)	-0.09
	(cases)	0.01
Outfit *t*	(items)	-0.03
	(cases)	0.06

Notes.[a] The cases pertain to all the data concerning teacher performance in the basketball CK test (i.e., pilot study data: 238 cases; pre-test data: 52 cases; post-test data: 47 cases). All cases were used in the same analysis to gain the necessary statistical power to run the specific analysis. This also helped put the pre- and the post-test scores on the same scale and avoid equating procedures.
[b] Separability (i.e., reliability) represents the percentage of observed variance that is explained.

To begin, Table 4.1 provides a summary of the statistics for the scale developed to measure teacher CK in basketball. The scale was found to have high separability (i.e., reliability) for test items (r=0.98) and relatively satisfactory separability for teachers

[21] The 24 items included in the basketball CK test are based on Ward's (2009) four knowledge domains: (a) knowledge of the rules, etiquettes, and safety; (b) knowledge of technique and tactics; (c) knowledge of errors; and (d) knowledge of instructional representations and tasks (e.g., task progression).

(r=0.75). This indicates that the emerged scale discriminates satisfactorily among teachers based on their estimated performance in the CK test and among the items included in the CK test on the basis of their difficulty (Andrich, 1988). Moreover, the infit/outfit mean squares were equal to 1.00 and the values of the infit/outfit t scores were close to zero, implying that there is a good person and item fit to the Rasch model.

```
--------------------------------------------------------------------------------
Item Estimates (Thresholds)
(N = 337 L = 24 Probability Level= .50)
--------------------------------------------------------------------------------
   HIGH ACIEVEMENT IN THE CK TEST                  DIFFICULT ITEMS
  4.0                                 |
                                      |
                                      |
                                      |
                                 XX   |
                                      |
                                      |
                                      |
  3.0                                 |
                                      |
                                XXX   |
                                      |
                                      |
                                      |
                                 XX   |
                                  X   |
  2.0                                 |
                              XXXXX   |
                                      |      23
                          XXXXXXXXX   |
                                      |
                       XXXXXXXXXXXX   |      17
                                      |
                XXXXXXXXXXXXXXXXXXX   |      22
  1.0                             X   |       7      14
                       XXXXXXXXXXXX   |
                                  X   |
              XXXXXXXXXXXXXXXXXXXXX   |      16      18      24
                 XXXXXXXXXXXXXXXXXX   |       8
                                  X   |       6
                 XXXXXXXXXXXXXXXXXX   |       9      21
   .0              XXXXXXXXXXXXXXXX   |       4
                              XXXXX   |       2      11
        XXXXXXXXXXXXXXXXXXXXXXXXXXX   |
         XXXXXXXXXXXXXXXXXXXXXXXXXX   |       3      10
                                XXX   |
           XXXXXXXXXXXXXXXXXXXXXXXX   |      20
                           XXXXXXXX   |      13
       XXXXXXXXXXXXXXXXXXXXXXXXXXXX   |      15
 -1.0         XXXXXXXXXXXXXXXXXXXXX   |      19
                                XXX   |      12
               XXXXXXXXXXXXXXXXXXXX   |
                                 XX   |       5
                                 XX   |
                        XXXXXXXXXXX   |
                               XXXX   |
                            XXXXXXX   |
 -2.0                                 |
                                      |
                                  X   |
                                      |       1
                                      |
                                  X   |
                                  X   |
                                      |
 -3.0                                 |
    LOW ACIEVEMENT IN THE CK TEST                    EASY ITEMS
--------------------------------------------------------------------------------
Each X represents 1 teacher's performance in the CK test
================================================================================
```

Figure 4.1 The one-parameter IRT scale capturing teachers' level of CK in basketball.

In addition, Figure 4.1 illustrates the scale for the 24 items included in the basketball CK test. Both item difficulties and teachers' measures are calibrated on the same scale. Figure 4.1 reveals that the items have a good fit to the measurement model and are well targeted against the teachers' measures. Specifically, teachers' scores range from -2.70 to 2.74 logits, with the exception of two cases that went beyond 3 logits (i.e., 3.46). At the same time, the item difficulties range from -2.33 to 1.68 logits. The targeting of the items measuring teacher CK in basketball could be improved in two ways: (a) by the inclusion of relatively more difficult items (i.e., their difficulties should range from 1.68 to 2.74 logits); and (b) by the inclusion of relatively easier items (i.e. their difficulties should range from -2.33 to -1.38 logits).

Moreover, Table 4.2 presents the fit indices and the difficulty level for each item included in the teacher CK test. As it can be observed, all the values of the infit and outfit mean squares are within the acceptable range of 0.5 – 1.5, which is identified as "productive for measurement" (Linacre, 2017). Concerning the values of the infit and outfit t, two items (i.e., item 7 and item 16) have values well beyond the acceptable range of ± 2 (Bond & Fox, 2007). However, if mean-squares are acceptable, then Zstd [i.e., infit/outfit t] can be ignored (Linacre, 2017). That is, the values of the infit/outfit mean squares are used to test the hypothesis '*Do the data fit the model usefully?'* whereas the values of the infit/outfit t are used to test the hypothesis '*Do the data fit the model perfectly?*' (Linacre, 2017). Thus, concerning our findings, the values of the infit/outfit mean squares suggest that the data fit the Rasch model usefully, while the values of the infit/outfit t suggest that in some cases (i.e., item 7 and item 16) the data do not fit the Rasch model perfectly. In other words, these items are useful to the measurement but require further refinement (Karim, Shah, Din, Ahmad, & Lubis, 2014).

Table 4.2

Item Difficulty, Standard Errors and Fit Indices for the Items Included in the Teacher CK Test

CK Items[a]		Task Difficulty (SE)	Fit			
			Infit Mean Square	Outfit Mean Square	Infit t	Outfit t
Item 1	How does a basketball game start?	-2.33 (.17)	1.00	1.08	.01	.40
Item 5	When a player stops dribbling, what is he/she allowed to do with the ball?	-1.38 (.13)	.84	.69	-2.60	-2.50
Item 12	Which of the following statements describes what will happen, when a foul is committed on a player while releasing a shot from the 2-point field goal area?	-1.06 (.13)	.95	.84	-.90	-1.40
Item 19	Which of the following statements represents a common error made by students when performing a pivot?	-.94 (.13)	.98	1.01	-.30	.10
Item 15	Which of the following situations is not a case of out-of-bounds violation?	-.77 (.12)	.94	.87	-1.20	-1.30
Item 13	Which of the following statements constitutes incorrect tactic when two offensive players face one defensive player?	-.77 (.13)	.90	.85	-2.0	-1.50
Item 20	Which is an appropriate instructional progression to teach the selection of the appropriate type of pass to beginners?	-.62 (.13)	.90	.87	-2.10	-1.40
Item 10	Which of the following statements constitutes incorrect technique when performing a quick stop?	-.33 (.12)	1.11	1.14	2.40	1.60
Item 3	Which of the following statements represents a common error made by students when performing speed dribbling?	-.28 (.12)	1.09	1.22	1.90	2.40
Item 2	Which of the following statements constitutes incorrect technique when performing control dribbling?	-.12 (.12)	.99	.99	-.30	-.10
Item 11	Which of the following statements represents a common error made by students when performing a set-shot?	-.03 (.12)	.93	.90	-1.60	-1.20
Item 4	Suppose you observe that beginners have mastered the technique of lay-up without dribbling. Which of the following statements represents an appropriate extension task?	.07 (.12)	.91	.88	-1.90	-1.40
Item 21	Which is an appropriate instructional progression to teach 'give-and-go' to beginners?	.14 (.13)	.90	.86	-2.20	-1.70
Item 9	Which of the following situations is not a case of travelling violation?	.21 (.12)	.98	.98	-.40	-.20
Item 6	Which of the following statements constitutes incorrect technique when performing a bounce pass with two hands?	.28 (.12)	.99	1.06	-.10	.70
Item 8	Suppose you observe that beginners have mastered the technique of stationary dribbling. Which of the following statements represents an appropriate extension task?	.38 (.12)	1.08	1.09	1.50	.90
Item 16	Which of the following statements constitutes incorrect technique when performing the defensive stance?	.50 (.13)	1.20	1.31	3.50	3.0
Item 18	Which of the following statements constitutes incorrect technique when performing a lay-up?	.54 (.13)	1.13	1.17	2.30	1.70
Item 24	Which is an appropriate instructional progression to teach quick stop and pivot to beginners?	.56 (.13)	.85	.79	-2.80	-2.30
Item 7	Which of the following statements represents a common error made by students when performing a chest pass?	.94 (.13)	1.29	1.44	4.10	3.40
Item 14	Which of the following statements represents a common error made by students when playing 'person-to-person' defense?	.97 (.14)	1.19	1.25	2.80	2.0
Item 22	Which is an appropriate instructional progression to teach fakes without the ball to beginners?	1.06 (.14)	.90	.81	-1.40	-1.60
Item 17	Which of the following statements represents a common error made by students on offense?	1.27 (.14)	1.05	1.05	.60	.40
Item 23	Which is an appropriate instructional progression to teach defensive stance and defensive sliding to beginners?	1.68 (.16)	.85	.86	-1.50	-.80

Notes.[a] Light blue: Knowledge of the rules (CCK); Blue: Knowledge of technique and tactics (CCK); Light red: Knowledge of common errors (SCK); Red: Knowledge of tasks – task progressions (SCK).

Table 4.2 also shows the ranking of the items in terms of their level of difficulty. As can be seen in the table, item 23 is the hardest and item 1 is the easiest. Overall, the items corresponding to the knowledge of rules (the light blue items) were easier than the items of the other three knowledge domains, while, the items corresponding to the knowledge of technique and tactics (the blue items), for the most part, were found to have middling difficulty. At the same time, six of the items corresponding to the knowledge of errors and instructional tasks (i.e., SCK) were the hardest items. Thus, our findings, to a degree, corroborate arguments that SCK items are harder (i.e., demand unique understanding and reasoning) than CCK items (e.g., Ball et al., 2008; Ward, 2009).

Research Question 2: Can a scale with good psychometric properties that measures students' performance in basketball be developed?

The extended logistic model of Rasch (Andrich, 1988) was also utilized in order to test the psychometric properties of the scale developed to measure student performance in basketball. Particularly, we tested the following: (a) the extent to which the 11 tasks[22] included in the basketball performance test could be reducible to a common unidimensional scale (i.e., unidimensionality); (b) whether the tasks could be ordered according to their difficulty degree, and the students according to their performance in the construct under investigation; and (c) how well the scale could discriminate among students based on their estimated basketball performance, and at the same time, how well the tasks could be discriminated from one another on the basis of their difficulty (i.e., reliability).

Table 4.3 provides a summary of the statistics for the scale developed to measure student achievement in basketball. The scale was found to have high separability (i.e., reliability) for test items (r=0.98) and considerably good separability for students (r=0.82).

[22] The term *tasks* describes the skills (i.e., dribbling, stopping, pivoting, passing, stealing the ball and passing in game situations), tactics (i.e., supporting, guarding/marking) and game dimensions (i.e., game involvement) included in the student performance test (i.e., BaST test).

This indicates that the emerged scale discriminates satisfactorily among students based on their estimated performance in the performance test and among the tasks included in the performance test on the basis of their difficulty (Andrich, 1988). Moreover, the infit/outfit mean squares were equal or close to 1.00 and the values of the infit/outfit t scores were close to zero, implying that there is a good person and item fit to the Rasch model. The value of outfit t for students (i.e., 0.10) is not considered to depart remarkably from zero.

Table 4.3

Item and Student Parameter Estimates for the Scale Developed to Measure Student Achievement in Basketball

Statistical Indicators		**Scale (N=1726[a])**
Means	(tasks)	-0.01
	(cases)	-0.32
Standard deviations	(tasks)	0.67
	(cases)	0.78
Separability[b]	(tasks)	0.98
	(cases)	0.82
Mean Infit mean square	(tasks)	1.00
	(cases)	0.98
Mean Outfit mean square	(tasks)	1.00
	(cases)	1.00
Infit *t*	(tasks)	-0.04
	(cases)	-0.03
Outfit *t*	(tasks)	0.01
	(cases)	0.10

Notes.[a] The cases pertain to all the data concerning student performance in basketball (i.e., pre-test data: 888 cases; post-test data: 838 cases). All cases were used in the same analysis to gain the necessary statistical power to run the specific analysis. This also ensured that students' pre- and post-intervention performance was put in the same scale.
[b] Separability (i.e., reliability) represents the percentage of observed variance that is explained.

Moreover, Figure 4.2 illustrates the scale for the 11 tasks included in the student performance test. Both item difficulties and teachers' measures are calibrated on the same scale. Figure 4.2 reveals that the tasks have a good fit to the measurement model and are well targeted against the students' measures. Specifically, students' scores range from -2.70 to 2.74 logits, with the exception of 14 cases (out of 1726 cases) that scored below -3 logits (i.e., -4.00 to -3.88 logits). Concurrently, the tasks difficulties range from -2.88 to 2.05 logits, with only one exception (i.e., item 4.1), where the task difficulty was below -3 logits (i.e., -3.63). The targeting of the tasks measuring student performance in basketball could be improved in two ways: (a) by the inclusion of a few relatively more difficult tasks (i.e., their difficulties should range from 2.05 to 2.74 logits); and (b) by the inclusion of a few relatively easier tasks (i.e. their difficulties should range from -2.88 to -1.56 logits).

```
--------------------------------------------------------------------------------
Item Estimates (Thresholds)
(N =1726 L = 11 Probability Level= .50)
--------------------------------------------------------------------------------
    HIGH ACHIEVEMENT IN THE                      DIFFICULT TASKS
       PERFORMANCE TEST
  3.0                              |
                                   |
                                   |
                                   |
                                   |
                                   |
                                   |
                                   |      1.3
  2.0                              |
                                   |
                               X   |
                               X   |      3.3
                                   |     11.3
                               X   |      8.4
                              XX   |
                             XXX   |      2.3    6.4
  1.0                        XXX   |      3.2
                             XXX   |      7.5
                       XXXXXXXXX   |      5.3   10.4   11.2
                            XXXX   |      3.1    6.3    9.4
                    XXXXXXXXXXXX   |
                 XXXXXXXXXXXXXXX   |      4.3    5.2    6.2    7.4
                       XXXXXXXXX   |      5.1    6.1
             XXXXXXXXXXXXXXXXXXX   |      8.3   10.3
   .0                   XXXXXXXX   |      2.2    9.3
             XXXXXXXXXXXXXXXXXXX   |      7.3
                    XXXXXXXXXXXX   |     11.1
             XXXXXXXXXXXXXXXXXXX   |      2.1    8.2
                      XXXXXXXXXX   |      9.2   10.2
                       XXXXXXXXX   |      7.2
                       XXXXXXXXX   |
 -1.0                    XXXXXXX   |      4.2
                        XXXXXXXX   |      8.1    9.1
                        XXXXXXXX   |     10.1
                                   |      1.2
                           XXXXX   |
                          XXXXXX   |      7.1
                                   |
                                   |
 -2.0                      XXXXX   |
                                   |
                                   |
                           XXXXX   |
                                   |
                                   |
                                   |
                             XXX   |      1.1
 -3.0                              |
                                   |
                                   |
                                   |
                                   |
                                   |      4.1
                               X   |
                                   |
 -4.0                              |
    LOW ACHIEVEMENT IN THE                          EASY TASKS
       PERFORMANCE TEST
--------------------------------------------------------------------------------
  Each X represents 8 students' performances in the basketball performance test
================================================================================
```

Figure 4.2 The one-parameter IRT scale capturing students' achievement in basketball.

In addition, Task 4.1[23] was found to be the easiest item included in the student performance test. The specific task corresponds to the passing task included in the DSPP test, and, more precisely, to the process criterion (i.e., critical element) '*passing the ball accurately'.* The specific process criterion was coded as present in 1665 student performances (out of 1717) which occurred both during the pre- and post-tests. Furthermore, as it can be observed, one task (i.e., Task 1.3) was somewhat more difficult compared to the sample's ability. The specific task corresponds to the dribbling task included in the DSPP test, and, more precisely, to the process criterion '*dribble without watching the ball*'. The specific process criterion was coded as present in only 126 student performances (out of 1717), from which 98 occurred during the post-test administration.

Moreover, Table 4.4 presents the fit indices and the difficulty level for each task included in the student performance test. As it can be observed, all the values of the infit and outfit mean squares are within the acceptable range of 0.5 – 1.5, which is identified as "productive for measurement" (Linacre, 2017). Concerning the values of the infit and outfit t, four performance indices (i.e., supporting in game, game involvement, passing in game, and stealing in game) have values well beyond the acceptable range of ± 2 (Bond & Fox, 2007). However, as described in the previous section, if mean-squares are acceptable, then Zstd [i.e., infit/outfit t] can be ignored (Linacre, 2017). Thus, our findings indicate that these items (i.e., supporting in game, game involvement, passing in game, and stealing in game) are useful to the measurement but require further refinement (Karim et al., 2014). Finally, Table 4.4 also shows the ranking of the student performance indices (i.e., skills or movements) in terms of their level of difficulty. In particular, the skill of *pivoting* was found to be the hardest, whilst, the skill of *passing* was found to be the easiest.

[23] The decimal numbers represent the item thresholds, which correspond either to the number of the performance criteria (i.e., critical elements) which were coded as present (e.g., 0-3) for the skills/tactics included in the student performance test or to the frequency of specific skills/dimensions (i.e., *task 7*: game involvement; *task 11*: number of steals).

Table 4.4

Item Difficulty, Standard Errors and Fit Indices for the Tasks included in the Student Performance Test

Skills/Tactics	Task Difficulty (SE)	Fit			
		Infit Mean Square	Outfit Mean Square	Infit t	Outfit t
Passing	-1.39 (.19)	1.03	1.02	1.20	.50
Dribbling	-.70 (.16)	.95	.96	-1.30	-.90
Supporting in game	-.27 (.09)	.88	.86	-4.20	-3.10
Game involvement	-.26 (.10)	.78	.75	-7.30	-6.50
Guarding in game	-.24 (.09)	1.06	1.05	2.0	1.10
Passing in game	.05 (.10)	1.28	1.36	8.30	7.30
Quick stop	.21 (.09)	.98	1.01	-.70	.20
Lay-up	.39 (.09)	.93	.97	-2.20	-.30
Shooting accuracy in lay-up	.56 (.12)	.99	1.05	-.20	.60
Stealing in game	.62 (.12)	1.22	1.25	6.10	4.60
Pivoting	1.06 (.16)	.89	.71	-2.2	-3.20

Research Question 3: What is the contribution of a basketball CK PD program to in-service generalist teachers' level of CK in basketball?

To answer this research question a series of descriptive (i.e., percentages, means, standard deviations) and inferential analyses (i.e., independent samples *t*-test) were carried out. In addition, we conducted a multiple linear regression analysis aiming to explain teachers' final performance in the basketball CK test. Finally, insights on teachers' task progressions (as depicted in their lesson plans), and on teachers' self-reflections on the PD program contribute toward a deeper understanding of the study's findings.

Descriptive and Inferential Statistics

Tables 4.5, 4.6, and 4.7 present descriptive and inferential statistics concerning the two groups' (i.e., treatment and comparison group) percentages of success in both pre- and post-tests. The three tables together give a more complete picture concerning teachers' level of CK in basketball before and after the intervention.

Table 4.5

Percentages of Success for the Items of the CK Test: Comparison between the Treatment and the Comparison Group

CK Items		Pre-test					Post-test				
		Treatment Group (n=23)	Comparison Group (n=29)	t	df	p	Treatment Group (n=23)	Comparison Group (n=24)[a]	t	df	p
AA	**Rules and etiquettes**										
1.	How does a basketball game start?	0.91	0.93	.24	50	.81	1.00	0.75	-2.77	23.00	.01
2.	When a player stops dribbling, what is he/she allowed to do with the ball?	1.00	0.97	-.89	50	.38	1.00	1.00			
3.	Which of the following situations is not a case of travelling violation?	0.52	0.66	.93	48	.36	0.83	0.63	-1.56	43.32	.13
4.	Which of the following statements describes what will happen, when a foul is committed on a player while releasing a shot from the 2-point field goal area?	0.96	0.97	.16	50	.87	1.00	0.92	-1.45	23.00	.16
5.	Which of the following situations is not a case of out-of-bounds violation?	0.96	0.86	-1.21	46.70	.23	1.00	0.83	-2.15	23.00	.04
	Technique and tactics										
6.	Which of the following statements constitutes incorrect technique when performing control dribbling?	0.74	0.59	-1.16	49.21	.25	0.91	0.71	-1.82	38.67	.07
7.	Which of the following statements constitutes incorrect technique when performing a bounce pass with two hands?	0.57	0.59	.15	50	.88	0.87	0.58	-2.28	40.77	.03
8.	Which of the following statements constitutes incorrect technique when performing a quick stop?	0.61	0.41	-1.40	50	.17	1.00	0.71	-3.08	23.00	.005
9.	Which of the following statements constitutes incorrect tactic when two offensive players face one defensive player?	0.87	0.97	1.21	31.98	.24	0.91	0.79	-1.17	41.09	.25
10.	Which of the following statements constitutes incorrect technique when performing the defensive stance?	0.45	0.59	.95	47	.35	0.61	0.48	-.88	44	.39
11.	Which of the following statements constitutes incorrect technique when performing a lay-up?	0.48	0.34	-.96	50	.34	0.74	0.38	-2.64	45	.01

Table 4.5 Continued

CK Items	Pre-test					Post-test				
	Treatment Group (n=23)	Comparison Group (n=29)	t	df	p	Treatment Group (n=23)	Comparison Group (n=24)	t	df	p
<u>Students' errors</u>										
12. Which of the following statements represents a common error made by students when performing speed dribbling?	0.65	0.72	.549	50	.585	0.61	0.75	1.03	45	.31
13. Which of the following statements represents a common error made by students when performing a chest pass?	0.22	0.14	-.742	50	.462	0.61	0.17	-3.40	41.14	.001
14. Which of the following statements represents a common error made by students when performing a set-shot?	0.70	0.62	-.555	50	.581	0.83	0.79	-.29	45	.77
15. Which of the following statements represents a common error made by students when playing 'person-to-person' defense?	0.26	0.29	.194	49	.847	0.61	0.13	-3.88	38.47	.001
16. Which of the following statements represents a common error made by students on offense?	0.22	0.24	.200	50	.842	0.48	0.33	-1.00	45	.32
17. Which of the following statements represents a common error made by students when performing a pivot?	0.78	0.76	-.200	50	.842	0.96	0.83	-1.38	35.97	.18
<u>Instructional tasks</u>										
18. Suppose you observe that beginners have mastered the technique of lay-up without dribbling. Which of the following statements represents an appropriate extension task?	0.57	0.48	-.582	50	.563	0.91	0.79	-1.17	41.09	.25
19. Suppose you observe that beginners have mastered the technique of stationary dribbling. Which of the following statements represents an appropriate extension task?	0.48	0.34	-.964	50	.340	0.74	0.46	-2,01	44.70	.05
20. Which is an appropriate instructional progression to teach the selection of the appropriate type of pass to beginners?	0.91	0.73	-1.701	42.928	.096	0.87	0.79	-.70	45	.49
21. Which is an appropriate instructional progression to teach '*give-and-go*' to beginners?	0.73	0.46	-1.909	45.826	.063	0.70	0.75	.41	45	.69
22. Which is an appropriate instructional progression to teach fakes without the ball to beginners?	0.32	0.19	-.993	46	.326	0.78	0.46	-2.38	44.10	.02
23. Which is an appropriate instructional progression to teach defensive stance and defensive sliding to beginners?	0.23	0.20	-.223	45	.824	0.70	0.46	-1.66	45	.10
24. Which is an appropriate instructional progression to teach quick stop and pivot to beginners?	0.50	0.42	.523	46	.603	0.83	0.50	-2.47	42.79	.02

Notes.[a] Due to practical reasons (i.e., teacher absences from the schools, other commitments that teachers had) it was not possible to obtain data (i.e., post-test) from five teachers participating in the comparison group. In the pre-test, three of them scored above (i.e., .47 to 1.05 logits) the average teachers' performance (i.e., .45 logits) and two below this performance (i.e., -.18 logits)

To begin, Table 4.5 presents the teachers' performance per CK test item. Specifically, the *t*-test revealed that there were not any statistically significant differences (p.<05) in the percentages of success between the two groups concerning the pre-test. In other words, the teachers of the TG and CG were found to have a similar level of basketball CK prior to the intervention. On the other hand, statistically significant differences (p.<05) were found regarding the percentages of success in nine items of the post-test (i.e., items 1, 5, 7, 8, 11, 13, 15, 22, and 24). In all these cases, the teachers participating in the TG exhibited a higher level of basketball CK than the teachers participating in the CG.

Moreover, Table 4.6 below presents the average percentages of success in the four CK domains proposed by Ward (2009). In particular, the *t*-test revealed that there were not any statistically significant differences at p.<05 between the two groups concerning the pre-test performance. On the contrary, statistically significant differences were found concerning the two groups' post-test performance in all the knowledge domains.

Table 4.6

Percentages of Success in the Four Knowledge Domains: Comparison between the Treatment and the Comparison Group

Knowledge Domains	**Pre-test**					**Post-test**				
	TG (n=23)	**CG (n=29)**	**t**	**df**	**p**	**TG (n=23)**	**CG (n=24)**	**t**	**df**	**p**
Rules and etiquettes	.86	.88	.36	50	.72	.97	.82	-3.02	28.81	.005
Technique and tactics	.62	.57	-.68	50	.50	.84	.61	-4.13	45	.001
Students' errors	.47	.46	-.18	50	.86	.68	.50	-3.47	45	.001
Instructional tasks	.53	.41	-1.69	49	.10	.79	.60	-3.34	45	.002

At the same time, the Rasch analysis, described in a previous section (see pp. 116-121), confirmed the above results. Specifically, by using the cases difficulty estimates we explored the extent to which there were any significant differences between the overall performance of the two groups in the pre- and post-tests. As it is observed in Table 4.7, the teachers participating in the TG performed significantly better in the post-test than those participating in the CG. Once again, we found that the difference concerning teachers' performance in the pre-test was not statistically significant. The distinct nature, in respect to the post-test performance of the two groups, was verified statistically with Cohen's *d* for effect size (Cohen, 1988). In particular, the effect size was *d*=1.60, which indicates a strong effect. However, it is noted that both groups exhibited a higher level of basketball CK in the post-test than in the pre-test.

Table 4.7

Comparison of the Pre- and Post-Test Performances between the Teachers of the Treatment and the Comparison Group

	Treatment Group (n=23)		Comparison Group (n=29; 24)				
	Mean	**SD**	**Mean**	**SD**	**t**	**df**	**p**
Performance in pre-test	.62	.80	.32	.66	1.33	50	.19
Performance in post-test	1.86	.91	.63	.64	5.35	45	.001

Multiple Regression Analysis

A multiple linear regression was then conducted to predict and explain teachers' *final CK level* in basketball (i.e., final performance in the basketball CK test), based on two independent variables: *participation in the PD program*, and *teachers' initial CK level in basketball*[24]. The regression coefficients are presented in Table 4.8. Specifically, using the stepwise method, we found that the *participation in the PD program* (Model 1) was a significant predictor of *teachers' final CK level in basketball* [F(1, 41)=28.65, p<.001]. Including *teachers' initial CK level* in the analysis, further improved the model's (Model 2)

[24] Except from these two variables a third independent variable was included in the regression analysis (i.e., teaching experience in PE measured in classes taught per year). This third independent variable was excluded from the analysis. For more information see the section of data analysis in Chapter 3 (p. 108).

predictive ability [$F(2,40) = 40.95$, $p < .001$]. As it is noted, the first independent variable (i.e., participation in the PD program) explained 40% of the variance in the *teachers' final CK level in basketball*, while the inclusion of the second independent variable (i.e., teachers' initial CK level in basketball) increased the explained variance of the dependent variable from 40% to 66%.

Table 4.8

Stepwise Multiple Regression Analysis for the Variables Explaining Teachers' Final Performance in the CK Test (N=47)

Independent Variables	B (SE)	β
Model 1		
Participation in PD (no-CG=0, yes-TG=1)	1.30 (0.24)	.64*
Model 2		
Participation in PD	1.12 (0.19)	.55*
Initial Performance	.62 (0.11)	.52*

Notes. R^2= .40 for Model 1; R^2= .66 for Model 2.
*p <001.

Furthermore, the results presented in Table 4.8 suggest that the two independent variables, *participation in the PD program* and *teachers' initial CK level in basketball*, had comparable beta values (i.e., standardized coefficients), and thus, it can be inferred that they had an almost equivalent contribution to predicting teachers' final CK level in basketball. In particular, based on the final model (Model 2) and by controlling the other independent variable of the model, a teacher who participated in the PD program scored an average of 1.12 points more than a teacher who did not, while an increase of one standard deviation in the variable *teachers' initial CK level in basketball* resulted in an increase of 0.52 standard deviations in *teachers' final performance.*

Finally, the emergent model met all the assumptions for multiple linear regression (i.e., checking for outliers, multicollinearity/singularity, linearity, homoscedasticity, normality, and independence of residuals). The specific results are presented thoroughly in Chapter 3 (see pp. 108-110).

Insights on Teachers' Task Progressions as Depicted in their Lesson Plans

From the above results (see Tables 4.5, 4.6, 4.7, and 4.8), it can be inferred that teachers who participated in the PD program (i.e., the intervention) exhibited higher performance than those who did not. We suggest that this change in teachers' CK can be (at least partly) attributed to the content and procedures of the PD program. The data drawn from the teachers' lesson plans support this argument.

Specifically, as it was described in the previous chapter, the teachers participating in the PD were asked to gradually develop 10-12 lesson plans for teaching a basketball unit. It is important to note once more that these lesson plans were not developed just for the purposes of the PD program; in contrast, they were used by the teachers during teaching basketball to their students. The researcher gradually collected 151 lesson plans from 19 teachers[25]. Through a thorough examination of these 151 lesson plans, 18 cases of sequentially inappropriate task progressions were identified (see Table 4.9 for examples of sequentially inappropriate task progressions). The rest of the lesson plans comprised sequences of task progressions which followed the principles discussed in the PD program (i.e., gradual increase of the difficulty level of the assigned tasks during the lesson or series of lessons).

Table 4.9

Examples of Sequentially Inappropriate Task Progressions found in Teachers' Lesson Plans

Lesson's topic	**Sequentially inappropriate task progressions**	**Comments**
Types of passes	• [...] *Activity 4*. Passing game in delimited space (2vs2). • *Activity 5*. Passing game in open space (2vs1). […]	Activity 5 is easier than activity 4 for two reasons: (a) in activity 5 there is only one defender, while in activity 4 there are two defenders; and (b) passing in delimited space is more difficult than passing in open space.

[25] Four teachers participating in the PD program did not submit their basketball unit lesson plans.

Table 4.9 Continued

Lesson's topic	Sequentially inappropriate task progressions	Comments
Types of passes	• […] *Activity 2*. The students are divided into two teams. The two teams line up in the same way. The first student of each team passes the ball to the second student (chest or bounce pass). Then the second student passes the ball to the third student and so on. The game is continued until the ball returns to the first student. The first team to complete the task wins. • *Activity 3*. Students stand in circles and pass the ball to each other using different types of passes. […]	Activity 2 is more difficult than activity 3, since it comprises time pressure.
Control and speed dribble	Lesson 1 • […] *Activity 2*. The students walk and dribble in open space. […] • *Activity 3*. The students run and dribble in open space. […] • *Activity 6*. Dribbling game in open space (1vs1). One student is dribbling and the other tries to steal the ball. Lesson 2 • […] *Activity 5*. The students are kneeling: (a) they dribble by keeping the ball close to them; (b) they move the ball around them and then farther out; (c) they change to the non-preferred hand; (d) they repeat the sequence with closed eyes. […]	The specific inappropriate task progression is observed across the first two lessons. The activities comprised in lesson 2 are used in the early stages of teaching beginners how to dribble (Launder & Piltz, 2013), and thus, they should have been taught before the activities comprised in lesson 1.
Defensive stance/slide	• *Activity 1*. The teacher demonstrates the defensive stance and the students get in the stance (without an opponent). • *Activity 2*. The teacher demonstrates the defensive slide and the students perform it (without an opponent). • *Activity 3*. Passing game in delimited space (2vs2). The students try to complete 5 consecutive passes without losing the possession of the ball. […]	There is a "gap" between activity 2 and 3, since the defensive stance and slide are taught to beginners. Before 2vs2 game-like situations, the defensive stance and slide can be practiced in 1vs1 situations (first without and then with a ball).
Types of shots: Lay-up	• […] *Activity 3*. The students line up and shoot layups. Students' errors are discussed and the teacher demonstrates the correct technique. • *Activity 4*. The students shoot layups to open space [without a basket]. • *Activity 5*. The students shoot layups to the basket […]	No task progression is used to teach the lay-up. The students are expected to perform the complete skill after the teacher's demonstration. Lay-up typically is taught progressively (e.g., at first without a ball, then with a ball but without dribbling and so on).

What was interesting about the sequentially inappropriate task progressions was their distribution across the basketball unit. As it can be observed in Figure 4.3, the percentage of sequentially inappropriate task progressions gradually decreased after the second lesson. From the eighth lesson onwards, no sequentially inappropriate task progression was found in the teachers' lesson plans. This finding conveys in a tangible manner the gradual increase in teachers' CK level in basketball and especially the increase of teachers' SCK (i.e., knowledge of instructional tasks).

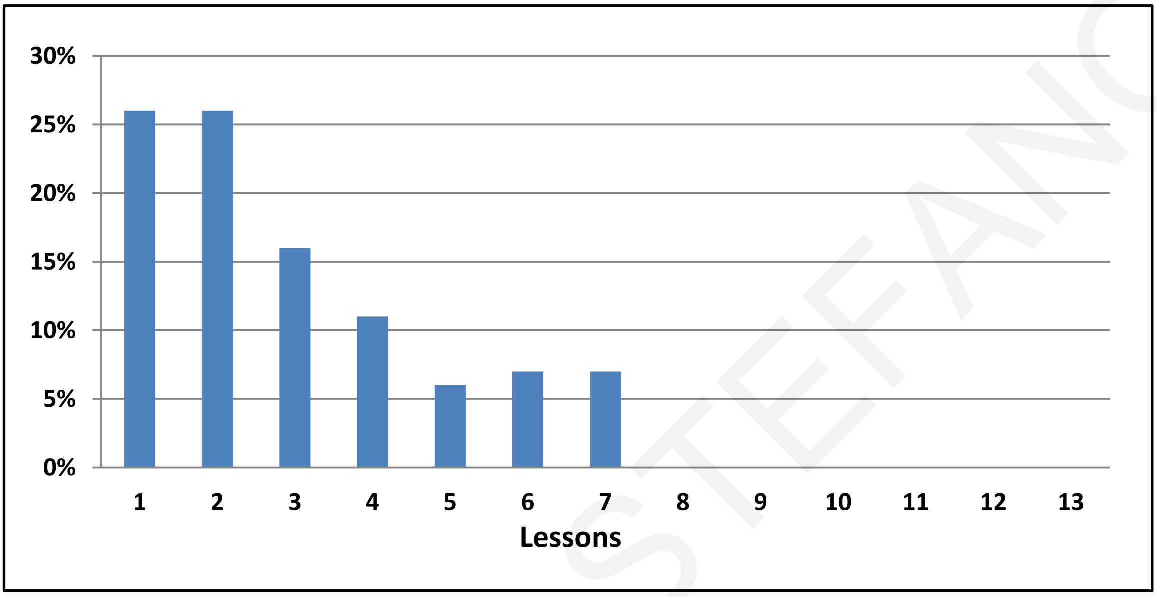


Figure 4.3 Percentage of inappropriate task progressions per lesson.

With this in mind, it is important to note that the researcher provided written feedback to the teachers regarding the content and structure of their first two or three lesson plans. For the most part, the feedback concerned inappropriate sequences of task progressions. Thus, the decrease in the percentage of sequentially inappropriate task progressions after the second lesson might be partially attributed to the feedback provided. Moreover, the gradual decrease in the percentage of sequentially inappropriate task progressions after the second lesson and its decrease to zero from the eighth lesson onwards, can be partially attributed to the long duration of the PD program (i.e., 5 sessions; one per two weeks; 2,5 hours each session). During the PD's eight weeks, teachers were gradually developing basketball lesson plans, which they were using to teach basketball to their students. Moreover, teachers had the opportunity to reflect on their teaching (i.e., self-reflection cards on teaching, group interviews) and to further discuss in each session, and thus further comprehend how to develop sequentially appropriate task progressions.

Finally, another important pattern that is worth mentioning pertained to the appropriateness of the task progressions' sequences found in teachers' lesson plans and their CK level and growth. Five teachers (out of the 19 teachers who submitted their lesson plans) had a higher percentage of sequentially inappropriate task progressions than the rest of the teachers participating in the PD program (i.e., 29% to 50% of their lesson plans comprised sequentially inappropriate task progressions). Four out of these five teachers scored below the average percentage of success in both tests measuring teachers' CK level in basketball (i.e., pre- and post-tests). Additionally, the progress they achieved in the CK test was also below the average progress achieved by the teachers participating in the PD program. We can thus infer that, to some degree, teachers' CK level was reflected in the content and structure of their lesson plans (i.e., development and inclusion of sequentially appropriate task progressions). More patterns concerning these five teachers are presented in the next section (pp. 145-146).

Teachers' Views on the PD Program

Our findings indicate that the teachers who participated in the PD program exhibited significantly higher performance than the teachers who did not. In the previous section, we showed that to a certain degree, teachers' CK level was reflected in the content and structure of their lesson plans (i.e., development and inclusion of appropriate sequences of task progressions), and we suggested that this change in teachers' CK could be (at least partly) attributed to the content and procedures of the PD program (e.g., feedback on the lesson plans, long duration of the PD program). To further emphasize the PD's contribution, in this section we present results concerning teachers' self-reflection data on the PD program. Specifically, Table 4.10 presents the two main themes and subthemes which emerged from the self-reflection data on the PD program. These themes and related quotes (as they were written) are presented below. All names presented are pseudonyms.

Table 4.10

Self-Reflection on the PD program: Outline of the Main Themes Emerged

Themes	Teachers (N=20)[a]	Frequency of Occurrence[b]
Theme 1: Positive views on specific aspects of the PD program • Subtheme 1.1: Hands-on-activities part (i.e., participation in the activities) • Subtheme 1.2: The activities included in the training material • Subtheme 1.3: Cues and critical elements • Subtheme 1.4: Task progression • Subtheme 1.5: Error recognition	20	45
Theme 2: General comments on the PD program • Subtheme 2.1: Particularly useful PD program • Subtheme 2.2: Structured and targeted PD program • Subtheme 2.3: Positive climate during the sessions	18	30

Notes.[a] Three teachers did not fill out the final reflection sheet regarding the content and procedures of the PD program.
[b] Frequency of occurrence refers to the number of 'thematic units' that fall within a specific theme.

Theme 1: Positive views on specific aspects of the PD program. As it can be observed in Table 4.10, all the teachers (i.e., 20) who filled out the final self-reflection sheet reported having positive views on specific aspects of the PD program. First, the vast majority of teachers (i.e., 16 teachers) commented on the usefulness of the *hands-on-activities part* that was included in each PD session (i.e., subtheme 1.1). These teachers pointed out that the hands-on activities part "facilitated the comprehension of the suggested activities" (Mr. Marinos), "helped to identify possible student errors or difficulties" (Mrs. Anastasia), and "gave the opportunity to practice in the various basketball skills and tactics" (Mrs. Andrianna). In addition, it seems that the participation in the activities strengthened some teachers' self-confidence. For example, Mr. Thanasis noted the following: "During the hands-on-activities part, I was successful to do things that I've never thought I could". Finally, there were three disconfirming cases relative to this subtheme. In particular, Mr. Andrew, Mrs. Thekla, and Mrs. Anastasia reported that more time had to be allocated to the hands-on-activities part. For example, Mr. Andrew noted that "[The practicum is] important and necessary! I suggest that more time has to be allotted to the hands-on-activities part".

Turning to the next subtheme, more than half of the teachers (i.e., 13 teachers) appraised positively the activities included in the training material. The related comments described the activities as “well-targeted” (Mr. Marinos); “realistic and age-appropriate” (Mr. Yiannis); “enjoyable and challenging” (Mr. Savvas); and “appropriate for the development of various skills and tactics” (Mr. Markos). In addition, Mrs. Andrianna shared the following: “Creative and pioneering activities. These activities changed the way we perceive the teaching of basketball”. As in the previous subtheme, we found three disconfirming cases relative to this subtheme. Specifically, three teachers reported that “some of the activities were difficult [for students] to understand” (Mr. Stavros) and that “in some cases the facilities and the materials limited their effectiveness” (Mr. Christopher).

Furthermore, half of the teachers (i.e., ten teachers) reported that the given critical elements and the relative cues were very useful for both the student and the teacher. For example, teachers shared the following: “[The PD program] enriched the cues and critical elements that I can use in teaching basketball” (Mrs. Andrianna); “In each session, the cues and critical elements for specific skills or tactics were presented to us. These cues and critical elements were very useful, both to us and to our students” (Mrs. Anastasia).

Finally, a number of teachers commented positively on two more components of the PD program; the parts concerning the recognition of students’ errors and the development/presentation of appropriate task progressions. Teachers’ self-reflection sheets included comments like: “The videotaped students’ performances helped me recognize common student errors” (Mrs. Anastasia); “The PD program helped us ‘built’ lessons, which included sequenced instructional tasks” (Mr. Gregory).

Theme 2: General comments on the PD program. A significant number of the teachers (i.e., 18 out of 20) reported having positive views on the PD program. The two quotes presented below are telling how the PD program was appreciated by its participants.

Mr. Thanasis shared the following: “It was a very educational experience. I think that [the PD] really opened my eyes! Similar training programs must be organized concerning other PE content areas. After participating in the program, I have more confidence in teaching basketball”. Mr. Christopher echoed Mr. Thanasis:

> This program should be extended and applied beyond the research. More teachers must have the opportunity to participate in it [...] Training programs, similar to this one, should be organized by the Ministry of Education for the improvement of teachers' knowledge.

Likewise, Mrs. Andrianna noted: “Excellent experience! It should not only be based on private initiatives, but should be systematically expanded to all teachers teaching PE”. Moreover, the teachers reported having positive views regarding other aspects of the PD program. The related comments described the PD program as: “comprehensive, well-targeted and useful” (Mr. Christopher); “well-structured and focused” (Mr. Constantinos); and “highly organized” (Mr. Michael). Finally, some teachers pointed out the positive climate that existed during the training sessions. As Mr. Iakovos shared: “The program came to an end in a pleasant climate of cooperation and mutual understanding”.

Before proceeding to the next section, an important element, which somehow determined PD’s content and structure, needs to be pointed out. As it was described in the previous chapter (see p. 91), the self-reflection data on the PD program were not only based on the final self-reflection sheet. At the end of the first two PD sessions, the participants were asked to fill out a self-reflection card (see Chapter 3 for more information). Among others, the teachers recorded the following suggestions: (a) more time should have been allotted to practicing the selected skills/tactics and/or activities (i.e., hands-on-activities part); (b) more time should have been devoted to error detection; and (c) more examples of appropriate task progressions should have been provided. Based on the above suggestions, we gradually modified the content and structure of the PD sessions in an effort to meet the participants' needs. Thus, we decided to omit the completion of the reflection card from the 3rd session onwards for practical reasons (i.e., lack of time).

In conclusion, the findings presented in this section indicate that the teachers who participated in the PD program exhibited significantly higher performance in the basketball CK test than the teachers who did not. Our findings also show that teachers' CK level was reflected in the content and structure of their lesson plans (i.e., inclusion of appropriate/inappropriate task progressions). The data drawn out of teachers' lesson plans and self-reflection sheets suggested that the change in teachers' CK can be (at least partly) attributed to the content and procedures of the PD program. The following procedures and elements of the PD program seem to have contributed to the improvement of teachers' CK: (a) the feedback on the content of teachers' lesson plans provided to the intervention participants; (b) the gradual modification of the PD's content and structure to meet the participants' needs; (c) the hands-on-activities part; (d) the actual content of the PD (i.e., the suggested activities, critical elements and cues, task progressions, recognition of errors); and (e) the positive climate during the training sessions.

Research Question 4: What is the contribution of a basketball CK PD program to student achievement in basketball?

To answer this research question, a series of descriptive (i.e., percentages, means, standard deviations) and inferential analyses (i.e., independent samples *t*-test) were carried out. To the same end (i.e., to investigate the contribution of the PD program to student achievement), we conducted a multilevel regression analysis due to the hierarchical structure of the data (i.e., students nested within classes/teachers). Furthermore, data collected from different sources (i.e., lesson plans, self-reflection cards on teaching, group interviews, and self-reflection cards on the PD program) were used to gain a deeper understanding of the phenomenon under study. All the relevant results are presented below.

Descriptive and Inferential Statistics

Table 4.11 presents descriptive and inferential statistics concerning the two groups' (i.e., TG and CG) pre- and post- test performance. Eleven performance indices were used to capture student achievement in basketball. In particular, the 11 performance indices included the following: (a) six basketball *skills* (i.e., dribbling, quick stop, pivoting, passing, shooting layups, and shooting accuracy in layups); and (b) five *elements of game performance* (i.e., passing in game, supporting, guarding/marking, stealing the ball, and game involvement).

To begin, the *t*-test revealed that there was one statistically significant difference (p.<05) concerning the two groups' pre-test performance. Specifically, the students participating in the CG performed significantly better in *passing* than the students participating in the TG. In all the other cases, no statistically significant difference was found regarding the two groups' pre-test performance. Thus, it can be inferred that the students of the TG and CG had a similar achievement level in basketball prior to the intervention. On the contrary, statistically significant differences were found for almost every skill and game performance element included in the post-test. Specifically, statistically significant differences were found for eight skills or game performance elements at p<.001. In yet another one case, statistically significant difference was found at p.<05 (i.e., *passing*). In all these cases, the TG students exhibited a significantly higher achievement level in basketball than the CG students. Statistically significant difference between the two groups' post-test performance were not found in the cases of *dribbling* and *stealing the ball*.

Table 4.11

Pre- and Post-Test Means for the 11 Tasks of the Student Performance Test: Comparison between the Treatment and the Comparison Group

Skills/Tactics	**Pre – Test**							**Post – Test**						
	Treatment Group (n=397)		**Comparison Group (n=491)**					**Treatment Group (n=368)**		**Comparison Group (n=470)**				
	Mean	**SD**	**Mean**	**SD**	**t**	**df**	**p**	**Mean**	**SD**	**Mean**	**SD**	**t**	**df**	**p**
Dribbling (range: 0-3)	1.63	.66	1.70	.66	-1.50	884	.13	1.93	.61	1.87	.62	1.40	829	.16
Quick stop (range: 0-3)	.72	1.03	.69	1.01	.37	884	.71	1.98	.99	1.24	1.07	10.33	806.08	.001
Pivoting (range: 0-3)	.15	.49	.12	.47	.94	884	.35	1.09	1.07	.32	.69	12.02	591.08	.001
Passing (range: 0-3)	1.83	.84	1.97	.88	-2.45	884	.01	2.13	.77	1.99	.85	2.58	829	.01
Lay-up (range: 0-3)	.39	.84	.40	.87	-.19	884	.85	1.69	1.31	.82	1.22	9.88	757.83	.001
Shooting accuracy in lay-up (range: 0-4)	.48	1.11	.44	1.06	.58	884	.57	1.75	1.46	.93	1.38	7.97	719.79	.001
Game[a] involvement (range: 0-5)	2.41	1.65	2.54	1.69	-1.16	886	.25	2.76	1.64	2.09	1.52	6.04	749.72	.001
Passing in game[a] (range: 0-4)	1.83	1.34	1.82	1.34	.07	886	.94	2.02	1.34	1.68	1.37	3.61	790.22	.001
Supporting in game[a] (range: 0-4)	1.94	1.48	1.99	1.50	-.54	886	.59	2.47	1.40	1.76	1.49	7.05	802.54	.001
Guarding in game[a] (range: 0-4)	1.85	1.49	1.93	1.50	-.77	885	.44	2.44	1.24	1.77	1.28	7.65	832	.001
Stealing in game[a] (range: 0-3)	.83	.96	.87	.94	-.53	885	.60	.79	.95	.68	.84	1.67	731.29	.09

Notes.[a] The term '*game*' is used to describe a game-like situation (i.e., a 2vs2 dribbling and passing game in delimited area without shooting) and not the full game of basketball.

The Rasch analysis described in a previous section, confirmed the above results. Specifically, by using the cases difficulty estimates, we explored the extent to which there were any significant differences between the overall performance of the two groups in the pre- and post-tests. As it is observed in Table 4.12, the students participating in the TG performed significantly better in the post-test than those participating in the CG. At the same time, we found that the difference between the two groups' pre-test performance was not statistically significant. The distinct nature, in respect to the post-test performance of the two groups, was verified statistically with Cohen's *d* for effect size (Cohen, 1988). In particular, the effect size was d=0.73, which indicates a moderate effect.

Table 4.12

Comparison of the Pre- and Post-Test Performances between the Students of the Treatment and the Comparison Group

	Treatment Group (n=397; 367)		**Comparison Group (n=491; 470)**				
	Mean	**SD**	**Mean**	**SD**	**t**	**df**	**p**
Pre-test performance	-.50	.82	-.45	.91	-.83	806	.45
Post-test performance	.18	.73	-.40	.84	10.79	828.57	.001

Multilevel Regression Analysis

After running the above analyses, due to the hierarchical structure of the data (i.e., students nested within classes/teachers), multilevel analyses were conducted in order to investigate the contribution of the PD program to the final student achievement in basketball. The related results, as presented in Table 4.13, are described below.

First of all, the empty model revealed that 84.01% of the total variance was situated at the student level and 15.99% of the variance at the teacher level. This variance decomposition implies that there is notable variance in students' performance that can be explained by the classroom membership of these students and apparently the instruction these students received.

Table 4.13

Parameter Estimates and (Standard Errors) for the Analysis of Student Achievement in Basketball

Factors	**Model 0**	**Model 1a**	**Model 1b**	**Model 2a**	**Model 2b**
Fixed Part (Intercept)	-0.14(0.05)	-0.02(0.06)	-0.02(0.06)	-0.01(0.06)	-0.29(0.06)
STUDENT LEVEL					
Context					
Initial performance		0.38(0.03)	0.38(0.03)	0.43(0.03)	0.38(0.03)
Gender (boys=0, girls=1)		-0.26(0.05)	-0.26(0.05)	-0.19(0.05)	-0.26(0.05)
Grade (grade 5=0, grade 6=1)		NSS	NSS	NSS	NSS
Left-handedness (no=0, yes=1)		NSS	NSS	NSS	NSS
CLASSROOM/TEACHER LEVEL					
Teacher Characteristics					
Gender (male=0, female=1)			NSS	NSS	NSS
CK Courses (0-1 courses=0, 2 or more courses=1)			NSS	NSS	NSS
Method Courses (0-1 courses=0, 2 or more courses=1)			NSS	NSS	NSS
Teaching Experience in PE (years)			NSS	NSS	NSS
Teaching Experience in PE Measured in Classes Taught per Year (1-5 classes=0, 1-10 classes=1, more than 10 classes=2)			NSS	NSS	NSS
Teaching Experience in PE Measured in Grade Levels Taught (only G1-3: 0, only G4-6=1, both levels: 2)			NSS	NSS	NSS
Other Experiences Concerning Basketball (no=0, yes=1)			NSS	NSS	NSS
Frequency of Watching Professional Basketball Games (2 or less times per year=0, 1-2 times per six months=1, 1 or more times per month=2)			NSS	NSS	NSS
Prior Experience in Playing Basketball (no experience=0, play for fun=1, play in a team=2)			NSS	NSS	NSS
Teacher Knowledge					
Initial Performance				NSS	
Final Performance				0.20(0.05)	
Intervention (no-CG=0, yes-TG=1)					0.62(0.07)
Variance components					
Teacher	15.99%	15.99%	15.99%	12.34%	5.61%
Student	84.01%	63.11%	63.11%	59.19%	63.11%
Absolute	0.71	0.58	0.58	0.51	0.49
Percentage Explained		20.90%	20.90%	28.47%	31.28%
Significance test					
X^2	2020.62	1746.39	1746.39	1531.68	1702.28
Reduction		274.23	274.23	214.71	44.11
Degrees of freedom[a]		2	2	1	1
p value		.001	.001	.001	.001

Notes. NSS=Not statistically significant effect at level .05.
[a] The models were estimated without the variables that did not have a statistically significant effect at level 0.05.

Next, as it can be observed, Model 1a explained 20.9% of the variance attributed to the student level. This was not surprising since student-level explanatory variables were introduced in Model 1a, i.e., student initial performance and student background characteristics: grade level, gender, and left-handedness. Of these variables, only students' initial performance and students' gender had statistically significant effects on student achievement. In the case of gender, boys were found to perform significantly better than girls. In addition, both these explanatory variables had a consistent effect on achievement when aggregated at the teacher level.

Turning to Model 1b, one can notice that none of the teacher background variables had any statistically significant effect on student achievement. Consequently, Model 1b did not explain any portion of the variance attributed to the two levels. Furthermore, Model 2a represents the contribution of teacher knowledge to student achievement, whereas, Model 2b the contribution of the PD program. The two variables were not entered simultaneously into the model because of multicollinearity reasons (the reader might recall that in the post-test the participants in TG had higher knowledge levels than those of the CG). In particular, Model 2a comprises the variables pertaining to teachers' initial and final performance in the teacher CK test. Of these two variables, only teachers' final performance had a statistically significant effect on student achievement. Specifically, Model 2a explained 3.65% of the variance attributed to the teacher level – which represents 22.83% of the unexplained variance at the teacher level – and 28.47% of the total variance to student achievement.

In addition, the variable that had the strongest effect in predicting student achievement was the one pertaining to the participation in the intervention (see Column 5-Model 2b). As it can be observed, Model 2b explained 10.38% of the variance attributed to the teacher level – which represents 64.92% of the unexplained variance at the teacher level – and approximately one third (i.e., 31,28%) of the total variance to student achievement. This important finding indicates that the students participating in the TG performed significantly better than those participating in the CG. Finally, approximately 63% of the variance attributed to the student level remained unexplained. Thus, it is suggested that other student-related variables could contribute to student achievement in basketball as well.

Using Elements from the Lesson Plans to Explain Student Performance

From the above results (see Tables 4.11, 4.12, and 4.13), we can infer that the students whose teachers participated in the PD program exhibited significantly higher performance than those whose teachers did not participate in the PD program. In this context, a particularly interesting pattern can be observed regarding the post-test performance of the students participating in the CG (see Table 4.11). The performance means clearly indicate that the students of the CG performed relatively better in the post-test than in the pre-test concerning all the measured basketball skills (i.e., dribbling, quick stop, pivoting, passing, shooting layups, and shooting accuracy in layups). However, this is not the case concerning the game performance elements (i.e., passing in game, supporting, guarding/marking, stealing the ball, and game involvement). As it can be observed in Table 4.11, the students participating in the CG performed slightly worse in the post-test than in the pre-test in all the measured game performance elements. On the contrary, the TG students showed significant improvement in almost every game performance element included in the student performance test (with the exception of *stealing performance*).

The above finding seems to resonate with specific patterns observed in the lesson plans. Particularly, as it can be observed in Table 4.14, the teachers participating in the TG devoted on average 67% of their lessons to teaching offensive and defensive moves (i.e., tactics). Offensive and defensive tactics comprise a significant part of what we term as 'game performance elements'. It should be borne in mind, however, that the percentages presented in Table 4.14 overlap since the various basketball skills and tactics were not taught in different lessons. For example, in most of the cases, the lessons' objectives pertained to both skills and tactics development.

Table 4.14

Average Percentage of Lessons Allocated to the Teaching of Each Skill or Tactic

Skills/Tactics	Average percentage of lessons
Dribbling: speed and control dribbling	24
Stopping: quick stop	18
Pivoting	17
Passing, catching, types of passes	31
Shooting: set-shot	16
Shooting: lay-up	17
Defensive stance	10
Defensive slide	10
Defensive and offensive moves (i.e., tactics)	67
All the taught skills and tactics	10

Notes. The results presented in this Table are based on the lesson plans of 14 teachers (out of the 19 teachers who submitted their lesson plans). These 14 teachers submitted a complete basketball unit plan.

Nevertheless, the data presented in Table 4.14 are based on the lessons' objectives and not on the activities included in each lesson plan. Thus, through a thorough examination of the 151 lesson plans submitted by the teachers we checked whether there was alignment between the lessons' objectives and activities. Our findings point to the same direction. Specifically, we found only 10 cases (i.e., 6%) of nonalignment between the lessons' objectives and the lessons' activities. Seven out of these 10 cases of nonalignment concern only one teacher (out of the 19 teachers who submitted their lesson plans).

Interestingly, this teacher was one of the five teachers who were found to have a higher percentage of sequentially inappropriate task progressions (i.e., 29% to 50%) in their lesson plans. As described in a previous section, four out of these five teachers (including the one who developed 'nonaligned' lesson plans) scored below the average percentage of success in both tests measuring teachers' CK level in basketball (i.e., pre- and post-tests). Additionally, the students of these four teachers performed below the average student performance in the post-test, and at the same time, the progress they made between the pre- and the post-test was below the average progress achieved by the TG students. Nevertheless, it is important to note that even these four TG teachers and their students performed above the average performance of their CG's counterparts in all the cases (i.e., teacher CK post-test, student performance post-test, teacher and student progress between the pre- and the post-tests).

Moreover, we found 28 cases (19%) of inappropriate allocation of time to the various activities of the lessons. In these cases, the teachers devoted inadequate time (i.e., less than 10 minutes) or no time at all to activities comprising game-like situations. Thus, it can be inferred that the teachers might have included in their lesson plans activities comprising game-like situations but did not allocate sufficient time to them. From these 28 cases of inappropriate allocation of time the 21 concern six specific teachers. These six teachers were found to have a higher percentage of inappropriate time allocation (i.e., 29% to 78%) in their lesson plans. It is important to note that five out of these six teachers were the same five teachers who included sequentially inappropriate task progressions in 29% to 50% of their lesson plans. However, we have to point out that in the vast majority of the submitted lesson plans (81%) the allocation of time was appropriate, meaning that in most of the cases emphasis was placed on activities involving game-like situations.

In conclusion, all the above findings shed some light to what might have actually happened during the lessons, and at the same time, provide some possible explanations regarding the significant improvement of the students whose teachers participated in the TG. In this case, the improvement of students' game performance seems to be related to the fact that the teachers participating in the TG placed emphasis on the development of defensive and offensive tactics within almost every basketball lesson they taught.

Using Elements from the Self-Reflection Data to Explain Student Performance

Although no data regarding the quality of teaching were collected (e.g., data from lesson observations), the study's self-reflection data contribute toward the understanding of the above findings. In particular, Table 4.15 presents the main themes and subthemes which emerged from the self-reflection data on teaching. These themes and related quotes (as they were written or spoken) are presented below. Whenever quotes are used, the following are reported: (a) a pseudonym indicating a participating teacher; (b) the source (i.e., SR = self-reflection cards on teaching; GI = group interview; FSR = final self-reflection sheets on the PD program); and the grade level (i.e., G5 = Grade 5; G6 = Grade 6).

Table 4.15

Self-Reflection on Teaching: Outline of the Main Themes Emerged

Themes	**Teachers (N=23)**	**Frequency of Occurrence[a]**	**Source[b]**
Theme 1: Positive effects of teaching • Subtheme 1.1: Promoting student enthusiasm and interest • Subtheme 1.2: Maximizing student engagement time (i.e., time on task) • Subtheme 1.3: Positive student learning outcomes	19	104	SR GI FSR
Theme 2: High-quality activities • Subtheme 2.1: Shaping practices • Subtheme 2.2: Game-like situations • Subtheme 2.3: Vigorous physical activity	10	17	SR GI
Theme 3: Feedback and task progressions • Subtheme 3.1: Specific and congruent feedback • Subtheme 3.2: Task progressions	7	14	SR GI
Theme 4: Challenges faced by the teachers • Subtheme 4.1: Complex descriptions[26] of activities • Subtheme 4.2: Lack of equipment and facilities • Subtheme 4.3: Providing feedback • Subtheme 4.4: Allocating students into groups	6	15	SR GI FSR

Notes.[a] Frequency of occurrence refers to the number of ‘thematic units’ that fall within a specific theme. [b] Sources of data: SR = self-reflection cards on teaching; GI = group interview; FSR = final self-reflection sheets on the PD program.

Theme 1: Positive effects of teaching. The vast majority of the teachers participating in the TG (19 out of 23) reported positive effects of teaching basketball building on the study’s training material. One can notice that this theme had the highest frequency of occurrence (i.e., 104 thematic units) and that it was corroborated by all three qualitative data sources. To begin with, many teachers reported during the group

[26] *Descriptions:* Teacher’s verbal explanation or illustration on what a particular skill (activity) is like (Kim, 2011).

interviews that the activities comprised in the training material promoted students' enthusiasm and interest. As Mr. Stavros (GI, G5) shared:

> With these activities, after the second or third lesson, the children's attitude toward basketball changed. They wanted to play basketball whenever I gave them free time. [...] I also noticed something important. Whenever I used the terms you gave us, such as the 'triple threat', I gained the full attention of children participating in basketball training programs.

Likewise, Mrs. Anastasia (GI, G5) noted:

> My students were used to play only soccer. It was difficult to convince them that they had to learn basketball too! Their ability in basketball was very low. Many of them were 'slapping' the ball when dribbling. I have to admit that things have started to change. The 'end-zone' [lead-up game (e.g., 5vs5, 6vs6] captured their interest […] They were thrilled when they had to dribble on their knees [...] They were also thrilled when performing the quick-stop and pivot activities [...]

Mrs. Thekla (GI, G5) continued as follows: "The kids really loved the activities and participated with enthusiasm. [...] Students, who are usually bored and prefer to sit than to participate in PE lessons, participated with great enthusiasm". Teachers reported their students' positive reactions in their self-reflections as well. For example, the self-reflection cards/sheets included comments like: "The students were thrilled with the dribbling game in triads [heavy traffic game]" (Mr. Elias, SR, G5); and "Very interesting and enjoyable activities for both the teacher and the student" (Mr. Constantinos, FSR, G6).

Beyond students' enthusiasm and interest, teachers reported increased levels of student engagement. Mr. Elias (GI, G5) shared the following:

> […] students, who felt alienated in PE and opted out most of the times, were highly engaged. Especially, all students participated in the 'end zone' [lead-

up game], mainly because of the modifications that were made to this game [e.g., five passes before passing to the goalie].

Likewise, Mr. Gregory (SR, G6) noted: “The time on task was maximized since each student had a ball and was dribbling throughout the lesson”. Moreover, the vast majority of the teachers reported positive student learning outcomes. The reported learning outcomes included the acquisition (or development) of knowledge, skills, and attitudes. Mr. Andrew (SR, G5) provided the following example to describe his students’ outcomes regarding the application of tactics:

> The proposed shooting game in half-court [e.g., 3vs2] is truly an excellent activity. It helped children to better understand and perform basic tactics, such as ‘when to pass the ball’, ‘to whom to pass the ball’, ‘when to shoot’, ‘from were to shoot’ etc.

Likewise, Mr. Thanasis (SR, G5) noted the following: “The children changed their defensive behavior. They also understood errors made in the game (e.g., not getting open)”. Teachers also reported student outcomes concerning the acquisition of the correct technique in performing various basketball skills. For example: “The fact that they [the students] were dribbling from a kneeling position and had a close control of the ball helped them understand the correct dribbling technique. They were not ‘slapping’ the ball anymore […]” (Mrs. Anastasia, SR, G5); “When the students experienced an improvement in shooting accuracy [set-shot] they understood the value of the correct shooting technique […]” (Mr. Christopher, SR, G5); and “The students were pivoting and executing quick stops correctly” (Mr. Michael, SR, G5).

Finally, some teachers reported student outcomes regarding the knowledge of basketball rules and the ability to collaborate with others (i.e., positive attitude toward teamwork). Teachers’ comments in the self-reflection cards included: “[…] the students cleared up many things concerning the basic basketball rules” (Mr. Thanasis, SR, G5);

"Very enjoyable game [dribbling, passing and possession game in delimited space (e.g., 2vs2, 3vs3)] through which children learned to work together in harmony […]" (Mr. Andrew, SR, G5).

We found four *disconfirming cases* relative to the first theme. These four teachers, although in most of the cases reported positive student outcomes, in some cases they reported difficulties in the acquisition of specific skills. For example, Mr. Andrew (GI, G5) shared the following: "Some children encountered many difficulties. They could hardly control the ball without looking at it all the time". Likewise, Mr. Markos (SR, G6) explained:

> Many children had a great difficulty in dribbling the ball [control dribble] and simultaneously trying to steal a ball. They were losing the ball all the time. As a result, they received little benefit from their participation in the specific activity [dribble-freeze-tag game (e.g., 6vs6, 7vs7)].

Theme 2: High-quality activities. The second theme refers to the inclusion of high-quality activities in the PD's training material. Almost half of the teachers pointed out significant aspects of those activities. First of all, teachers noted that the activities 'forced' the correct skill or tactics performance. In other words, teachers were referring to the manipulation of one or more game variables (e.g., rules, playing area dimensions, differential scoring system) to emphasize particular aspects of effective play (i.e., shaping play). For instance, teachers shared: "They [the students] were forced to dribble without watching the ball" (Mr. Constantinos, RC, G6); "The fact that scoring a basket with a lay-up was allocated more points than the other types of shots, forced students to shoot layups in game-like situations" (Mr. Iakovos, GI, G5); "The rules forced the students to get open to receive a pass" (Mr. Andrew, GI, G5).

In addition, some teachers pointed out the alignment between the suggested practices (i.e., activities) and the real game. All the main activities included in the training material comprised game-like situations. For example, Mr. Savvas (SR, G5) noted the following: “The students made decisions under time pressure, which is an aspect of the real game [lead-up game (e.g., 5vs5, 6vs6)]”. Mr. Leontios (SR, G6) echoed Mr. Savvas: “The activity [shooting game in delimited space (1vs1)] had many similarities with the real game; it increased offensive and defensive tactical demands”. Finally, some teachers reported that the suggested activities promoted vigorous physical activity. For example, Mr. Andrew (SR, G5) noted that “the high-intensity which was promoted by the activity [passing game in open space (e.g., 2vs1, 3vs2)] had a positive effect on the students’ fitness level”.

Theme 3: Feedback and task progressions. A number of teachers participating in the TG recorded in their self-reflection cards/sheets two significant aspects of quality teaching. That is, providing specific and congruent feedback, and using appropriate task progressions. Concerning feedback, Mr. Christopher (SR, G5) provided the following example: “When the students experienced an improvement in shooting accuracy [set-shot] they understood the value of the correct shooting technique. Continuous feedback, based on the relevant critical elements and cues, had an important role in acquiring the correct shooting technique”. Regarding task progressions, Mr. Andrew (SR, G5) shared the following: “The children understood the ‘lay-up movement’ to a large extent, since the lesson started with a very simple task (bounce-one-two). Gradually, the students performed the complete skill (at first without dribbling)”.

Similar reports were found in teachers’ final self-reflection sheets on the PD program. These reports included comments like the following: “The PD program helped us ‘built’ lessons, which included sequenced instructional tasks; that is, the tasks were sequenced in a progressive manner and were not cut off from each other” (Mr. Gregory, FSF, G6). It is important to note that the teachers who recognized and reported the importance of task progressions (i.e., seven teachers) did not belong to the group of teachers (i.e., five teachers) who were found to include inappropriate task progressions in 29% to 50% of their lessons plans. Six out of these seven teachers achieved high student outcomes. Specifically, their students performed above the average student performance in the post-test, and at the same time, the progress they made between the pre- and the post-test was above the average progress achieved by the students participating in the TG.

Theme 4: Challenges faced by the teachers. As it is observed in Table 4.15, six teachers encountered a number of challenges when teaching basketball based on the study's training material (i.e., had difficulties in: providing exact descriptions of the activities in which students would engage appropriately; providing feedback; allocating students into groups; and implementing the activities comprised in the training material due to lack of equipment and facilities). For example, Mr. Stavros shared: "I had a little trouble explaining the activity [lead-up game (e.g., 5vs5, 6vs6)]. I had to repeat the instructions two and three times for the students to understand" (GI, G5). Likewise, Mr. Savvas noted the following: "I also faced some difficulties concerning the first activity's instructions [lead-up game (e.g., 5vs5, 6vs6)] […] I divided the students into four groups, and thus, two games were played simultaneously. It was difficult to coordinate two games at the same time" (GI, G5). Moreover, Mr. Christopher's (GI, G5) words, as were stated in the group interview, summarize most of the subthemes included in this theme:

> First, it took a lot of time to explain the activity to the children [lead-up game (e.g., 5vs5, 6vs6)] […] Generally speaking, children needed some time to comprehend the activity, since it was new to them with many variations and rules. […] Another difficulty I encountered concerned the challenges included in the activities [e.g., lead-up game: a shot to the basket was awarded after each successful pass to the goalie]. The limited number of baskets [two baskets] increased the waiting time.

[…] I also struggled to give feedback. There are 24 children in this class. When I was working in small groups it was not easy to give feedback to everyone.

Similar challenges were also reported in the self-reflection cards on teaching and in the final self-reflection sheet on the PD program. For example: "If I had the money I would place four more basketball facilities […] I have used the two existing basketball facilities and two portable basketball systems. The children were complaining when they had to practice on the portable basketball systems" (Mr. Thanasis, SR, G5); "The ten activities constitute a complete basketball unit. One or two of them had complex descriptions" (Mr. Stavros, FSR, G5).

In addition, some teachers reported having difficulties allocating students into groups. These reports included comments like the following: "It took a lot of time to allocate students into triads" (Mrs. Andrianna, SR, G6); "The transition from a 2vs1 game to a 3vs2 game was not easy. […] I have to use a routine for allocating students into groups" (Mr. Savvas, SR, G5).

Summary of Findings

The study's results were organized around the four research questions. The first two research questions asked whether it was possible to develop two scales with good psychometric properties to measure in-service teachers' CK and students' performance in basketball. The data analysis revealed that the developed scales had satisfactory psychometric properties (*teacher CK scale*: items' r=0.98 – teachers' r=0.75; *student performance scale*: items' r=0.98 – students' r=0.82).

The third research question concerned the contribution of a basketball CK PD program to in-service generalist teachers' level of CK. The study's findings revealed that teachers who participated in the PD program exhibited significantly higher performance than those who did not. Specifically, the multiple regression analysis revealed that the participation in the PD program and teachers' initial performance were significant predictors of teachers' final performance in the CK test [$F(2,40) = 40.95$, $p < .001$]. Cohen's *d* verified the difference between the study's groups (i.e., TG and CG), indicating a strong effect ($d=1.60$).

Moreover, the study's outcomes underlined that teachers' CK level was reflected in the content and structure of their lesson plans (i.e., inclusion of sequentially appropriate/inappropriate task progressions, appropriate/inappropriate time allocation to the activities). The data drawn out of teachers' lesson plans and self-reflection sheets suggested that the gains in teachers' CK can be (at least partly) attributed to the content and procedures of the PD program.

Turning to the fourth research question, which concerned the contribution of a basketball CK PD program to student achievement in basketball, the results indicated that the students whose teachers participated in the PD program exhibited significantly higher performance than those whose teachers did not participated in the PD program. In particular, the multilevel regression analysis showed that the variable pertaining to the teachers' participation in the intervention had the strongest effect in predicting student achievement. Teachers' participation in the PD explained 10.38% of the variance attributed to the teacher level – which represents 64.92% of the unexplained variance at the teacher level. Cohen's *d* verified once again the difference between the study's groups (i.e., TG and CG), indicating a moderate effect ($d=0.73$). Moreover, students' initial performance and students' gender (i.e., boys were found to perform significantly better than girls) also had statistically significant effects on student achievement. It is noteworthy that none of the teacher background variables had statistically significant effect on student achievement. Our findings also indicate that teacher CK is of critical importance to student achievement. That is, the variable pertaining to teachers' final performance in the teacher CK test explained 3.65% of the variance attributed to the teacher level – which represents 22.83% of the unexplained variance at the teacher level.

Descriptive and inferential analysis revealed that the TG students performed significantly better in almost every skill and game performance element included in the post-test. Specifically, statistically significant differences were found in eight skills or game performance elements at $p<.001$ (i.e., quick stop, pivoting, shooting layups, shooting accuracy in layups, passing in game, supporting, guarding/marking, and game involvement). In yet one case (i.e., passing), statistically significant difference was found at $p<.05$. Statistically significant differences between the two groups' post-test performance were not found in the cases of dribbling and stealing the ball.

Finally, the qualitative data support the findings of quantitative data analyses and provide possible answers to the following major question: What CK components contributed to the gains in student achievement? Particularly, it seems that the TG students exhibited significantly higher performance since they had the opportunity to participate in high-quality activities which: (a) promoted their enthusiasm, interest, and engagement; (b) involved shaped practices, game-like situations, and high-intensity physical activity; and (c) comprised appropriate task progressions. At the same time, it seems that these students were given specific and congruent feedback (based on the suggested critical elements and cues) by their teachers. In the next chapter, all the study's findings are revisited and discussed.

CHAPTER 5: DISCUSSION

Abstract

The purpose of this study was twofold: to develop reliable and valid scales to measure teachers' CK and students' achievement in basketball and to investigate the contribution of a content-focused PD program to both teacher and student outcomes. This exploration revealed several key findings. First, the developed scales had satisfactory psychometric properties and thus, could provide valid and reliable measurements of teachers' CK and students' achievement. Second, teachers' participation in the PD program was found to be a significant predictor of both teacher and student outcomes. Third, teacher final CK was found to be a significant predictor of student achievement. Fourth, the study's findings provide some possible explanations regarding the significant gains in teacher and student performance. Finally, although several limitations should be considered in interpreting the results of the current study, theoretical, methodological, and practical implications are presented along with suggestions for future research.

The present study sought to investigate the contribution of a content-focused PD program to teacher and student outcomes, using direct measures of teachers' CK and students' achievement in basketball. The discussion of the main findings is organized around the four research questions that the study sought to answer. Specifically, in the first two sections the results concerning the development of the scales measuring teachers' CK and student achievement in basketball are discussed. The next two sections discuss the contribution of a content-focused PD program to teacher and student outcomes. Finally, the theoretical, methodological, and practical implications are outlined along with suggestions for future research.

Research Question 1: Can a scale with good psychometric properties that measures in-service teachers' CK in basketball be developed?

In this study, teachers' learning – as a result of their participation in the PD program – was directly measured via a basketball CK test. For the development of the specific test, we drew on a modified version[27] of Ward's (2009) four-domain CK conceptualization in PE. The analysis of the data revealed that the developed scale had satisfactory psychometric properties (e.g., items' r=0.98; teachers' r=0.75), and thus it

[27] It is strongly noted, that the suggested modified version of Ward's (2009) CK framework in PE, is applicable only within the context of a *paper-and-pencil* test, comprising multiple-choice questions.

could provide valid and reliable measurements of teachers' CK (Kyriakides, Kaloyirou, & Lindsay, 2006). Moreover, the examination of the fit indices for each item included in the teacher CK test revealed that all the items (i.e., 24 items) were useful to the measurement (Linacre, 2017), while in two cases (i.e., items 7 and item 16) further refinement is required.

These findings are deemed important since attempts to directly measure teachers' CK in PE (i.e., via a test) are relatively scarce, and even then, the psychometric properties of the developed tests are rarely reported. To our knowledge, only one previous study in the area of PE (i.e., Li et al., 2013) examined the psychometric properties of the developed CK test using IRT analysis. The existing research gap is also recognized by Ward et al. (2015) who calls for valid and reliable measures of CK and in particular SCK. We have learned that developing a reliable and valid measure of teachers' CK (and especially SCK) can be difficult but is possible.

The development of a reliable and valid test to measure teachers' CK in basketball contributes to the literature in another significant way. Specifically, the utilization of measures with satisfactory psychometric properties is a critical element in establishing empirical links between PD, teacher knowledge, and student achievement (Hill et al., 2004; Yoon et al., 2007). According to Ward (2013), "without such measures to serve as dependent variables, we cannot move forward. With such measures, student learning can be compared relative to the content knowledge of their teachers" (p. 438).

Moreover, the development of the teacher CK test – comprising CCK and SCK items – allows the investigation of possible connections between CCK and SCK (Steele, 2013) and at the same time, the examination of the separate contribution of CCK and SCK to student achievement. In this study we have investigated the joint contribution of these two CK sub-domains to student outcomes. Yet, research findings (i.e., Baumert et al., 2010; Carlisle et al., 2009; Garet et al., 2008; Sadler et al., 2013a, 2013b) suggest that CCK might not be as good predictor of student achievement as SCK.

Finally, it is noteworthy that the specific test comprises, for the most part, multiple-choice questions. Despite the concerns raised in the literature regarding the use of multiple-choice questions to measure teachers' CK (cf., Buchholtz et al. 2013; Charalambous, 2016; Fauskanger, 2015; Hill et al., 2008b; Steele, 2013) this study's findings indicate that "the type of studying promoted by a test is more a function of the quality of the questions than the type of questions" (Morrow et al., 2011, p. 149). In particular, in an effort to ensure the quality of the test items, the construction of the multiple-choice questions was based on a series of recommendations identified in the literature (Lacy, 2011; Morrow et al., 2011), such as: the stems were written in positive terms to the highest possible extent; the distractors and the correct answer of each item were about the same length; patterns that would help the examinees guess the correct answers were avoided; and no clues were given in the stems of the items that would help the examinees select the correct answer of other items (Lacy, 2011; Morrow et al., 2011). In conclusion, the findings of this study are in par with previous research efforts supporting the use of multiple-choice questions in measuring teachers' knowledge (e.g., Diamond et al., 2014; Heller et al., 2012; Hill & Ball, 2004; Li et al., 2013; Maerten-Rivera et al., 2015; Sadler et al., 2013a, 2013b).

Research Question 2: Can a scale with good psychometric properties that measures students' performance in basketball be developed?

The present study attempted to measure students' performance by developing a direct measure of student achievement in basketeball; that is, the Basketball Skills and Tactics Test (BaST test). The BaST test comprises the following three tasks: (a) the LU task; (b) the DSPP task; and (c) the ODeMS task. The developed scale was found to have satisfactory psychometric properties (e.g., items' r=0.98; students' r=0.82), allowing the establishment of empirical links between PD, teacher knowledge, and student achievement

(Yoon et al., 2007). In addition, the examination of the fit indices for each task included in the student performance test revealed that all the tasks were useful to the measurement (Linacre, 2017), while in four cases (i.e., supporting in game, passing in game, stealing in game, game involvement) further refinement is required.

Moreover, the BaST test is *process-oriented*, since it measures – for the most part – the correct form (i.e., critical elements) of the selected skills (Morrow et al., 2011). We consider this to be particularly important since, to our knowledge, the existing basketball performance tests are *product-oriented* (e.g., Hopkins et al., 1984; Kolovelonis et al., 2012; Stöckel et al., 2011). That is, they only measure the product of the included tasks, e.g., the speed at which a performer completes a task or the number of successful shots (Morrow et al., 2011). We suggest that a process-oriented test is more sensitive in capturing differences in student performance. For example, a low-skilled student participating in a product-oriented shooting task might not exhibit progress in performance between the pre- and post-measurement. However, the same student when participating in a process-oriented test might exhibit progress in the shooting technique (e.g., from no critical element coded as present to one or two critical elements coded as present). It is important to note though, that the successful administration of a process-oriented test requires carefully selected and intensively trained scorers. This study's scorers had a background in PE (i.e., they were master's students in a post-graduate degree in PE and sport pedagogy and/or acquired specialization in PE during their under-graduate studies) and underwent an intensive training program comprising four three-hour sessions.

Research Question 3: What is the contribution of a basketball CK PD program to in-service teachers' level of CK in basketball?

Turning to the contribution of the PD program to teachers' CK, the study's findings corroborate previous research findings indicating the significant positive effect of content-focused PD programs on teachers' CK in general education (Diamond et al., 2014;

Faulkner & Cain, 2013; Garet et al., 2008; Greene et al., 2013; Heller et al., 2012; Hill & Ball, 2004; Khourey-Bowers & Fenk, 2009; Maerten-Rivera et al., 2015) and in PE (Hunuk et al., 2013). In particular, the multiple regression analysis revealed that the participation in the PD program and teachers' initial performance were significant predictors of teachers' final performance in the CK test. The first independent variable (i.e., participation in the PD program) explained 40% of the variance in the teachers' final CK in basketball, while the inclusion of the second independent variable (i.e., teachers' initial CK in basketball) increased the explained variance of the dependent variable from 40% to 66%. Cohen's *d* verified the difference between the study's groups (i.e., TG and CG), indicating a strong effect (d=1.60).

Interestingly, teachers' lesson plans depicted in a tangible manner the gradual increase in teachers' CK. Specifically, the percentage of sequentially inappropriate task progressions identified in the lesson plans, gradually decreased after the second lesson. In fact, from the eighth lesson onwards, no sequentially inappropriate task progression was found in teachers' lesson plans (see Figure 4.3, p. 133). This finding resonates with Kim's (2016) findings showing that participation in a volleyball CK workshop changed a teacher's enacted teaching practices in the following manner: from less content progressions to more content progressions.

Another important pattern emerged regarding the content of teachers' lesson plans. Five particular teachers were found to have a higher percentage of sequentially inappropriate task progressions (i.e., 29% to 50% of their lesson plans comprised sequentially inappropriate task progressions). Four out of these five teachers scored below the average percentage of success in both tests measuring teachers' CK level in basketball (i.e., pre- and post-tests). This finding supports previous research findings suggesting that teachers vary considerably in their response to the same PD (Franke, Carpenter, Levi, & Fennema, 2001; Knapp & Peterson, 1995). Nevertheless, it is important to note that even these four TG teachers performed above the average performance of their CG's counterparts in all the cases (i.e., teacher CK post-test, teacher progress between the pre- and the post-test).

Moreover, the findings revealed that the TG's mean performance increased from .62 logits to 1.86 logits, whereas, the CG's mean performance increased from .32 logits to .63 logits (see Table 4.7 in Chapter 4). It is not surprising that the teachers participating in the CG also improved in CK performance. It has been shown in the literature that the required curriculum is a major source of teacher CK (Arzi & White, 2008; Diamond et al., 2014). In other words, the use of curricular materials to teach could positively inform teachers' CK.

Turning to teachers' background characteristics, in line with previous pertinent studies in general education (Carlisle et al., 2009; Diamond et al., 2013, 2014; Hill et al., 2005; Maerten-Rivera et al., 2015; Nowicki et al., 2013; Rice, 2005) and in PE (Castelli & Williams, 2007; Santiago et al., 2009), our findings suggested that teachers' gender, coursework (i.e., number of content and methods PE courses taken during initial teacher education), and teaching experience (measured in years; number of PE classes taught per year and grade levels taught) were not significant predictors of teachers' final CK in basketball. Concerning PE teaching experience, our findings suggest that CK (and especially SCK) may not be obtained from experience alone. Improving teachers' CK requires deliberate practice characterized by reflecting and refining teaching performance (Ward, He, Wang & Li, 2018). In addition, results of this study showed that prior experience in playing basketball (i.e., playing basketball in a team or playing regularly pick-up games for amusement/exercise) did not significantly predict teachers' final CK in basketball. This finding stands in contrast to research findings (Li et al., 2013; Stefanou, 2014; Stefanou et al., 2015; Stuhr et al., 2007) indicating that teachers with more playing experience in a content area possess a higher CK level in the specific content area. Possibly this is because SCK – which constitutes a significant part of the CK test – is typically acquired through reflecting and refining teaching performance in PE and not by playing the game (Ward, 2009; Ward, Tsuda, Dervent, & Devrilmez, 2018). Nevertheless, more research work is needed to further and deeper examine how the prior playing experience affects teachers' CK.

Moreover, our findings suggest that the identified change in teachers' CK can be (at least partly) attributed to the features of the developed PD program. Particularly, in line with PD literature (Birman et al., 2011; Capps et al., 2011; Desimone; 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015) this study's findings stress that an effective PD must give opportunities to teachers to actively participate in the PD's activities in order to construct their own meaning and understanding. Numerous aspects of active learning (see Table 2.2) were integrated in the PD program developed within this study. Especially, in line with previous pertinent research, the teachers participating in the PD program reported that performing the activities as learners (i.e., *hands-on-activities* part included in each PD session) enhanced their CK in basketball (Appleton, 2008; Braga et al., 2017; Diamond et al., 2014; Murphy & O' Leary, 2012), and that their enhanced CK led to increased confidence in teaching basketball (Coulter & Woods, 2012; Diamond et al., 2014; Shallcross et al., 2002). It is acknowledged, however, that at the first PD session less time was allotted to the hands-on-activities part. Based on the participants' suggestions (i.e., self-reflection cards), the time allotted to the hands-on-activities part was gradually increased from the second PD session onwards.

Finally, the patterns emerged in the data (i.e., lesson plans), suggest that planning for, implementing and receiving feedback on teaching was an effective strategy for acquiring and developing CK and understanding (Shallcross et al., 2002). Specifically, during the PD's eight weeks, teachers were gradually developing basketball lesson plans, which they were using to teach basketball to their students. After the implementation, the teachers had the opportunity to reflect on their teaching, further discuss in each session, receive feedback on the content and structure of their first two or three lesson plans, and thus further comprehend how to transfer the new knowledge to classroom practice.

Research Question 4: What is the contribution of a basketball CK PD program to student achievement in basketball?

In line with previous research findings in general education (Diamond et al., 2014; Heller et al., 2012) and in PE (Hunuk et al., 2013; Iserbyt et al., 2016, 2017; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015), we found that teacher participation in a content-focused PD program contributed to significant gains in student achievement. Specifically, the multilevel regression analysis revealed that the variable pertaining to the teachers' participation in the PD program had the strongest effect in predicting the final student achievement. Cohen's *d* verified once again the difference between the study's groups (i.e., TG and CG), indicating a moderate effect (d=0.73).

Our findings also resonate with previous findings (Hill et al., 2005; Lane et al., 2009; Mullens et al., 1996; Rowan et al., 1997; Strauss & Sawyer, 1986; Tatto et al., 1993; Tchoshanov et al., 2017) suggesting that teacher CK is of critical importance for student achievement. In particular, the variable pertaining to teachers' final performance in the teacher CK test explained 3.65% of the variance attributed to the teacher level – which represents 22.83% of the unexplained variance at the teacher level.

Moreover, descriptive and inferential analysis (see Table 4.11, p. 140) revealed that the students, whose teachers participated in the PD program, performed significantly better in almost every skill and game performance element included in the performance test (i.e., BaST test). Specifically, statistically significant differences were found in eight skills or game performance elements at p<.001 (i.e., quick stop, pivoting, shooting layups, shooting accuracy in layups, passing in game, supporting, guarding/marking, and game involvement). In yet one case (i.e., passing), statistically significant difference was found at $p<.05$. Similar findings were reported by Kim (2016) who found that teachers' participation in a volleyball CK workshop contributed to gains in student learning in terms of appropriate decision-making, skill execution, and support movements during volleyball game play.

These findings are particularly important, since students in Grades 5 and 6 are expected to perform more advanced skills with greater control, coordination and precision, and use them in modified individual and team activities, by applying more complex rules and tactics (Ministry of Education and Culture, 2010). The skills and offensive/defensive moves included in the BaSt test are not considered important only according to the Cypriot PE curriculum (or other PE curriculums around the world). There is a general consensus among coaches, players, and basketball instructors (with experience at all age levels) on the following: passing is the most important fundamental in basketball; lay-up is the cornerstone shot in basketball; footwork (e.g., quick stop, pivot) is vital in playing basketball; pivot is one of the least used and most poorly learned skills in basketball; on-the-ball defense can be considered the spearhead of defense; off-the-ball defense is a crucial individual defensive skill which makes a significant contribution to team defense; learning to move without the ball (e.g., supporting) is critical to success (Krause et al., 2008; Miniscalco & Kot, 2009; Paye & Paye, 2013).

In addition, it is important to stress that the significant differences in student performance were not only found in the 'isolated' skills (i.e., LU task, DSPP task) but also within a modified game of basketball (i.e., ODeMS task). Our findings indicate that the students participating in the TG performed significantly higher – than their counterparts participating in the CG – in almost every game performance element included in the ODeMS task (i.e., passing in game, supporting in game, guarding/marking in game, and game involvement). The over-emphasis on the development of the basic skills of the game, at the expense of other aspects of skilled play (e.g., defensive and offensive moves), has been a target for criticism in PE literature (Griffin et al., 1997; Launder & Piltz, 2013). The activities included in the training material (Launder & Piltz, 2013), situate learning within game play, 'forcing' the learners to actively interact with the individual, environmental and task constraints placed upon them. This process contextualizes learning of skills within the games they will be played in, with skills learned more likely to be transferrable to actual game performance situations (Chow & Atencio, 2012; Launder & Piltz, 2013).

Notably, the above described quantitative results are in par with the study's qualitative results. Specifically, the teachers participating in the TG reported positive effects of teaching on their students. Actually, the theme with the highest frequency of occurrence (i.e., 104 thematic units) referred to the positive effects of teaching on students (see *theme 1* in Table 4.15, p. 147). This theme was corroborated by all three qualitative data sources (i.e., self-reflection cards on teaching, group interview, and final self-reflection sheet on the PD program), and comprised the reflections of 19 out of the 23 teachers participating in the PD program. In particular, these teachers repeatedly reported that the activities included in the training material promoted students' enthusiasm, interest, engagement, and learning (i.e., knowledge, skills, and attitudes). Nevertheless, it is important to keep in mind that six teachers encountered a number of challenges when teaching basketball based on the study's training material. In particular, these teachers reported the following: the description of one activity (i.e., '*end zone'*; see Appendix D) was too complicated for students to understand; in some cases, the lack of equipment and facilities (e.g., only two baskets) caused problems in implementing the activities; and providing feedback was not an easy task, since in many cases the students were working in small groups.

Moreover, we did not find statistically significant differences between the two groups' post-test performance in two cases; that is, dribbling and stealing the ball. In accordance to Launder and Piltz (2013), our findings suggest that it takes time for novices to master the skill of dribbling. Particularly, the critical element '*dribble without watching the ball*' was coded as present in only 126 student performances (out of 1717; i.e., 7%), from which 98 occurred during the post-test administration. In addition, executing speed dribbling around a course of cones approximates the game performance (Morrow et al., 2011) and is considered as a complex basketball skill since it requires the alignment of body movement to external objects and events (Stöckel et al., 2011).

Turning to the skill of *stealing the ball*, we suggest that the size of the playing area in the ODeMS task (i.e., one eighth of the basketball court) did not allow for all students' actions to be coded as 'steals'. In many cases, the defenders were deflecting an opponent's pass, but they did not end up with possession of the ball (i.e., the ball was deflected out-of-bounds). In accordance to the Official Basketball Statisticians' Manual (FIBA, 2012), these actions were not coded as 'steals'. Thus, stealing the ball – as a component of the ODeMS task – might have worked better in capturing differences between the two groups in a larger playing area (e.g., one fourth of the basketball court).

In addition, findings indicated that students' initial performance and students' gender were significant predictors of the final student performance in basketball. Regarding gender, the boys were found to perform significantly better than girls. This finding resonates with previous studies indicating that boys were more competent in object control skills (e.g., Barnett, van Beurden, Morgan, Brooks, & Beard, 2010) and in basketball skills, such as dribbling, passing, and receiving (Hushman, 2015). According to Hushman (2015), these differences could be a result of boys playing the game of basketball more frequently than girls.

Moreover, concerning teachers' background variables (i.e., gender, coursework: number of content and methods PE courses taken during the initial teacher education, PE teaching experience measured in: years, number of PE classes taught per year, and grade levels taught; frequency of watching professional basketball games; and prior experience in playing basketball), none of them was found to statistically predict the final student achievement. These results support previous studies' findings (Diamond et al., 2014; Hill et al., 2005) suggesting that teacher coursework is unrelated to students' achievement. At the same time, our findings contradict previous research findings (Diamond et al., 2014; Rice, 2003; Wayne & Youngs, 2003) indicating that teaching experience (measured in years) generally has a positive effect on student achievement. This indicates that teaching experience alone does not necessarily enhance student achievement. Yet, more research work is needed to further examine how teaching experience affects student achievement in PE.

In appraising the above findings, it is important to consider that the teachers participating in the TG taught on average 9.7 basketball lessons, whereas, their counterparts participating in the CG taught on average 9.2 lessons[28]. Thus, the differences in student achievement between the two groups cannot be attributed to the given opportunities to learn. However, we did not collect any information concerning the basketball skills and tactics taught by the CG teachers. Therefore, it is possible that the CG teachers choose to teach only specific skills and/or tactics to their students. Yet, taking into account that the TG students performed significantly better in almost every skill and game performance element included in the performance test, we suggest that the differences in student achievement between the two groups are less related to *what the students were taught as content* and more related to *the SCK used to teach the CCK*.

In particular, our findings indicate that student achievement is enhanced when teachers know (i.e., knowledge of instructional tasks) and apply high-quality activities that are shaped to improve specific elements of performance, involve game-like situations and promote vigorous physical activity (see *theme 2* in Table 4.15). To start, *shaping play* is a key principle of Play Practice model (Launder & Piltz, 2013) and refers to the

[28] Information on the number of basketball lessons taught by each participant was gathered from a small survey.

manipulation of one or more game variables (e.g., rules, playing area dimensions, differential scoring system) to emphasize particular aspects of effective play. For example, in the *2vs1 passing game* (activity 2 in the training material), a defensive player was trying to prevent an offensive player (P1) from receiving a pass from the ball handler, who was not allowed to move. In addition, the defensive player could only guard P1. These modified rules were 'forcing' P1 to move in order to get open and receive a pass. At the same time, the ball handler, without pressure from a defender, had the time to decide where, when, and how to pass the ball (Launder & Piltz, 2013).

In addition, the specific activity was aligned to the real game of basketball, since it comprised authentic game challenges (e.g., pressure from an opponent). A noteworthy pattern emerged from the data regarding this key characteristic of high-quality activities. Specifically, in 28 lesson plans (19%) the teachers allocated inadequate time (i.e., less than 10 minutes) or no time at all to activities comprising game-like situations. From these 28 cases of inappropriate allocation of time, the 21 concerned six specific teachers. These six teachers were found to have a higher percentage of inappropriate time allocation in their lesson plans (i.e., 29% to 78% of their lesson plans comprised inappropriate time allocation) than the other teachers participating in the TG. Importantly, the students of five out of these six teachers performed below the average student performance in the post-test, and at the same time, the progress they made between the pre- and the post-test was below the average progress achieved by the TG students. This finding is in accordance with Ward's (2013) postulate that "you get what you teach. If you use low-quality tasks, students acquire something different than if you used high-quality tasks" (p. 437).

Finally, our findings revealed that the progressive content development (i.e., from simple to complex, from easy to difficult, or from static to dynamic) as depicted in teachers' lesson plans, may enhance student achievement. In particular, five teachers participating in the TG were found to have a higher percentage of sequentially inappropriate task progressions in their lesson plans (i.e., 29% to 50% of their lesson plans comprised sequentially inappropriate task progressions). Interestingly, these five teachers were the same five teachers (plus one more), who allocated inadequate time to game-like activities and their students exhibited low gains in achievement. Thus, we can infer that the lack of teachers' SCK (i.e., how to progressively sequence instructional tasks or selecting activities comprising game-like situations), to a certain degree, was also evident in students' achievement. This significant finding supports previous research efforts (cf. Ball et al., 2008; Krauss et al., 2008; Ward, 2013) indicating that teachers' knowledge of instructional tasks and their ability to sequence them in meaningful ways are critical skills for teachers.

Implications of the Study

This study examined the contribution of a content-focused PD intervention to teacher CK and student achievement as measured by a CK test and a performance test, respectively. Several significant implications can be drawn from our findings; namely, theoretical, methodological, and practical implications.

Theoretical Implications

Our findings suggest that what is measured or provided as CK is a key aspect in investigating links between teacher CK and student achievement. Ward's (2009) CK framework guided the efforts undertaken herein. More precisely, we drew on Ward's (2009) four-domain CK conceptualization in PE to develop a scale for measuring teacher CK in basketball. Moreover, Ward's CK framework informed the content and materials used in the PD program designed for the purposes of the current study. Our findings support Ward's (2009) CK conceptualization in PE and thus contribute toward the establishment of one common definition of CK in PE.

A thorough review of PE literature indicated that there is "a lack of conceptual clarity relative to what is the subject matter knowledge that best serves a teacher" (Ward, 2009, p. 346). In fact, a number of studies directly measuring teachers' CK in PE (e.g., Hunuk et al., 2013; Kim, 1996; Santiago, Disch, & Morales, 2012a) consider CK to include only the knowledge described under the construct of CCK. Likewise, research findings in general education (i.e., Baumert et al., 2010; Carlisle et al., 2009; Garet et al., 2008; Sadler et al., 2013a, 2013b) indicated that teacher CK – when measured exclusively under the construct of CCK – is a poor predictor of student achievement. In other words, it seems that CCK (e.g., knowledge of the rules, technique and tactics) is not as good predictor of student achievement as SCK (e.g., knowledge of student common errors, high-quality instructional tasks and task progressions). According to Ward (2009), CCK is the knowledge that one must possess to simply perform an activity or play a sport, whereas SCK is the knowledge that is necessary for someone to teach the activity. For example, there is no doubt that in playing volleyball a player must know basic rules, etiquette, techniques, and tactics. Yet, in teaching volleyball, besides knowing the rules, etiquettes, techniques and tactics, a teacher must be able to analyze the source of students' errors, address incorrect students' performances using correct feedback and cues, and provide appropriate tasks (Kim, 2011).

Methodological Implications

Turning to the methodological implications of this study's findings, teacher PD researchers (Desimone, 2009) and PE researchers (Iserbyt et al., 2017; Ward et al., 2015) have called for the development of standardized measures of teachers' knowledge. In particular, Ward and colleagues (2015) argued that "to our knowledge, valid and reliable knowledge tests of SCK do not exist at present. Measures of CK and, in particular, SCK are needed to demonstrate direct changes in teacher knowledge" (p. 138). This study provides a description of a measure developed to directly assess teachers' CK in basketball. The teacher CK test was found to have satisfactory psychometric properties (e.g., items' r=0.98; teachers' r=0.75), and thus it can provide valid and reliable measurements of teachers' CK in basketball (Kyriakides, Kaloyirou, & Lindsay, 2006). We have to indicate, however, that although all the items were found to be useful to the measurement (Linacre, 2017), in two cases (i.e., items 7 and item 16) further refinement is required.

Moreover, this study contributes to PE literature in another significant way; that is, through the development of a student performance test in basketball (i.e., BaST test), which was found to have satisfactory psychometric properties (e.g., items' r=0.98; students' r=0.82). The specific test, for the most part, is *process-oriented*. In other words, the emphasis is placed on evaluating the correct form (i.e., critical elements) of the selected skills, something which is not common in PE literature. As in the case of the teacher CK, all the tasks were found to be useful to the measurement (Linacre, 2017), yet, four game performance elements (i.e., supporting in game, passing in game, stealing in game, game involvement) require further refinement.

In addition, the present study followed a *quasi-experimental* design, which is not particularly common in educational studies, let alone in PD studies in PE examining relationships between teacher knowledge and student achievement. The specific design included both a comparison group and pre/post-measurements (Shadish et al., 2002). In doing so, we have provided a series of data concerning the baseline equivalence between the treatment and the comparison group.

Finally, as far as we can tell, this is the first content-focused PD study in PE utilizing advanced techniques for the analysis of data. Other pertinent studies (e.g., Iserbyt et al., 2016, 2017; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015) mainly used descriptive statistics and inferential analysis. For the analysis of this study's quantitative data, besides descriptive and inferential statistics, three advanced statistical techniques were utilized; IRT analyses, multiple linear regression analyses, and multilevel model analyses. The use of these advanced techniques for the analysis of data is another important contribution of the current study.

In conclusion, researchers from different contexts and disciplines could replicate this study's methodological advancements or aspects thereof. This challenging research agenda will enrich and deepen our understanding of the complex relationships among teacher knowledge, quality of teaching, student achievement and PD.

Practical Implications

Findings of this study suggest a number of policy implications for government and higher education. First, the study's findings indicate that teacher CK is of critical importance in enhancing student achievement. Therefore, CK – comprising both CCK and SCK – should be included in and shape teacher initial education and continuous PD programs. Notably, a teacher should be prepared in such a way as to: know the basic rules and etiquettes of a number of activities; know the technique of the skills required to perform a number of activities and the basic tactics relevant to those activities; anticipate specific student common errors relevant to the activities and know appropriate error corrections; discriminate between correct and incorrect performances in live conditions; select high-quality instructional tasks; develop appropriate sequences of task progressions (i.e., from simple to complex, from easy to difficult, or from static to dynamic); and finally, know and use efficiently instructional representations (e.g., verbal representations: cues; visual representations: demonstrations). It is important to note, however, that it was not among the aims of the study to examine the separate contribution and/or importance of the above CK components. Our findings show the overall contribution of these CK components, and thus, interpretations should be evaluated with care.

The above implication is particularly important for generalist teachers teaching PE, since they were found to lack the necessary CK and/or PCK to teach PE effectively (Graber, Locke, Lambdin, & Solmon, 2008; Petrie, 2010; Stefanou et al., 2015). Generalist teachers' participation in content-focused initial education and PD programs in PE, seems to be indispensable in enhancing teacher and student outcomes. As it is noted by Murphy and O'Leary (2012), it is the profession's responsibility to provide coherent and meaningful PD opportunities to generalist teachers.

Second, this study's results can have a potential impact on how PD programs are designed and implemented. The proposed conceptual framework of effective PD that was utilized for the purposes of the present study drew on high-quality PD features identified in the literature (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). In particular, this study's findings stress that an effective PD should be focused in enhancing teachers' CK (and especially teachers SCK) and should give opportunities to teachers to actively participate in the PD's activities (e.g., performing the activities as learners: hands-on-activities part; planning for, implementing and receiving feedback on teaching).

There is no doubt that this would be a challenging agenda. However, major changes to the structure and content of the existing PD in PE are required if it is to impact upon teacher and student outcomes (Armour & Yelling, 2004a). Importantly, what seems to be almost undisputed in the PD literature is the belief that a series of 'one-shot' PD activities, undertaken away from the classroom without specific follow-up, are unlikely to have lasting impact upon quality of teaching and student learning (Armour & Yelling, 2004a, 2007; Bautista & Ortega-Ruiz, 2015; Garet et al., 2001). We envision that such an endeavor could be feasible on the following basis:

- ***PD on a long-term basis***. It would have been unrealistic to envision that such a large-scale endeavor could take place within a school year, or during afternoon time. A PD program that would aim to provide the necessary CK for teaching PE in primary education should be spread over a longer period of time and should take place during working hours.

- ***Coherent PD***. Each year the emphasis could be placed on a different content area included in the PE curriculum (i.e., educational gymnastics, dance, games, track and field, life activities, health-related fitness, responsible personal and social behavior). That is, the content, goals, and activities of the PD should be aligned to practice and to the curriculum (Armour & Yelling, 2004b; Desimone, 2009; O'Sullivan & Deglau, 2006).
- ***Targeted PD***. It is not expected that all the primary school teachers will participate in the PD for teaching PE. As it was described in Chapter 3, generalist teachers who teach PE in Cypriot primary schools can be classified into three groups. The first group refers to classroom teachers who are responsible for teaching PE only to their own class along with other subjects, whilst, the second group comprises teachers who teach PE not only to their own class, but also to some other classes. Finally, the third group refers to PE coordinators who teach only PE to students of one or more primary schools (Kyriakides & Tsangaridou, 2008). Thus, we suggest that the PD could be targeted to the PE coordinators, who could undertake support of colleagues within their schools and/or CoPs (Murphy & O'Leary, 2012).
- ***Establishing CoPs***. The trained PE coordinators could then cascade the knowledge to colleagues (Kennedy, 2014), through the establishment of CoPs (Deglau & O'Sullivan, 2006; Desimone, 2009; Patton & Parker, 2015). Wenger (2006) described CoPs as 'groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly' (p. 1). Belonging to a learning community that extends beyond classrooms and school buildings, provides opportunities for collaboration and collective learning (Desimone, 2009; Patton & Parker, 2015). For the establishment of these CoPs a number of five to ten schools could be grouped together on a geographical basis.

The trained PE coordinators could serve as CoP facilitators (Hunuk et al., 2013). The facilitator's role would be to present key topics to the discussion groups, listen to teachers' voices and keep the discussions focused. Importantly, the facilitator should let teachers have an equal voice during meetings, with his/her role decreasing over time (Hunuk et al., 2013).

- ***Retaining knowledge.*** Importantly the knowledge provided to the CoP's facilitators should be retained and developed further based on the following approaches: (a) engagement with professional readings; and (b) provision of opportunities to link with experts and/or teacher educators (Murphy & O'Leary, 2012).
- ***Use of official personnel meetings for further PD***. Teachers in Cypriot primary schools participate in official personnel meetings one hour per week. These meetings, for the most part, are used to facilitate managerial issues. We suggest that part of this time could be devoted to PD issues in various subject areas (including PE).

Third, our findings can inform the development of instructional materials for teachers (e.g., teacher guides, handbooks). The basketball material developed for the purposes of the current study comprised ten high-quality activities (Launder & Piltz, 2013) – as they were defined by the teachers participating in the PD intervention (i.e., activities involving progressive content development and shaped, game-like situations). The following components were provided for each given activity: (a) the description of the activity; (b) the organizing arrangement using a diagram; (b) a list of critical elements for each skill/tactic; (c) a list of cues for each skill/tactic; (d) a list of common errors and error corrections; and (e) a set of task progressions related to each primary activity (see Appendix D). In developing related instructional materials, it is important to take into account that six teachers encountered a number of challenges when teaching basketball based on the study's training materials (i.e., the description of one activity was too complicated for students to understand; in some cases, the lack of equipment and facilities caused problems in implementing the activities; and providing feedback was not an easy task, since in many cases the students were working in small groups).

Finally, policymakers should look into and address the issue of the underrepresentation of female teachers in the teaching of PE in primary education. We suggest that there is no single quick fix solution to ensure a greater diversity of classroom teachers deliver PE. To start, the pertinent research suggests the following: the typical stereotype of PE teachers involves being fit, healthy, athletic, and able-bodied (Tinning et al., 2001), masculine, male, and Caucasian (Nettleton, 1985); gender inequalities and stereotyping are part of teachers' own experiences of their school PE, sport participation, and their initial teacher education (Flintoff & Scraton, 2006); teachers are among the primary agents for reproducing existing gender relations in PE (Kirk & Oliver, 2014); girls are constructed by others, including their teachers and their peers, as inferior to males in PE and sport contexts (Flintoff & Scraton, 2006). Importantly, little progress appears to have been made to changing the situation for girls in school PE for at least the past 40 years (Oliver & Kirk, 2016).

Taking into consideration all the above, we suggest that the root of the problem (i.e., underrepresentation of female teachers in teaching primary PE), seems to lay in teachers' own PE experiences, stereotypes and self-perceptions. Stereotypes and self-perceptions are important in understanding how people develop their self-knowledge and social identity, and become members of groups (Hogg & Vaughan, 2008). As it was described before, in Cypriot primary education the teachers who teach PE classes are not assigned by each school's principle. For the most part, PE classes are taught by the teachers that are willing to do so. Female teachers typically opt not to teach PE and if “forced” opt to teach PE only to their own class. Thus, for the most part, PE is taught by male teachers.

Therefore, it is crucial that policymakers make an effort to break the reproductive cycle around girls and female teachers in PE (i.e., girls are inferior to boys in PE – girls construct a low self-perception concerning participation in PE and/or in sports – female generalist teachers opt not to teach PE). To this end, Oliver and Kirk (2016) offer a promising way of working with girls from an activist approach. We suggest that this approach could also shape PE-PD programs for in-service generalist teachers (and/or pre-service education programs), in an effort to recruit more female teachers in teaching primary PE. Specifically, they propose the following four critical aspects: (a) teachers should be student-centered in their pedagogical practices; (b) teachers should create spaces in their curriculum for girls to critically study their embodiment; (c) PE should be inquiry-based and centered in action; and (d) there should be sustained listening and responding to girls over time (for more details on these elements, see Oliver and Kirk, 2016).

Additional Directions for Future Research

The limitations of our study provide additional directions for future research. First, although the quasi-experimental design applied in this study is considered to be a rigorous research design (Yoon et al., 2007), the adoption of an experimental design seems to be the next logical step. When undertaking a quasi-experimental design, the presence of selection bias has to be examined in terms of baseline characteristics. As it was described in a previous section, the two groups of this study were found to be equal in respect to teachers’ background characteristics (e.g., gender, coursework, PE teaching experience, and prior experience in playing basketball) and teachers’ initial level of CK in basketball. Nevertheless, it is acknowledged that the absence of pre-test differences in a quasi-experimental study is never a proof that selection bias is absent, since unmeasured variables might cause the selection (Shadish et al., 2002). Thus, the utilization of an experimental design could allow causal inferences to be made in exploring the contribution of a PD program to teacher and student outcomes.

Second, the present study applied a pre-post design, which only allowed the investigation of the short-term contribution of the PD program to teacher and student outcomes. Recognizing that teacher and student performance may be different between the acquisition and retention phase (Heller et al., 2012; Olosová & Zapletalová, 2015) the applied study design could be improved by including more longitudinal measures, such as retention tests for both teacher CK and student achievement. The administration of retention tests would allow the investigation of the long-term contribution of the PD program.

Third, we acknowledge that teacher quality is more than CK. Therefore, future studies could examine the contribution of a content-focused PD program to teacher PCK, enacted PCK and/or the quality of teaching PE. To start, it has been widely recognized in the PE literature that CK is highly related to PCK (Chen, 2004; Jenkins & Veal, 2002; McCaughtry & Rovegno, 2003; Schempp et al., 1998; Siedentop, 1989/2002; Tsangaridou, 2002), there is a dearth of research in PE trying to establish links between these two types of teacher knowledge by utilizing direct measures thereof. Moreover, concerning quality of teaching, this study's design cannot provide answers to the following crucial question: How teachers' CK plays out in teaching? According to Locke (1977) this 'black box' phenomenon makes no attempt to describe the process in learning. Thus, future studies in an effort to overcome this limitation and open the so-called 'black box', could collect data from lesson observations to measure teachers' enacted PCK and/or teaching quality. The use of observation data could provide objective information and prevent many of the biases related to self-report data (Strong, 2011), that were collected for the purposes of this study.

Fourth, an immediate next step for further research involves the investigation of the separate contribution of CCK and SCK to student achievement. In this study we have investigated the joint contribution of these two CK sub-domains to student outcomes. However, research findings in general education (i.e., Baumert et al., 2010; Carlisle et al., 2009; Garet et al., 2008; Sadler et al., 2013a, 2013b) indicated that teacher CK – when measured exclusively under the construct of CCK – is a poor predictor of student achievement. This study's qualitative data point to the same direction. However, quantitative data are also needed in the quest for generalizability.

Fifth, the efforts undertaken herein were exclusively focused on teacher CK and student psychomotor performance in basketball. Hence, future researchers could apply our study design in investigating other PE content areas (e.g., volleyball, handball, football) and/or other student learning outcomes (i.e., cognitive, affective, and social). Certainly, this is not an easy task, since it requires the development of reliable and valid measures for assessing teacher and student outcomes, as well as the development of appropriate PD materials. However, such attempts will shed more light into the complex relationships among the features and process of PD, teacher knowledge, quality of teaching, and student achievement.

Finally, the findings of this study support the idea that the effectiveness of PD rests on two types of theories: a theory explicitly defining the components of the CK provided (Ward, 2009); and a theory describing evidence-based, *high-quality PD features* (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). As it was documented in the review of PD literature, in many PD studies (e.g., Diamond et al., 2014; Faulkner & Cain, 2013; Greene et al., 2013) the CK provided was not thoroughly specified, and thus, it is not clear which CK aspects were addressed. On the contrary, a number of PD studies in PE (i.e., Iserbyt et al., 2017; Iserbyt et al., 2016; Kim, 2011, 2016; Lee, 2011; Sinelnikov et al., 2016; Ward et al., 2015) describe explicitly the nature and components of the CK provided. However, these studies include fewer key features of effective PD as proposed in the literature (e.g., they do not comprise sustained duration and collective participation). Figure 5.1 presents the proposed integrated conceptual framework of effective PD.

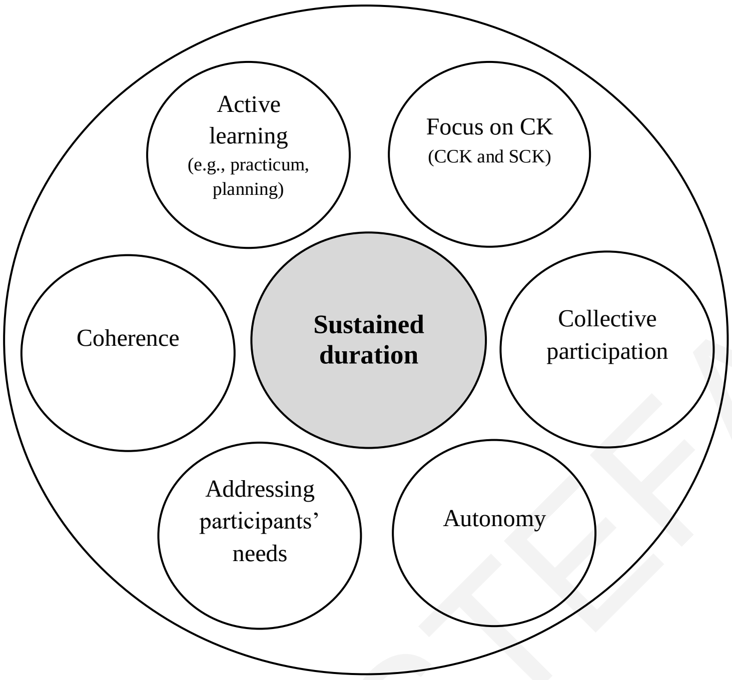


Figure 5.1 Integrated conceptual framework of effective PD

This study's findings support the utilization of the following high-quality PD features: (a) *sustained duration*: sustained duration increases the opportunities for in-depth discussion of content, active learning, and coherence with teachers' other experiences (Armour & Yelling, 2004a; Darling-Hammond & McLaughlin, 2011; Desimone, 2009; Guskey, 2003; Patton & Parker, 2015); (b) *content focus:* Ward's (2009) CK conceptualization in PE should inform the selection of CK dimensions to be provided, as well as the development of the PD materials; (c) *active learning:* teachers should participate actively in the PD's activities in order to construct their own meaning and understanding (e.g., teachers should engage in hands-on activities, plan for and implement teaching); (d) *coherence:* content, goals, and activities should be aligned to practice and to the PE curriculum; (e) *collective participation:* participants should be teachers from the same grade, subject, or school, and should collaborate in PD activities; (f) *addressing participants' needs:* teachers should participate in decision-making regarding what they will learn, how they will learn, and how they will use what they learn; and (g) *autonomy:* pedagogical strategies should be used to aid teachers in becoming independent and lifelong learners (Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015).

However, this study's findings, for the most part, examined the joined contribution of the above PD features. Therefore, future studies could examine their separate contribution to teacher and student outcomes. For example, future research could compare the contribution of PD programs, comprising different high-quality PD features, on teacher CK and student achievement. This in turn would allow future researchers to assess the utility and importance of each feature. Actually, this approach was followed in few previous pertinent studies (e.g., Antoniou & Kyriakides, 2011; Heller et al., 2011). Indicatively, Antoniou and Kyriakides (2011) compared the impact of two different approaches to teacher PD; that is, the dynamic integrated approach and the holistic approach.

Conclusion

Having recognized the lack of conceptual clarity regarding the components of teacher CK, the extensive use of proxy variables in measuring teachers' CK, and the dearth of research exploring the efficacy of PD programs using direct measures of both teacher and student outcomes, the present study sought to investigate the contribution of a content-focused PD program to teacher and student outcomes, using direct measures of teachers' CK and students' achievement in basketball. Importantly, the data analysis showed that the developed scales had satisfactory psychometric properties and thus, could provide valid and reliable measurements of teacher CK and student achievement.

Moreover, the study's findings revealed that teachers, who participated in the PD program, scored significantly higher in the post-test than those who did not. Specifically, the analysis revealed that the participation in the PD program was a significant predictor of teachers' final performance in the CK test explaining 40% of its variance.

Correspondingly, the students, whose teachers participated in the PD program, performed significantly higher in the post-test than those whose teachers did not participate in the PD program. In particular, we found that the variable pertaining to the teachers' participation in the PD had the strongest effect in predicting student achievement. Likewise, teacher final CK was found to be a significant predictor of student achievement. These findings indicate that teacher CK is of critical importance for student achievement. At the same time, the study's findings suggest that what is measured (or provided in PD programs) as teacher CK is a key aspect in investigating links between teacher CK and student achievement. For the purposes of this study, we drew on Ward's (2009) four-domain CK conceptualization in PE.

Finally, the study's PD was aligned to high-quality PD features (e.g., Desimone, 2009; O'Sullivan & Deglau, 2006; Patton & Parker, 2015). Specifically, the developed PD was content-focused, sustained, coherent, collective, and tailored to meet the teachers' needs. At the same time, it provided opportunities for active learning and featured elements of autonomy and choice. Findings of the study provided empirical support on the effectiveness of these high-quality PD features and, therefore, constitute an important contribution to the field of teacher PD. As Shulman (1983) indicated, these significant findings "evoke images of the possible [...] not only documenting that it can be done, but also laying out at least one detailed example of how it was organized, developed, and pursued" (p. 495).

Appendices

Appendix A: Teacher CK Test in Basketball

University of Cyprus
Department of Education

Dear colleagues,

I am conducting a study to examine factors that influence the teaching of primary physical education (PE). One of the study's main aims is to develop valid and reliable instruments for then investigating what is needed for teaching primary PE effectively. In particular, with this instrument we are trying to determine the fundamentals for teaching basketball in primary education.

We would greatly appreciate it if you could devote about 40 minutes to complete the following survey, which includes three parts. Please answer *all* the following questions with *honesty*. It is strongly noted that the collected information will be kept highly *confidential* and used exclusively for the study's purposes.

Thank you in advance for your help.

Lambros Stefanou
(Doctoral Candidate in Physical Education Pedagogy)

PART A

All the following questions concern teaching basketball to beginners (5th or 6th graders). Choose one answer in each case.

1. How does a basketball game start? (beginning of the first period)

(a) With a throw-in at the endline

(b) With a throw-in at the centre line extended

(c) With a jump-ball in the free-throw semi-circle

(d) With a jump-ball in the centre circle

2. Which of the following statements constitutes incorrect technique when performing control dribbling?

(a) Bending the knees

(b) Pushing the ball with the palm

(c) Keeping the ball below waist level

(d) Flexing the wrist

3. **Which of the following statements represents a <u>common error</u> made by students when performing speed dribbling?**

(a) Kicking the ball with the legs

(b) Pushing the ball out in front excessively

(c) Eyes looking the whole court

(d) Keeping the ball at the side of the body

4. **Suppose you observe that beginners have mastered the technique of lay-up without dribbling. Which of the following statements represents an <u>appropriate</u> extension task?**

(a) Executing layups after dribbling

(b) Executing layups without a ball

(c) Executing layups after dribbling and under pressure

(d) Executing layups after receiving a pass by carrying the ball

5. **When a player stops dribbling, what is he/she allowed to do with the ball?**

(a) He/She can continue dribbling

(b) He/She can only pass the ball

(c) He/She can only shoot the ball

(d) He/She can pass or shoot the ball

6. **Which of the following statements constitutes <u>incorrect</u> technique when performing a bounce pass with two hands?**

(a) Holding the ball at chest level

(b) Stepping into the direction of the pass

(c) The ball should hit the floor halfway to the teammate

(d) The ball should arrive to the teammate at waist level

7. **Which of the following statements represents a <u>common error</u> made by students when performing a chest pass?**

(a) Elbows at shoulder height when holding the ball

(b) Elbows close to the body when holding the ball

(c) Passing the ball with the palms

(d) Passing the ball with the fingers

8. Suppose you observe that beginners have mastered the technique of stationary dribbling. Which of the following statements represents an <u>appropriate</u> extension task?

(a) Walking dribble in free space

(b) In pairs, one student dribbles and the other tries to steal the ball

(c) Dribbling in delimited space around obstacles

(d) All of the above

9. Which of the following situations is <u>NOT</u> a case of travelling violation?

(a) Lifting the pivot foot before starting a dribble

(b) Taking more than one step before starting a dribble

(c) Two steps without dribbling when shooting a lay-up

(d) None of the above

10. Which of the following statements constitutes <u>incorrect</u> technique when performing a quick stop?

(a) Feet hit the floor at the same time

(b) Knees bent

(c) Landing on the front part of the feet

(d) Landing in a parallel stance

11. Which of the following statements represents a <u>common error</u> made by students when performing a set-shot?

(a) Placing the non-dominant foot (non-shooting side foot) slightly forward

(b) Flexing the wrist after releasing the ball

(c) Eyes are not kept on the target

(d) Shooting the ball with both hands

12. Which of the following statements describes what will happen, when a foul is committed on a player while releasing a shot from the 2-point field goal area?

(a) If the shot is successful, the goal shall count and in addition, one free throw shall be awarded

(b) If the shot is successful, the goal shall not count and two free throws shall be awarded

(c) If the shot is unsuccessful, a throw-in shall be awarded at any place at the endline

(d) If the shot is unsuccessful, one free throw shall be awarded

13.Which of the following statements constitutes <u>incorrect</u> tactic when two offensive players face one defensive player?

(a) Quick passing between the two offensive players

(b) The offensive players get open to receive a pass

(c) Choosing the appropriate type of pass depending on the defensive player's position

(d) Dribbling fast and continuously

14.Which of the following statements represents a <u>common error</u> made by students when playing 'person-to-person' defense?

(a) Eyes on the assigned opponent and on the ball-handler

(b) Eyes only on the assigned opponent

(c) The ball-handler is directed toward the sidelines

(d) The ball-handler is directed toward the middle

15. Which of the following situations is <u>NOT</u> a case of out-of-bounds violation?

(a) The ball touches a player who steps on the boundary line

(b) The ball touches a player who steps outside the boundary line

(c) A player moving within the boundary line touches a ball which is in the air outside the boundary line

(d) The ball touches the back of the backboard

16.Which of the following statements constitutes <u>incorrect</u> technique when performing the defensive stance (on-the-ball defense)?

(a) One hand in front of the ball to prevent a shot and the other hand ready to prevent a pass

(b) The feet shoulder-width apart

(c) The defensive player is in a position between the ball-handler and the other offensive players

(d) Knees bent

17.Which of the following statements represents a <u>common error</u> made by students on offense?

(a) Passing to a teammate who is guarded

(b) The offensive players are not spread out on the court area

(c) Passing to a teammate who is in a long distance

(d) Offensive players move every time the ball is passed

18. Which of the following statements constitutes <u>incorrect</u> technique when performing a lay-up?

(a) High jump toward the basket after the last step

(b) Jump from the right foot when shooting right-handed

(c) Shooting with the outside hand

(d) Eyes early on the target

19. Which of the following statements represents a <u>common error</u> made by students when performing a pivot?

(a) Looking at the feet

(b) Moving the pivot foot

(c) Holding the ball with both hands under the chin

(d) Pivoting on the heel of the permanent foot

PART B

All the following questions concern teaching basketball to beginners (5th or 6th graders). In each case, use the letters which identify the responses to sequence the four activities (e.g., C-B-D-A) in a progressive manner (i.e., from simple to complex or from easy to difficult). In each case, the given activities may correspond to more than one PE lessons.

1. Which is an appropriate instructional progression to teach the selection of the appropriate type of pass to beginners?

A. Three students pass the ball to each other and two students are trying to steal the ball.
B. Modified basketball game (e.g., 3vs3) in half-court.
C. Two teams (e.g., 3vs3) play against each other in delimited space. The aim of the team which has the ball in its possession is to make five consecutive passes, without losing the possession of the ball. If the ball is stolen, the other team starts trying to make five consecutive passes. A point is given if a team makes the five consecutive passes.
D. Three students pass the ball to each other and one student is trying to steal the ball.

……..

2. Which is an <u>appropriate</u> instructional progression to teach '*give-and-go*' to beginners?

A. Performing the give-and-go against an active defense.
B. Performing the give-and-go without defense.
C. Executing V-cuts.
D. Performing the give-and-go against two passive defenders; one on the receiver and the other on the passer-cutter.

…….

3. Which is an <u>appropriate</u> instructional progression to teach fakes without the ball to beginners?

A. Two teams (e.g., 3vs3) play against each other in delimited space. The aim of the offensive players is to make as many passes as possible, without losing the possession of the ball.
B. The students are divided into groups of 4-5 persons. Each group lines up behind a course of cones. On the signal, the first student in each line runs around the cones. At each cone the students perform a hesitation move (fake a cut and change direction).
C. Passing game in triads. Student A (passer) stands in a specific spot and has the ball in his/her possession. Student B guards student C, who tries to get open to receive a pass. Players change roles after each successful pass.
D. The students are divided into pairs. Student A tries to surpass student B and reach the opposite sideline.

…….

4. Which is an <u>appropriate</u> instructional progression to teach defensive stance and defensive sliding to beginners?

A. The students are divided into groups of 3-4 persons. The students of each group line up on the baseline. On the signal, the first student in each line gets in a defensive stance and slides to the opposite baseline. Students return with the other foot leading.
B. The students walk freely in the court. On the first signal (e.g., blowing the whistle one time), students get in defensive stance, whilst, on the second signal (e.g., blowing the whistle twice) students side gallop.
C. The students stand in a circle. On the signal, they get in defensive stance. One point is awarded to the student who will remain in stance for the longest period of time.
D. The students are divided into pairs. The one student tries to surpass the other and reach the opposite baseline (without a ball). The defender is in a defensive stance and he/she slides.

……

5. **Which is an <u>appropriate</u> instructional progression to teach quick stop and pivot to beginners?**

   A. The students are divided into groups of 2-3 persons. The students of each group line up on the baseline. On the first signal, the first student in each line dribbles to the opposite baseline. On every other signal the students execute a quick stop and follow the teacher's instructions (e.g., front pivot on the right foot).
   B. The students are divided into groups of 3-4 persons. The students of each group line up on the baseline. On the signal, the first student in each line executes a quick stop by hopping slightly from one foot and then returns to the end of the line. After 3-4 repetitions students execute quick stops after running.
   C. The students are divided into triads. Student A pivots and students B and C try to steal the ball. The goal is for the student A to keep the ball away from students B and C for 5 seconds.
   D. The students are divided into pairs. Student A pivots and student B tries to steal the ball. The goal is for the student A to keep the ball away from student B for 5 seconds.

………

PART C

Put a √ in the appropriate box/boxes or fill out whatever applies to you.

1. **Gender**: Male ☐ Female ☐

2. **Courses taken during your studies:**

	No course	One course	2-3 courses	More than 3 courses
(a) PE content courses:	☐	☐	☐	☐
(b) PE methods courses:	☐	☐	☐	☐

3. **Years of PE teaching experience (including the current year)**: …………………….

4. **<u>How many years</u> (including the current year) have you taught PE to:**

   - **one class: ………………………………….**
   - **2-5 classes: …………………………………**
   - **6-10 classes: ………………………………**
   - **more than 10 classes: …………………**

5. **To which grades have you taught PE during your career?**

Grade 1 ☐ Grade 2 ☐ Grade 3 ☐ Grade 4 ☐ Grade 5 ☐ Grade 6 ☐

6. **Do you have any other experiences regarding basketball?** (e.g., participating in basketball seminars/workshops, coaching a basketball team):

Yes ☐ No ☐

If YES, describe your experiences:

……

……

7. **How often do you watch professional basketball games?**

never	1-2 times a year	1-2 times every six months	1-2 times a month	3 or more times a month
☐	☐	☐	☐	☐

8. **What is your prior experience in playing basketball?**

- **Few to no experiences** ☐
- **Playing regularly pick-up games for amusement/exercise** ☐
- **Playing basketball in a school/university/non-professional team** ☐
- **Playing basketball in a professional team** ☐

Thank you very much for taking the time to participate in the study!

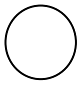
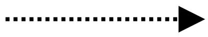
Appendix B: Student Performance Test in Basketball

The Basketball Skills and Tactics Test

(BaST Test)

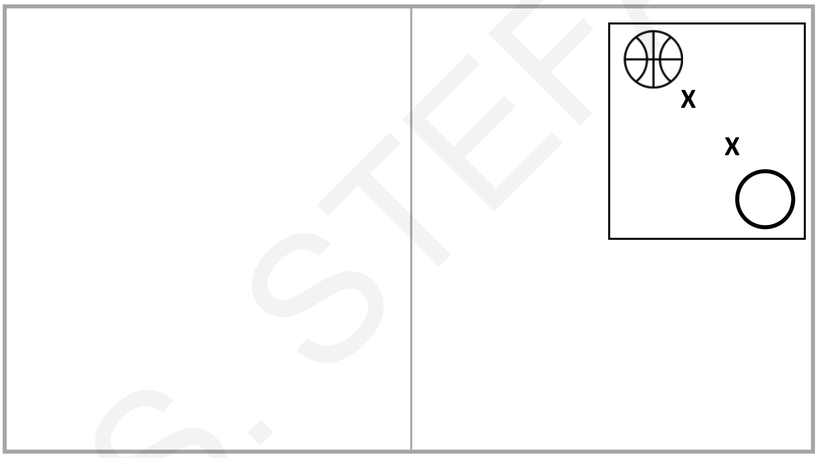
Department of Education
University of Cyprus

Key To Diagrams

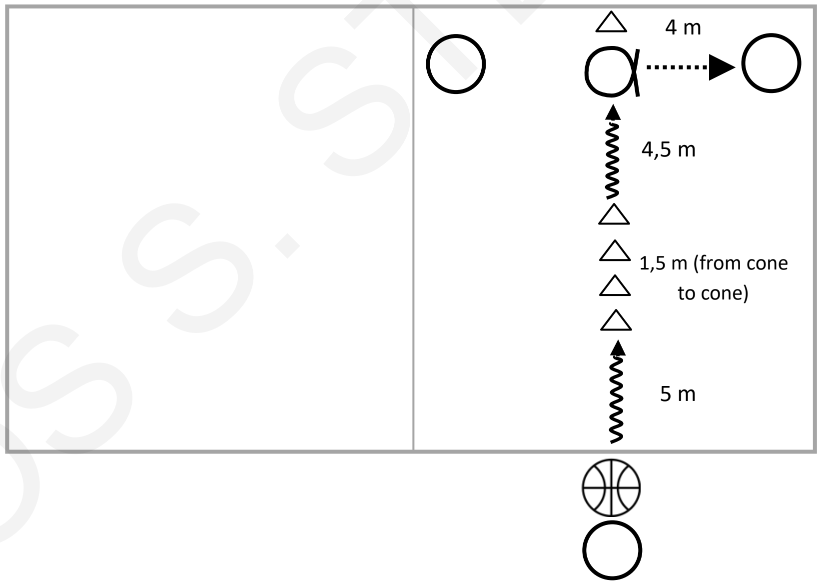
	**Player with ball**
	**Offensive player**
X	**Defensive player**
	**Cone**
	**Path of ball (pass or shot)**
	**Dribble**
	**Path of player (without the ball)**
	**Pivot**

OFFENSIVE-DEFENSIVE MOVES AND SKILLS TASK (ODeMS TASK)

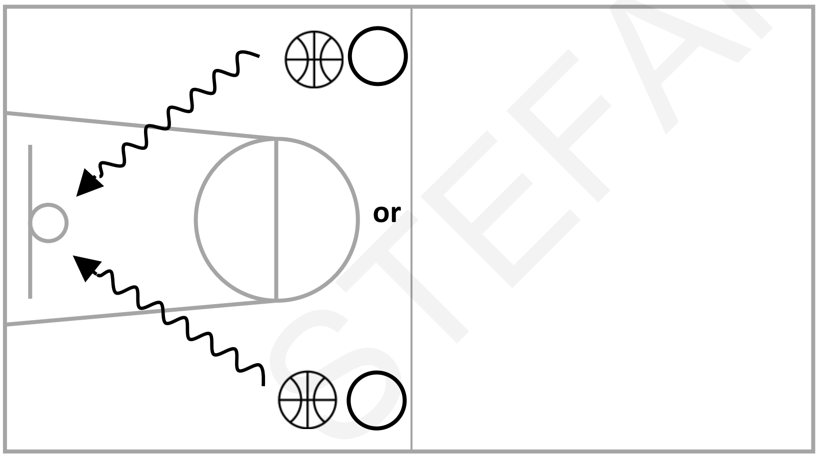
The ODeMS task is based on parts of the Game Performance Assessment Instrument (GPAI, Griffin et al., 1997)

Task Description	The scorers describe/demonstrate the activity (without explaining the correct technique/tactics) and ask the students to play the game in groups of four. In particular, the following instructions are provided: • Playing in delimited space. • The two offensive players have the ball in their possession. • The two defensive players try to gain possession of the ball. • If the defensive players manage to steal the ball, the ball is returned to the offensive players and the game restarts with a throw-in. • On the signal the teams alternate possession of the ball (and the same procedure is repeated). *Notes*. Practice time for each group: 10-20 seconds.
Equipment	One basketball, 12 cones - marker discs, two blue bibs (with the numbers “1” and “2”), and two red bibs (with the numbers “1” and “2”).
Task Organizing Diagram	
Duration	21-22 min for a group of 24 students: 3 min per four students + 1-2 min for practicing the game + 2-3 min for the description and demonstration of the task.
Assessment Scoring Rubric	Selected critical elements: • ***Supporting***: off-the-ball movement to a position to receive a pass. • ***Guarding or marking***: defending against an opponent who may or may not have the ball. • ***Passing***: the ball reaches the intended target. • ***Stealing***: gaining possession of the ball (legally taking/tipping the ball away from an opponent or intercepting/deflecting an opponent’s pass).
Scoring System	Tally system
Remarks	• The PE teacher is asked to allocate the students into groups of four on the basis of the following criteria: (a) similar ability grouping (to the most possible extend); and (b) gender-based grouping (to the most possible extend). • If the number of boys or girls in a class is not a multiple of 4 (e.g., 7, 9, 10 or 11) a number of students (boys or girls) participate in the activity for a second time (without being coded). A student should not participate in the activity two consecutive times (to the most possible extend). • The same group composition must be kept in both the pre- and post-test (to the most possible extend). If a student is absent during the post-test administration, he/she will be substituted by another student on the basis of the two grouping criteria (following the suggestion of the PE teacher). • The game is separated in four segments (45 seconds each). During the first 45-second segment, the two scorers code the offensive moves/skills of the pair that has the ball in its possession (one scorer – one performer), while, during the second 45-second segment, the scorers code the defensive moves/skills of the pair that is trying to steal the ball. After the first two segments are over, the ball is given to the other pair and the same procedure is followed for another 1,5 minutes.

DRIBBLING-STOPPING-PIVOTING-PASSING TASK (DSPP TASK)

Task Description	The scorer demonstrates the four skills (without explaining the correct technique) and asks the students to execute them in sequence. In particular, the following instructions are provided: • Begin dribbling with your dominant hand. • Run while dribbling. • Dribble around the cones. • Change between dominant and non-dominant hand at each cone. • Look at the arrows: right-handed students pass the first cone from the left side, whereas, left-handed students from the right side. • Execute a quick stop at the spot marker facing the cone. • Choose freely the direction of the pivot. • Freeze and wait for the signal. • On the signal pass the ball (chest pass or bounce pass). *Notes*. One practice trial and one evaluated trial for each student.
Equipment	One basketball, four spot markers (starting point, quick stop point, passing points), four cones (50 cm), and one cone (30 cm).
Task Organizing Diagram	
Duration	14-15 min for a group of 12 students: 1 min per student + 2-3 min for the description and demonstration of the task.
Assessment Scoring Rubric	Selected critical elements: • ***Speed dribbling***: (1) dribbling using the fingers and the pads of the hands; (2) keeping the dribble to waist level; (3) dribbling without watching the ball. • ***Quick stop***: (1) feet hit the floor at the same time; (2) landing in a parallel stance; (3) knees bent. • ***Pivot***: (1) permanent pivot foot; (2) knees bent; (3) holding the ball with both hands under the chin (elbows to shoulder level). • ***Chest/Bounce pass*****:** (1) holding the ball in a thumbs-up position (elbows low); (2) extending both elbows to throw the pass; (3) passing to an appropriate catching area (between the waist and the neck).
Scoring System	Check-list for marking the presence or absence of the selected critical elements.

LAY-UP TASK (LU TASK)

Task Description	The scorer demonstrates the lay-up (without explaining the correct technique) and asks the students to execute layups from the side of the basket they prefer (left or right side of the basket). *Notes*. (1) One practice trial and three evaluated trials for each student. (2) Approaching angle: 45 degrees. (3) Starting points: the two starting points are set on the 3-point line.
Equipment	Two basketballs, two spot markers (starting points), two rubber rinks.
Task Organizing Diagram	
Duration	13-14 min for a group of 12 students: 1 min per student + 1-2 min for the description and demonstration of the task.
Assessment Scoring Rubric	Selected critical elements: • ***Lay-up***: (1) two steps without dribbling before the jump; (2) jumping and shooting using the opposite foot/hand (i.e., jumping from the left foot when shooting right-handed and from the right foot when shooting left-handed); (3) shooting with the outside hand (i.e., shooting right-handed when approaching the basket from the right side and left-handed when approaching the basket from the left side). *Notes*. (1) Acceptable types of layups: (a) underhand (or scoop) layup, and (b) overhand (or push) layup. (2) The three selected critical elements are coded in each of the three trials. (3) No critical element is considered to be present and no points are awarded regarding the successful shots made, if the shot is coded as '*non-lay-up*'. For a shot to be considered as a lay-up it has to meet two basic criteria: (a) steps without dribbling the ball (not necessarily two steps) before the jump; and (b) shot from a jump (not necessarily from a high jump).
Scoring System	• ***Critical elements***: Check-list for marking the presence or absence of the selected critical elements. • ***Shooting accuracy***: Two (2) points are awarded for each successful shot and one (1) point for each shot that is not successful, but the ball hits the hoop on its downward flight.

ASSESSMENT SCORE SHEET: BASKETBALL SKILLS AND TACTICS TEST (BaST TEST)

School Code: ……..……………..……. Class: …………… Teacher Code: ………………………….…………… Scorer Code: ……………….……………… Date: ……………….. Time: ……..….

1. OFFENSIVE-DEFENSIVE MOVES AND SKILLS TASK (ODeMS TASK)

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

Administration instructions: ● playing in delimited space ● the two offensive players have the ball in their possession ● the two defensive players try to gain possession of the ball ● if the defensive players manage to steal the ball, the ball is returned to the offensive players and the game restarts with a throw-in ● on the signal the teams alternate possession of the ball (and the same procedure is repeated) ● when completing the game, wait quietly.

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

STUDENT NAME	OFFENSIVE MOVES AND SKILLS				DEFENSIVE MOVES AND SKILLS		
	1. PASSING: The ball reaches the intended target		2. SUPPORTING: Off-the-ball movement to a position to receive a pass		3. GUARDING: Defending against an opponent who may or may not have the ball		4. STEALING: Gaining possession of the ball
	Efficient performance	Inefficient performance	Appropriate movements	Inappropriate movements	Appropriate movements	Inappropriate movements	
1.							
2.							
1.							
2.							

2. DRIBBLING-STOPPING-PIVOTING-PASSING TASK (DSPP TASK)

SN	Left handed	DRIBBLING			STOPPING			PIVOTING			PASSING		
		Dribbling using the fingers and the pads of the hands	Keeping the dribble to waist level	Dribbling without watching the ball	Feet hit the floor at the same time	Landing in a parallel stance	Knees bent	Permanent pivot foot	Knees bent	Holding the ball with both hands under the chin	Holding the ball in a thumbs-up position (elbows low)	Extending both elbows to throw the pass	Passing to an appropriate catching area
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													
11.													
12.													
13.													
14.													
15.													
16.													
17.													
18.													
19.													
20.													
21.													
22.													
23.													
24.													
25.													

Administration instructions: ● begin dribbling with your dominant hand ● run while dribbling ● dribble around the cones ● change between dominant and non-dominant hand at each cone ● look at the arrows: right-handed students pass the first cone from the left side, whereas, left-handed students from the right side ● execute a quick stop at the spot marker facing the cone ● choose freely the direction of the pivot ● freeze and wait for the signal ● on the signal pass the ball (chest pass or bounce pass) ● one evaluated trial will follow one practice trial ● when completing your trial, wait quietly in line.

3. LAY-UP TASK (LU TASK)

SN	Trial 1					Trial 2					Trial 3				
	Two steps without dribbling before the jump	Jumping and shooting using the opposite foot/hand	Shooting with the outside hand	Shooting accuracy	Non-lay-up	Two steps without dribbling before the jump	Jumping and shooting using the opposite foot/hand	Shooting with the outside hand	Shooting accuracy	Non-lay-up	Two steps without dribbling before the jump	Jumping and shooting using the opposite foot/hand	Shooting with the outside hand	Shooting accuracy	Non-lay-up
1.															
2.															
3.															
4.															
5.															
6.															
7.															
8.															
9.															
10.															
11.															
12.															
13.															
14.															
15.															
16.															
17.															
18.															
19.															
20.															
21.															
22.															
23.															
24.															
25.															

Administration instructions: ● perform the layups from the side you prefer ● three evaluated trials will follow one practice trial ● when completing your trials, wait quietly in line.

Appendix C: Set of Qualitative Techniques

LESSON PLAN

Teacher name: ....

Date: ....

Topic: ....

Objectives:

Instructional Activities	**Time**
....	
....	
....	
....	
....	
....	
....	
....	
....	
....	
....	
....	
....	
....	

SELF-REFLECTION CARD

ON TEACHING

1. Positive aspects of the lesson:

2. Difficulties encountered during the lesson:

SELF-REFLECTION CARD

ON THE PROFESSIONAL DEVELOPMENT

1. Positive aspects of today's PD session:

2. Difficulties encountered during today's PD session:

3. Suggestions for changes/improvements on the content of the PD:

FINAL SELF-REFLECTION SHEET

ON THE PROFESSIONAL DEVELOPMENT

1. General comments concerning the content of the PD program (e.g., critical elements, cues, students' common errors, task progressions):

____

____

____

____

2. General comments concerning the activities included in the training material:

____

____

____

3. General comments concerning the hands-on-activities part included in the PD program:

____

____

____

4. Other general comments concerning the PD program:

____

____

____

Appendix D: The Training Material Activities

Content Knowledge for Teaching Basketball

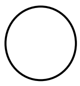
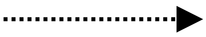
in Primary Education

Based on the principles of

Play Practice (Launder & Piltz, 2013)

Department of Education
University of Cyprus

KEY TO DIAGRAMS

	**Player with ball**
	**Offensive player**
X	**Defensive player**
	**Cone**
	**Path of ball (pass or shot)**
	**Dribble**
	**Path of player (without the ball)**
	**Pivot**

The Four Principles of "Play Practice"

(Launder & Piltz, 2013)

Simplifying Activities

Simplifying play is about creating learning environments that enable children to experience success. This can be achieved in many ways (e.g., minimizing the technical and/or tactical demands of a game, minimizing the agility and/or endurance demands of a game).

Shaping Practices

Shaping play is about *teaching through the game*; it involves manipulating one or more of the variables that form the game (e.g., primary and secondary rules, playing area dimensions, the nature of the goal, the number of players, attacker-to-defender ratio, differential scoring system) in order to create a variety of learning situations that emphasize particular aspects of effective play.

Focusing Practices

Focusing play is about *teaching in the game*. Teachers can focus the play by emphasizing the important concepts or cues of the play practice, and then repeating them in various ways to ensure quality and transfer of learning. The *freeze replay* is an important tool for focusing the play.

Enhancing Play Experiences

The process of enhancing the play is associated with various motivational strategies that can be applied to induce learner interest and maintain an engaged learning state. *Controlled playing time* and *action fantasy games* are examples of ways to enhance the play.

Proposed activities for teaching basketball in primary education*

*The following activities do not constitute complete daily lesson plans. They should be used along with other activities and be adapted to the needs and special characteristics of particular students (e.g., age, ability level).

Activity
1

End zone

Lead-up game 5vs5: Passing – Catching – Offensive/Defensive tactics*

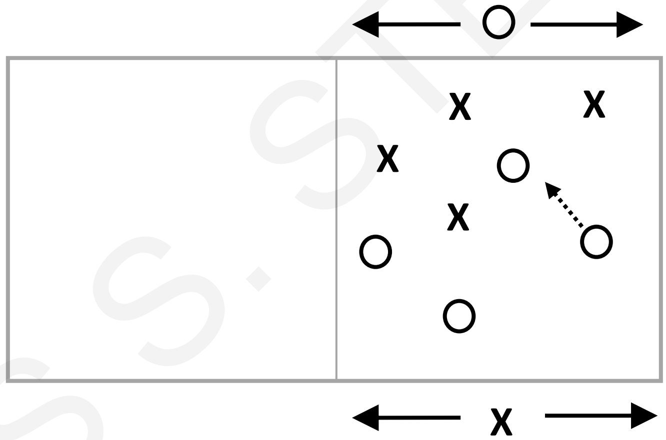
Description

Two teams (e.g., 5vs5) play against each other in half-court. Each team has four court players and one goalie. A goal is scored by passing the ball to the goalie, who can run anywhere behind the goal line (half-court sideline). The passer who scores the goal changes places with the goalie. The ball is then given to the other team to start an attack.

Challenge: ***Which team shall achieve the highest shooting percentage?*** Whenever a goal is scored, the player who scored is allowed to shoot a set-shot from the free-throw line (or closer). A separate score is kept concerning the shots (*Note*. Set-shot does not comprise the focus of the activity – no feedback is provided regarding possible errors in shooting technique).

*The same game is played in the other half-court.

Organizing arrangement



Critical elements

- **Passing principles**: (a) look for the pass before dribbling; (b) pass with the feet on the floor (in most situations); (c) pass accurately to a spot target (i.e., the chest area or the raised hand of the receiver).
- **Catching principles**: (a) catch the ball with both hands; (b) eyes on the ball.
- **Offensive principles (movement without the ball)**: (a) get open to receive a pass (support the ball-handler); (b) raise your hand to provide a spot target (ask for the ball).
- **On-the-ball defense**: maintaining the proper position between the ball-handler and the basket/target.

Cues

- **Passing principles**: *look to pass – feet on the floor – pass to the target.*
- **Catching principles**: *catch with a click (use both hands and eyes).*
- **Offensive principles (movement without the ball):** *create a passing lane – provide a target (ask for the ball).*
- **On-the-ball defense:** *ball-defender-basket/target.*

Common errors – Corrections	• **Offensive principles**: players do not pass the ball. **<u>Correction</u>**: (a) modifying the rules: the players cannot dribble (freeze) when receiving a pass; (b) modifying the rules: “complete at least three passes before shooting”.
Task progression	**<u>Simplifying</u>** • Same as Activity 1, but without dribbling. • Same as Activity 1, but this time the physical conduct is forbidden (i.e., the ball cannot be taken away from the ball-handler). • Same as Activity 1, but with a different attacker-to-defender ratio (e.g., 6vs5), to encourage the offensive players to attempt more passes. **<u>Extending</u>** • Same as Activity 1, but with a smaller goal size (e.g., the goalie is positioned on a gym mat).

Activity
2

Choose the appropriate type of pass

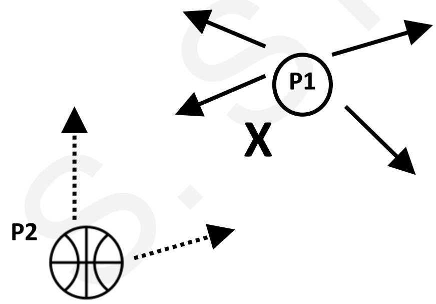
2vs1 in free space: Passing – Offensive/Defensive tactics

Description

A defensive player tries to prevent an offensive player (P1) receiving a pass from the ball handler (P2), who is not allowed to move. Without pressure from a defender, P2 has the time to decide where, when, and how to pass the ball to P1, who tries to get open. Points are awarded as follows: (a) one point is awarded to the offensive players if the receiver (P1) takes two consecutive passes; and (b) one point is awarded to the defender each time he/she intercepts the ball. The ball is returned to the ball-handler (P2) after each attempt to pass the ball. Players change roles when a team reaches a specific score (e.g., 3 points).

Challenge: ***Can I achieve a shooting percentage higher than 50%?***
Whenever a change of roles occurs, each player is allowed to shoot a set-shot from the free-throw line (or closer). A separate score is kept concerning the shots (*Note*. Set-shot does not comprise the focus of the activity – no feedback is provided regarding possible errors in shooting technique).

Organizing arrangement



Critical elements

- **Chest pass**: (a) hold the ball at chest level, close to the body, in a thumbs-up position; (b) pass the ball by extending the elbows, and flipping both wrists to a thumbs-down ending position; (c) take a quick step forward to pass when there is time; and (d) pass the ball toward the chest area of the receiver or toward the target given by the receiver (e.g., a raised hand).
- **Bounce pass**: Like the chest pass, but instead of aiming at the receiver’s chest, the ball must hit the floor about two-thirds of the distance between the passer and the receiver.
- **Overhead pass**: (a) hold the ball just overhead with the elbows flexed (and locked) and the thumbs behind the ball; (b) throw the pass with the wrist and fingers; (c) step forward with the pass; and (d) aim at the receiver’s head.
- **Offensive principals (movement with the ball)**: choose the correct pass.
- **Offensive principals (movement without the ball)**: (a) get open to receive a pass (support the ball-handler); (b) use fakes and/or V-cuts; and (c) raise your hand to provide a spot target (ask for the ball).
- **Off-the-ball defense**: (a) guard your assigned opponent; (b) eyes on the assigned opponent and on the ball.

Cues

- **Chest/Bounce pass**: *elbows down – hands fully extended – wrist flipping – quick step.*
- **Overhead pass:** *ball overhead – elbows locked – [throw pass with] wrists and fingers.*
- **Offensive principals (movement without the ball):** *create a passing lane – provide a target (ask for the ball).*
- **Off-the-ball defense:** *eyes on the [assigned] opponent and on the ball.*

Common errors – Corrections

- **Chest pass**: elbows at shoulder height (the thumbs point downwards). **<u>Correction</u>**: (a) demonstrate the correct technique; (b) emphasize the learning cues (i.e., elbows down).
- **Bounce pass**: bounce the ball too close to the thrower and/or bounce the ball too high. **<u>Correction</u>**: (a) demonstrate the correct technique; (b) specific feedback (i.e., "*the ball should touch the ground approximately two thirds of the distance to the receiver and bounce up to the receiver at hip level").*
- **Overhead pass**: large 'back swing' movement. **<u>Correction</u>**: (a) demonstrate the correct technique; (b) emphasize the learning cues (i.e., elbows locked or short back movement).
- **Offensive principles:** choosing the incorrect type of pass. **<u>Correction</u>**: (a) specific feedback; (b) reflection on specific passing situations to discover the type of pass that fits each situation.
- **Off-the-ball defense**: the defender does not guard his opponent. Instead he/she is standing and hopping in the middle (i.e., piggy in the middle). **<u>Correction:</u>** (a) demonstrate the correct positioning; (b) specific feedback.
- **Off-the-ball defense**: the defender watches either the ball or the receiver exclusively. **<u>Correction</u>**: (a) demonstrate the correct positioning in order to see both the ball and the receiver; (b) emphasize the learning cues [i.e., eyes on the (assigned) opponent and on the ball].

Task progression

<u>Simplifying</u>

- Passing activities (e.g., in pairs) without pressure by an opponent (at first stationary).

<u>Extending</u>

- Same as Activity 1, but in delimited space.
- Same as Activity 1, but with a different attacker-to-defender ratio (i.e., 3 vs 2): The two defenders are not allowed to guard the ball handler, who again is not allowed to move.

Activity
3

Dribble-Freeze-Tag Game

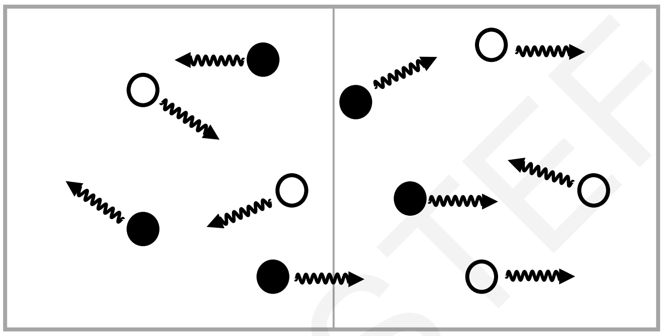
Control/Speed dribbling

Description

The players are divided into two teams. All the players have a ball in their possession and dribble around the full-court trying to touch the opponents' balls. When their balls are touched by an opponent, players must freeze until released by a teammate (by a touch). For as long a player is not released, he/she performs a predetermined exercise (e.g., stationary dribbling with the dominant/non-dominant hand – the other hand is raised).

Challenge:
- ***Can you dribble for a minute without being tagged by an opponent?***
- ***How many balls can you touch in a minute?***

Organizing arrangement



Critical elements

- **Control dribbling**: (a) bend your knees; (b) keep the dribble below waist level; (c) protect the ball with the body and with the free hand; (d) move away from the defender.
- **Speed dribbling**: (a) push the ball using the fingers and the pads of the hands; (b) push the ball out in front; (c) keep the dribble to waist level; (d) dribble without watching the ball.

Cues

- **Control dribbling:** *knees bent – the ball low – protect – move away.*
- **Speed dribbling**: *push with the fingers – push out in front – eyes up.*

Common errors – Corrections

- **Control dribbling**: the player does not protect the ball with the body/free hand. **<u>Correction</u>**: demonstrate the correct position of the body/free hand.
- **Speed dribbling**: slapping the ball with the palm, pushing the ball out in front excessively, the ball bounces above the waist level, eyes on the ball. **<u>Correction</u>:** use the activities described below (i.e., simplifying).

Task progression

<u>Simplifying</u>
- Additional activities for gradual transition from stationary dribbling to speed dribbling. For example:
  - Kneeling and holding the ball close. Treat the ball like a friend, so do not slap it! Move the hand with the ball and not against it. Use your fingertips. Gradually, move the ball around your body and then farther out. Change to the non-dominant hand.
  - Repeat the sequence having your eyes closed/standing/moving slowly.
  - Dribble freely and fast – without watching the ball – in full-court/half-court/one quarter of the court etc.
  - In pairs, move freely, following and copying a partner, who continually changes hands, the height and speed of the bounce, and the direction of movement.

<u>Extending</u>
- Same as Activity 3, but in half-court, one quarter of the court etc.

Activity
4

Dribbling in triads

Speed dribbling – Stopping – Pivoting

Description

The players are divided into groups of three and line up as shown in Figure 1. As the first player (P1) dribbles across, he/she calls out the number of fingers player P2 is showing and continually changing on one hand. When P1 arrives, P2 dribbles toward P3, who shows fingers for P2 to count and call. All players must keep the ball bouncing throughout. When they are stationary, they must use their non-dominant hand.

Then, the teacher adds signals to indicate: (a) changing hands; (b) changing speed; (c) staying in place and continue dribbling; (d) executing a quick stop; and/or (e) pivoting.

Challenge: ***How many times can you dribble across without losing the control of the ball?***

Organizing arrangement

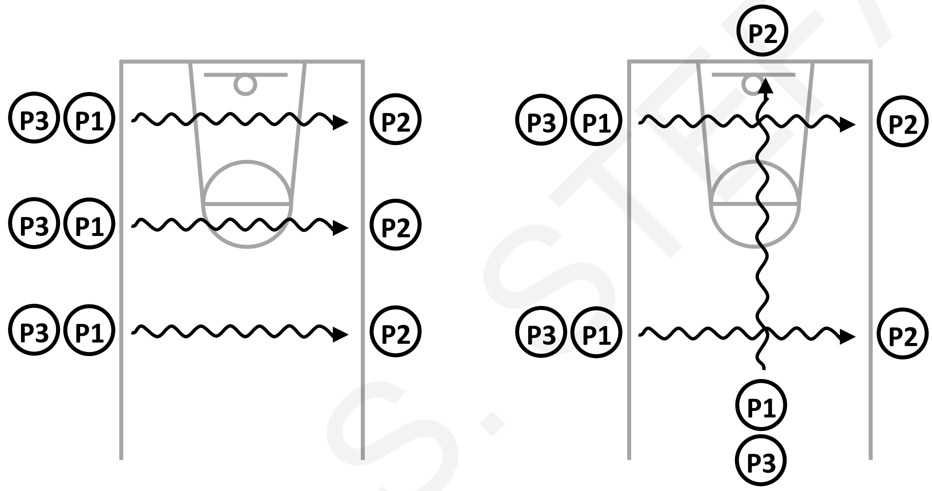


Figure 1
Figure 2

Critical elements

- **Speed dribbling**: (a) push the ball using the fingers and the pads of the hands; (b) push the ball out in front; (c) keep the dribble to waist level; (d) dribble without watching the ball.
- **Quick stop**: (a) hop slightly from one foot; (b) feet hit the floor at the same time; (c) land in a parallel stance; (d) bend your knees.
- **Pivoting**: (a) keep the pivot foot on the floor; (b) bend your knees; (c) hold the ball with both hands under the chin (elbows raised to shoulder height).

Cues

- **Speed dribbling**: *push with the fingers – push out in front – eyes up.*
- **Quick stop:** *hop from one foot – knees bent.*
- **Pivoting:** *pivot foot (remains) planted on the floor – knees bent – protect the ball.*

Common errors – Corrections

- **Speed dribbling**: slapping the ball with the palm; pushing the ball out in front excessively; the ball bounces above the waist level; eyes on the ball. **Correction:** use the activities described below (i.e., simplifying).
- **Pivoting**: lifting the pivot foot. **Correction**: demonstrate the correct technique.

Task progression

Simplifying

- Additional activities for gradual transition from stationary dribbling to speed dribbling (see the *task progression* section in Activity 3).
- Additional activities concerning quick stop. For example, the players are divided into 4-5 groups and line up on the sideline. The following activities are performed in sequence:
  - On the signal the first player in each line executes a quick stop by hopping slightly from one foot and then returns to the end of the line.
  - The same activity, but this time the players execute quick stops after running.
  - The players run freely in full-court. On each signal they execute a quick stop.

Extending

- Same as Activity 4, but this time the players dribble around a course of cones. At each cone, the players change between dominant and non-dominant hand.
- Same as Activity 4, but this time the players line up as shown in Figure 2 (i.e., ‘heavy traffic’ activity).
- Additional activities concerning pivoting under pressure. For example:
  - The players are divided into pairs (A and B). Player A pivots and player B tries to steal the ball. The goal is for the player A to keep the ball away from player B for 5 seconds.
  - The players are divided into triads (A, B and C). Player A pivots and players B and C try to steal the ball. The goal is for the player A to keep the ball away from players B and C for 5 seconds.

Activity

5

Five passes

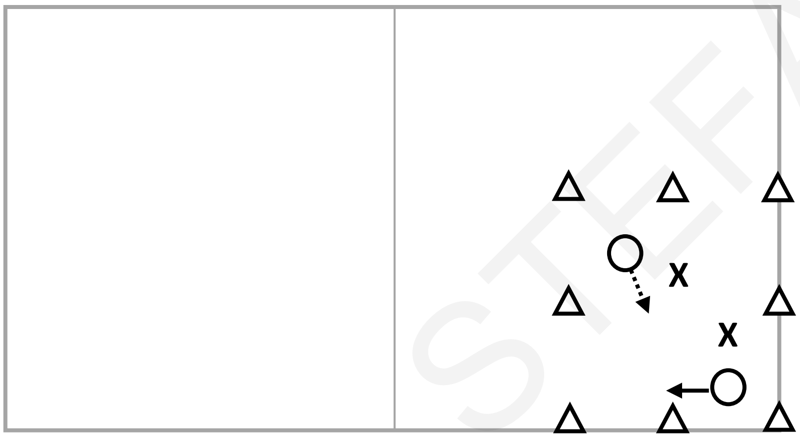
2vs2 in delimited space: Passing – Dribbling – Offensive/Defensive tactics*

Description

Two teams (e.g., 2 vs 2) play against each other in delimited space (e.g., one eighth of the basketball court). The aim of the team which has the ball in its possession is to make five consecutive passes, without losing possession of the ball. If the ball is stolen, the other team starts trying to make five consecutive passes. A point is given if a team manages to make the five consecutive passes.

*The court is divided into as many squares (i.e., delimited spaces) as needed, for all players to participate in the activity simultaneously.

Organizing arrangement



Critical elements

All the critical elements included in activities 1-4 and in addition:

- **Defensive stance**: (a) bend your knees; (b) the feet about shoulder-width apart; (c) keep the arms short (bend your elbows) and near the body; (d) eyes on the ball and on the assigned opponent.
- **Defensive sliding**: (a) side gallop; (b) bend your knees.
- **On-the-ball defense (live ball):** continuous pressure on the ball [the hand(s) mirror the position of the ball].
- **Off-the-ball defense**: (a) guard your assigned opponent; (b) eyes on the assigned opponent and on the ball.

Cues

- **Defensive stance**: *knees-elbows bent – eyes on the ball/(assigned) opponent.*
- **Defensive sliding:** *side gallop – knees bent.*
- **On-the-ball defense (live ball):** *mirror the ball.*
- **Off-the-ball defense:** *eyes on the [assigned] opponent and on the ball.*

Common errors – Corrections

- **Defensive stance**: players do not stay in stance. **Correction**: use the activities described below (i.e., simplifying).
- **Defensive sliding**: crossing the feet. **Correction**: use the activities described below (i.e., simplifying).
- **On/Off-the-ball defense**: the defenders do not guard their assigned opponents – they are hopping in the middle (i.e., piggy in the middle). **Correction**: (a) demonstrate the correct positioning; (b) specific feedback.
- **On-the-ball defense:** the defender holds/pushes the ball-handler. **Correction**: specific feedback (e.g., "hands on the ball – not on the opponent").

Task progression

Simplifying

- Same as Activity 5, but in the one fourth of the court.
- Additional activities concerning defensive stance and sliding. For example:
    - The players stand in a circle. After the signal they get in defensive stance. One point is awarded to the player who will remain in stance for the longest period of time.
    - The players walk freely in the court. On the first signal (e.g., blowing the whistle one time) players get in defensive stance, whilst, on the second signal (e.g., blowing the whistle twice) players side gallop.
    - The players are divided into groups of 3-4 persons. The players of each group line up on the baseline. On the signal, the first player in each line gets in a defensive stance and slides to the opposite baseline. Players return with the other foot leading.
    - The players are divided into pairs. The one player tries to surpass the other and reach the opposite baseline (without a ball). The defender is in a defensive stance and he/she slides.

Extending

- Same as Activity 5, but with different number of players in each group (e.g., 3vs3, 4vs4).

Activity
6

Look for the easy shot

3vs2 in half-court: Set-shot – Offensive/Defensive tactics*

Description

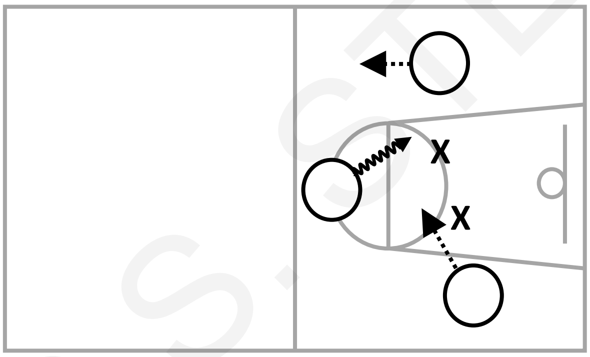
Three offensive players (1, 2, 3) try to score using only a set-shot. Two defensive players (4, 5) try to steal the ball. The offensive players win if they manage to score, whereas, the defensive players win if they manage to steal the ball. Every time a basket is scored players change roles (e.g., the offensive player with number 3 becomes the defensive player with number 4).

Challenge:

- ***How many successful shots can you make?***
- ***How many times can you steal the ball?***

*The same game is played in the other half-court. In each half-court one or two teams wait behind the baseline. While waiting the teams play a different game (e.g, "five passes"). The teams change place every 3-4 minutes.

Organizing arrangement



Critical elements

All the critical elements included in activities 1-5 and in addition:

- **Set-shot**: (a) place the dominant foot (shooting side foot) slightly forward; (b) bend your knees; (c) put the ball into the "shooting pocket" (i.e., shooting hand grip: using the whole hand, except for the heel – the index finger and thump are forming a V); (d) eyes on the target; (e) keep the elbow of the shooting hand in front of the wrist and above the shooting foot; (f) shoot the ball with the shooting hand (the balance hand is only used to steady the ball, not to shoot it); (g) full follow-through after releasing the ball (elbow extension, wrist flexion).
- **Offensive principles**: pass to a teammate who is in a better shooting position.
- **Offensive principles:** maintain proper spacing (about 5 meters) from the other offensive players.

Cues

- **Set-shot**: *knees bent – ball into the shooting pocket – one-hand shooting – full follow-through – goose neck (wrist flexion).*
- **Shooting pocket:** *the ball in the whole hand – lock the wrist – load the ball into the shooting pocket.*
- **Offensive principles:** *spacing.*

Common errors – Corrections

- **Set-shot**: shooting the ball with both hands. **Correction**: (a) demonstrate the correct placement of the balance hand (i.e., the balance hand is kept at the side of the ball); (b) shooting from a closer distance/using a lower basket and/or a lighter ball.
- **Offensive principles**: improper spacing between the offensive players. **Correction**: specific feedback (i.e., explain that maintaining proper spacing keeps other defenders away).

Task progression

Simplifying

- Additional activities concerning set-shot. For example:
  - Individual shooting challenge. Players start executing set-shots within 1.5 meters of the basket, moving back about 50 centimeters every time they score. After three consecutive misses, they must begin again from 1.5 meters but at a different angle of the basket.
  - Team shooting competition. Five to seven players at each basket work as a team to score as many baskets as possible. Each player has a ball in his/her possession. On the signal, free shooting begins. The first team to score a predefined number of baskets (e.g., 12 baskets) wins. Teams must call out each successful shot (i.e., 1! 2! 3! and so on).
- Same as Activity 6, but with a different attacker-to-defender ratio (e.g., 3vs1 in half-court).
- Same as Activity 6, but with a different type/size of goal (e.g., the backboard).

Extending

- Same as Activity 6, but with a different attacker-to-defender ratio (e.g., 3vs3 in half-court).

Activity

7

Choose the appropriate type of shot

1vs1 in delimited space: Set-shot – Lay-up*

Description

The court is divided into three areas (station 1, 2 and 3) as shown in Figure 3. One offensive player tries to score using a set-shot or a lay-up. The defensive player tries to steal the ball and prevent his opponent from scoring. Two points are allocated for a successful set-shot, and five points for a successful lay-up. Whenever a shot is made (whether successful or not) the players change roles. Every 2 minutes the players rotate between the three stations.

*Other pairs are waiting behind the sidelines. While waiting they play a different game (e.g., "the one player dribbles and the other tries to steal the ball"). Change of roles every 6-7 minutes (between the pairs that are in the stations and the pairs that are waiting behind the sidelines).

Organizing arrangement

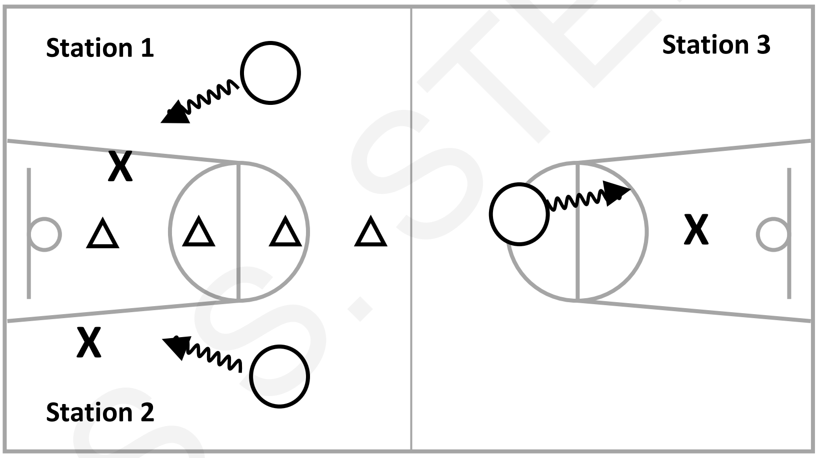


Figure 3

Critical elements

- **Lay-up**: (a) take two steps without dribbling before the jump; (b) jump and shoot using the opposite foot/hand (i.e., jumping from the left foot when shooting right-handed and from the right foot when shooting left-handed); (3) shoot with the outside hand (i.e., shooting right-handed when approaching the basket from the right side and left-handed when approaching the basket from the left side).

All the critical elements concerning offensive/defensive tactics included in activities 1-6 and in addition:

- **On-the-ball-defense (live ball)**: (a) defensive stance; (b) maintain proper distance from the ball-handler (about one length of an arm and a half); (c) continuous pressure on the ball [the hand(s) mirror the position of the ball].
- **On-the-ball-defense (dead ball)**: (a) defensive stance; (b) swarming the ball/ball-handler (pressure option); (c) continuous pressure on the ball [the hand(s) mirror the position of the ball].

Cues

- **Lay-up**: *bounce-one-two*

Common errors – Corrections

- **Lay-up**: more than two steps before the jump; not jumping toward the basket.
  Correction: use the activities described below (i.e., simplifying).

Task progression

Simplifying

- Additional activities concerning lay-up. For example:
  - Curry the ball (without dribbling) – jump – shoot the ball.
  - Dribble the ball (one bounce) – take two steps – jump – shoot the ball.
  - Dribble the ball (more bounces) – take two steps – jump – shoot the ball.
  - Dribble the ball from both sides of the basket take two steps – jump – shoot the ball.

Activity

8

Give-and-go

2vs1: Offensive tactics*

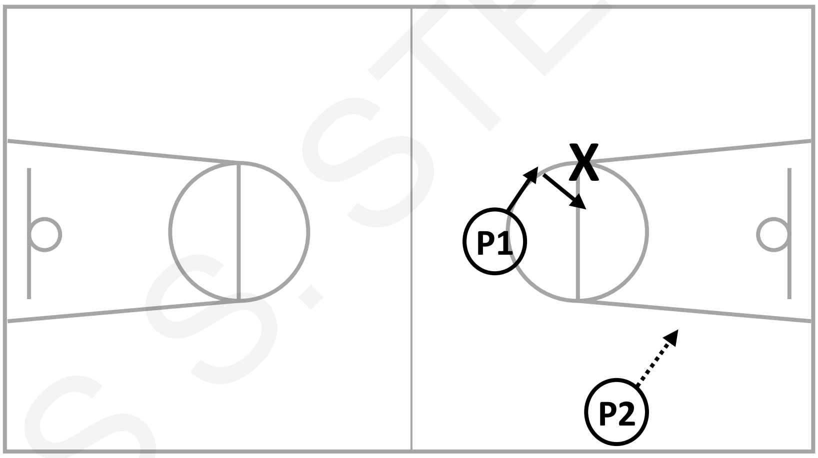
Description

Two offensive players (P1 and P2) play against one defensive player. The defensive player can guard only the offensive player that has the ball in his/her possession (P1). P1 passes to P2 and makes 2-3 steps opposite the desired direction. After making the steps, P1 suddenly changes direction and "cuts" to get open toward the basket (i.e., V-cut). If P1 manages to get open he/she receives a pass from P2 and makes a shot (set-shot or lay-up). After each attempt players change roles.

Challenge: ***How many successful shots can you make;***

*The same game is played in the other half-court. In each half-court two or three teams wait behind the baseline. While waiting the teams play a different game (e.g, "give-and-go without shooting"). The teams change place every 3-4 minutes.

Organizing arrangement



Critical elements

- **Offensive tactics**: give-and-go.

Cues

- **Offensive tactics**: *fake-and-break.*

Common errors – Corrections

- **Give-and-go**: passing and remaining to the same position (not cutting to get open). __Correction__: (a) demonstrate the correct movement; (b) emphasize the learning cues.

Task progression

__Simplifying__

- Additional activities concerning give-and-go. For example:
  - Executing V-cuts without a ball.
  - Performing the give-and-go without defense.
  - Performing the give-and-go against two passive defenders; one on the receiver and the other on the passer-cutter.

Activity
9

Mini game

3vs3 in half-court: All the skills and tactics*

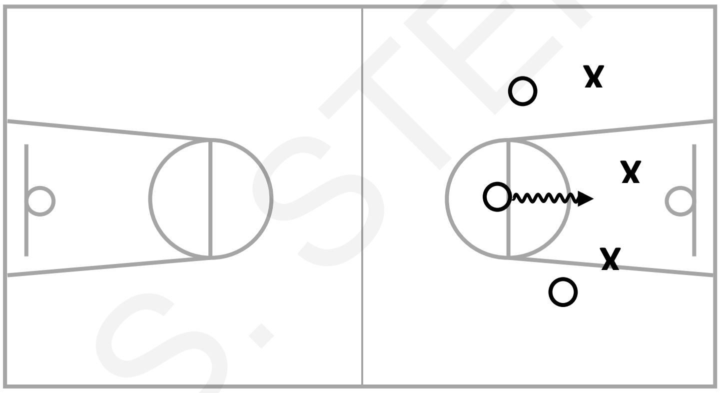
Description

This is the fundamental play practice for basketball. This game can be used to introduce virtually all the previously described basketball skills and tactics. Two teams (e.g., 3vs3) play against each other in half-court. The team that has the ball in its possession tries to score, whereas, the other team tries to gain possession of the ball. In every successful shot the ball is given to the other team to start an attack.

Challenge: ***How many successful shots can your team make in a row?***

*The same game is played in the other half-court. In each half-court one or two teams wait behind the baseline. While waiting the teams play a different game (e.g, "five passes"). The teams change place every 3-4 minutes.

Organizing arrangement



Critical elements

All the critical elements included in activities 1-8 and in addition:
- **Offensive principles**: offensive players move every time the ball is passed.
- **Off-the-ball defense:** (a) the assigned opponent is one pass away from the ball: getting in the "denial" stance (i.e.., putting the lead foot and hand in the passing lane); (b) the assigned opponent is two passes away from the ball: getting in the "pistols" stance (open stance), which allows them to see the ball and their assigned opponent (without turning the head).

Cues

- **Offensive principles**: *movement.*
- **Off-the-ball defense (one pass away from the ball):** *denial (stance).*
- **Off-the-ball defense (two passes away from the ball)**: *pistols (stance).*

Common errors – Corrections

- **Offensive principles**: the offensive players are not moving on every pass. <u>**Correction**</u>: specific feedback (i.e., explain that this keeps all defenders engaged, allowing the one-on-one player to operate against only one defender).
- **Off-the-ball defense**: eyes on the assigned opponent only or on the ball-handler. **Correction:** specific feedback.

Task progression	**Simplifying** • Same as Activity 9, but this time the physical conduct is forbidden (i.e., the ball cannot be taken away from the ball-handler). • Same as Activity 9, but with a different type/size of goal (e.g., the backboard). **Extending** • Same as Activity 6, but with different number of players in each time (e.g., 4vs4 in half-court).

Activity

10

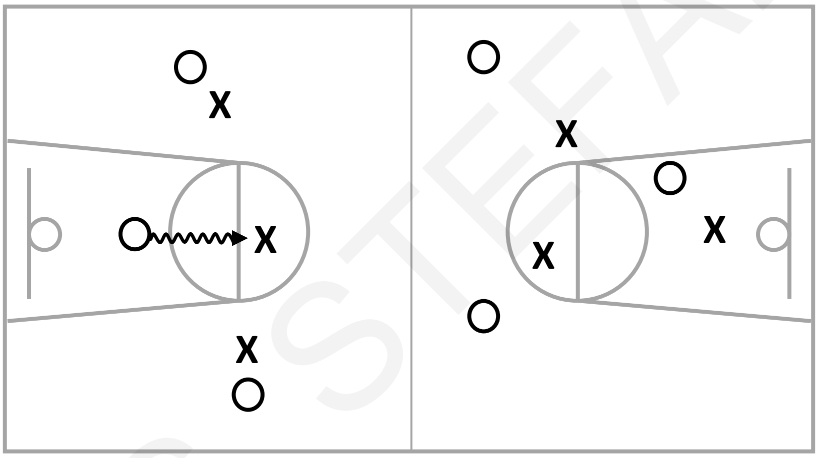
Modified basketball game

6vs6 or 8vs8 in full-court: All the skills and tactics*

Description

The court is divided into two zones (i.e., the two half-courts). Two teams (e.g., 6vs6) play against each other. Three players from each team can only move in the first zone (the one half-court), while, the other three players of both teams can only move in the second zone (the other half-court). Therefore, the defensive players of both teams cannot proceed beyond the center line, and correspondingly, the offensive players of both teams cannot retreat beyond the center line. The players change roles (move to the other zone; offensive players become defensive players and vice versa) every 3-4 minutes.

Organizing arrangement



Critical elements

All the critical elements included in activities 1-9.

Cues

All the cues included in activities 1-9.

Common errors – Corrections

All the common errors/corrections included in activities 1-9.

Task progression

Simplifying

- Same as Activity 10, but this time the court is divided into three zones.

Extending

- Go-for-goal game. The court is divided into two zones (i.e., the two half-courts). Three defenders are positioned in the first zone and another three in the second zone. All the other players are divided into teams of three (offenders) and line up behind the baseline. On the signal the first team of offenders enters the court. The goal is for the offenders to surpass the defenders (which are positioned in the two zones) and to score a basket. After a successful shot or after a steal, the next team of offenders enters the court. Every 5-6 minutes players change roles.
- Introducing the full game of basketball without dividing the court into zones (e.g., 4vs4 or 5vs5) and by modifying the rules (e.g., "complete at least five passes before shooting").

Appendix E: The Structure and Content of the PD program

Content-focused PD program on Basketball: Session 1

Time	Content
20´	**Overview of the PD program** ▪ Purpose and objectives of the PD program (see Table 3.3) ▪ Structure and content of the PD program (see Table 3.4) ▪ Play Practice principles (see Table 3.1) ▪ Principles for the development of appropriate sequences of task progressions: (a) part-to-whole progression; and (b) simplification/extension.
10´	**Activity 1: End zone: lead-up game (e.g., 5vs5, 6vs6)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10´	**Activity 2: Passing game in open space (e.g., 2vs1, 3vs2)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10´	**Error recognition** ▪ Recognizing errors through the observation and analysis of video-taped student performances ▪ Discussion
10´	**Presentation of related student common errors and error corrections by the instructor** (see Appendix D for more information on the selected common errors and error corrections for each activity)
25´	**Participation in the activities** ▪ The participants practiced in demonstrating the selected skills/tactics: (a) evaluation using the assessment score sheet; and (b) provision of specific and congruent feedback ▪ Participation in the two primary activities
10´	**Break**
15´	**Task progressions** ▪ Simplifying/extending the two primary activities ▪ Developing developmentally appropriate sequences of task progressions for each skill/tactic
10´	**Discussion on the ideas presented** Topic: How are you going to transfer the two primary activities into your classroom?
10´	**Presentation of related task progressions by the instructor** (see Appendix D for more information on the related task progressions for each activity)
10´	**Final evaluation using a set of written questions**
10´	**Self-reflection card on the PD session** Reflection topics: (a) positive aspects of today's PD session; (b) difficulties encountered during today's PD session; and (c) suggestions for changes/improvements on the content of the PD.

Content-focused PD program on Basketball: Session 2

Time	Content
5΄	**Whole-group feedback on the final evaluation of session 1**
10΄	**Basketball rule: Jump ball and alternating possession** Description of the rule as it is presented in FIBA's official basketball rules (2014)
10΄	**Activity 3: Dribbling game: dribble-freeze-tag (e.g., 6vs6, 7vs7)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10΄	**Activity 4: Dribbling, stopping and pivoting drill/game in groups of three** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
15΄	**Error recognition** ▪ Recognizing errors through the observation and analysis of video-taped student performances ▪ Discussion
10΄	**Presentation of related student common errors and error corrections by the instructor** (see Appendix D for more information on the selected common errors and error corrections for each activity)
30΄	**Participation in the activities** ▪ The participants practiced in demonstrating the selected skills/tactics: (a) evaluation using the assessment score sheet; and (b) provision of specific and congruent feedback ▪ Participation in the two primary activities
5΄	**Break**
15΄	**Task progressions** ▪ Simplifying/extending the two primary activities ▪ Developing developmentally appropriate sequences of task progressions for each skill/tactic
10΄	**Discussion on the ideas presented** Topic: How are you going to transfer the two primary activities into your classroom?
5΄	**Presentation of related task progressions by the instructor** (see Appendix D for more information on the related task progressions for each activity)
10΄	**Evaluation using a set of written questions**
5΄	**Self-reflection card on the PD session** Reflection topics: (a) positive aspects of today's PD session; (b) difficulties encountered during today's PD session; and (c) suggestions for changes/improvements on the content of the PD.
10΄	**Discussion on the development and implementation of the first series of lesson plans** ▪ Development and implementation of 3-4 lesson plans ▪ Focus on the training material's primary activities ▪ Adaptation of the activities to meet the needs of the students in each class ▪ Self-reflection card on teaching. Reflection topics: (a) any positive aspects of the lesson; and (b) any difficulties encountered during the lesson.

Content-focused PD program on Basketball: Session 3

Time	Content
20΄	**Self-reflection on teaching: Group interviews** Two topics were used to guide the discussion during the interviews: (a) positive aspects of the lessons; and, (b) difficulties encountered during the lessons.
5΄	**Whole-group feedback on the final evaluation of session 2**
5΄	**Basketball rule: Player/ball out-of-bounds** Description of the rule as it is presented in FIBA's official basketball rules (2014)
10΄	**Activity 5: Dribbling, passing and possession game in delimited space** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10΄	**Activity 6: Shooting game in half-court (e.g., 3vs2)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
15΄	**Error recognition** ▪ Recognizing errors through the observation and analysis of video-taped student performances ▪ Discussion
10΄	**Presentation of related student common errors and error corrections by the instructor** (see Appendix D for more information on the selected common errors and error corrections for each activity)
35΄	**Participation in the activities** ▪ The participants practiced in demonstrating the selected skills/tactics: (a) evaluation using the assessment score sheet; and (b) provision of specific and congruent feedback ▪ Participation in the two primary activities
5΄	**Break**
15΄	**Task progressions** ▪ Simplifying/extending the two primary activities ▪ Developing developmentally appropriate sequences of task progressions for each skill/tactic
10΄	**Discussion on the ideas presented** Topic: How are you going to transfer the two primary activities into your classroom?
10΄	**Presentation of related task progressions by the instructor** (see Appendix D for more information on the related task progressions for each activity)

Content-focused PD program on Basketball: Session 4

Time	Content
10΄	**Self-reflection on teaching** Two topics were used to guide the discussion: (a) positive aspects of the lessons; and, (b) difficulties encountered during the lessons.
15΄	**Feedback on the content of the lesson plans** ▪ Whole-group feedback ▪ Individualized written feedback
5΄	**Basketball rule: Personal foul – Free throws** Description of the rule as it is presented in FIBA's official basketball rules (2014)
10΄	**Activity 7: Shooting game in delimited space (1vs1)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10΄	**Activity 8: Shooting game (e.g., 2vs1)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
15΄	**Error recognition** ▪ Recognizing errors through the observation and analysis of video-taped student performances ▪ Discussion
10΄	**Presentation of related student common errors and error corrections by the instructor** (see Appendix D for more information on the selected common errors and error corrections for each activity)
35΄	**Participation in the activities** ▪ The participants practiced in demonstrating the selected skills/tactics: (a) evaluation using the assessment score sheet; and (b) provision of specific and congruent feedback ▪ Participation in the two primary activities
5΄	**Break**
15΄	**Task progressions** ▪ Simplifying/extending the two primary activities ▪ Developing developmentally appropriate sequences of task progressions for each skill/tactic
10΄	**Discussion on the ideas presented** Topic: How are you going to transfer the two primary activities into your classroom?
10΄	**Presentation of related task progressions by the instructor** (see Appendix D for more information on the related task progressions for each activity)

Content-focused PD program on Basketball: Session 5

Time	Content
10΄	**Self-reflection on teaching** Two topics were used to guide the discussion: (a) positive aspects of the lessons; and, (b) difficulties encountered during the lessons.
10΄	**Basketball rule: Travelling** Description of the rule as it is presented in FIBA's official basketball rules (2014)
10΄	**Activity 9: Mini game in half-court (3vs3)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
10΄	**Activity 10: Modified basketball game in full-court: two zones (e.g., 6vs6, 8vs8)** Modeling the selected basketball skills/tactics by the instructor: ▪ Description of the activity ▪ Demonstration of selected skills/tactics ▪ Presentation of related critical elements and cues (see Appendix D for more information on the selected skills and tactics for each activity)
15΄	**Error recognition** ▪ Recognizing errors through the observation and analysis of video-taped student performances ▪ Discussion
10΄	**Presentation of related student common errors and error corrections by the instructor** (see Appendix D for more information on the selected common errors and error corrections for each activity)
35΄	**Participation in the activities** ▪ The participants practiced in demonstrating the selected skills/tactics: (a) evaluation using the assessment score sheet; and (b) provision of specific and congruent feedback ▪ Participation in the two primary activities
5΄	**Break**
15΄	**Task progressions** ▪ Simplifying/extending the two primary activities ▪ Developing developmentally appropriate sequences of task progressions for each skill/tactic
10΄	**Discussion on the ideas presented** Topic: How are you going to transfer the two primary activities into your classroom?
10΄	**Presentation of related task progressions by the instructor** (see Appendix D for more information on the related task progressions for each activity)
10΄	**Final self-reflection sheet on the PD program** (see Appendix C)

Appendix F: Examples of Assessment Score Sheet and Evaluation Form

Assessment Score Sheet (Session 2)

Teacher name	Skill											
	Control dribble			Speed dribble			Quick stop			Pivot		
Marinos	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Thekla	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Thanasis	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Stavros	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
....	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**

Description of performance

1: low performance [one or no critical element is present]
2: moderate performance
3: high performance [all the critical elements are present]

Evaluation Form (Session 2) – Sample Questions

Teacher name: ……………………………………………………………………

Date: ……..…………………………………………………………………………

1. Three critical elements of control dribbling:

2. Three critical elements of speed dribbling:

3. Two critical elements of quick stop:

4. Two critical elements of pivot:

5. One student common error concerning speed dribbling and one appropriate correction thereof:

6. Appropriate cues for teaching control dribbling:

7. Three appropriate and progressively sequenced activities for teaching pivot to beginners:

Appendix G: Studies that Investigated CK in General Education and in PE

Table G1

Studies that Investigated CK in General Education

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Leinhart & Smith (1985)	To explore the nature, level, and use of CK among a set of expert teachers and novices.	4 in-service mathematics teachers (experts) and 4 pre-service teachers (novices) – Elementary	Lesson observations (videotaped), interviews, card sorting	Mathematics	• Findings indicated wide variations among the knowledge of expert teachers. • Some teachers displayed relatively rich conceptual knowledge of fractions, although others relied on precise knowledge of algorithms.
Strauss & Sawyer (1986)	To examine the determinants (e.g., quality of teachers, as measured by standardized test scores) of average student performance on standardized examinations, and also the determinants of the extent to which students fail such examinations.	Data from 105 school districts in North Carolina (in-service teachers) –Secondary	Test (National Teacher Evaluation)	Reading and mathematics	• A 1% increase in teacher quality, as measured by standardized test scores, was accompanied by a 5% decline in the rate of failure of students on standardized competency examinations. • The corresponding impact of teacher quality on mean student achievement was quite modest: 0.5-0.8% per 1% improvement in teacher quality.
Hoz et al. (1990)	To explore the development of the conceptual disciplinary (i.e., CK) and pedagogical knowledge of teachers with short or long teaching experience.	7 biology and 6 geography in-service teachers – Secondary	Interviews, concept map	Biology and geography	• The disciplinary and pedagogical knowledge of teachers of both biology and geography was unsatisfactory. • The two types of knowledge did not improve with experience and the latter slightly deteriorated. • The teachers mastered their disciplinary knowledge better than their pedagogical knowledge.
Even (1993)	To investigate teachers' CK and its interrelations with PCK in the context of teaching the concept of function.	152 pre-service mathematics teachers – Secondary	Test (open-ended questions) and interviews	Mathematics	• Many of the subjects did not have a modern conception of function. • The limited conception of function influenced the subjects' pedagogical thinking.
Shymansky et al. (1993)	To examine the impact of a specially designed in-service model on teacher understanding of selected science concepts.	42 in-service teachers – Secondary	Concept map	Physical sciences	• The analysis showed significant growth in the number of valid propositions expressed by teachers between the initial and final mappings in all topic groups.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Tatto et al. (1993)	To examine the effectiveness and costs of three approaches to elementary teacher education (i.e., pre-service, conventional in-service, and distance in-service) by measuring teachers' theoretical and applied knowledge, classroom performance, and student achievement.	415 in-service teachers and 186 pre-service teachers – 2nd and 4th Grade students (the exact number of students is not specified) – Elementary	Two tests with both open-ended and multiple-choice questions (one for mathematics and the other for language)	Mathematics and language	• Although distance education was the most cost-effective of the approaches, graduates of colleges of education were significantly effective in producing high achievement in their pupils in mathematics and language.
Baturo & Nason (1996)	To evaluate first-year teacher education students' understanding of CK in the domain of area measurement.	13 pre-service teachers - Elementary	Structured interviews comprising eight tasks	Mathematics	• The area measurement subject matter knowledge of the sample of first-year teacher education students was rather impoverished in nature. Much of their substantive knowledge was incorrect, and/or incomplete, and often unconnected.
Mullens et al. (1996)	To explore whether the educational attainments, pedagogical training, and subject matter competence of primary school teachers in Belize predict their effectiveness in helping students to learn mathematics.	72 in-service teachers and 1,043 3rd Grade students –Elementary	Test (a primary-school-leaving examination administered to all students seeking access to secondary school)	Mathematics	• The students learned more mathematics when their teachers had a strong command of the subject.
Rowan et al. (1997)	To investigate the influence of teachers' ability (e.g., CK), teachers' motivation, and work situations on students' achievement.	2077 in-service mathematics teachers and 5,381 10th Grade students –Secondary	Test (a single close-ended item tapping teachers' knowledge of high school mathematics)	Mathematics	• The teachers' knowledge of subject matter and expectancy motivation had direct effects on students' achievement in mathematics.
Bos et al. (2001)	To examine the perceptions and knowledge of pre-service and in-service educators about early reading instruction.	252 pre-service and 286 in-service teachers (Grade K-3) – Kindergarten/Elementary school	Test (multiple choice format)	Reading	• The teachers expressed positive attitudes toward explicit and implicit code instruction. • Pre-service and in-service teachers demonstrated limited knowledge of phonological awareness or terminology related to language structure and phonics.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Hill & Ball (2004)	To evaluate public PD programs using an instrument designed to measure teachers' CK for teaching mathematics.	398 in-service teachers – Elementary	Test (multiple choice format)	Mathematics	• The teachers participating in the mathematics PD programs improved their performance during the extended summer workshop portion of their experience. • The program length as measured in days in the summer workshop and workshop focus on mathematical analysis, reasoning, and communication predicted teachers' learning.
Hill, Schilling, & Ball (2004)	To design and empirically test measures of teachers' CK for teaching elementary mathematics.	377-640 in-service teachers (depending on the number of obtained responses to each of three pilot forms) – Elementary	Test (multiple choice format)	Mathematics	• Teachers' knowledge for teaching elementary mathematics was multidimensional and included knowledge of various mathematical topics (e.g., number andoperations, algebra) and domains (e.g., knowledge of content, knowledge of students and content). • The constructs indicated by factor analysis formed psychometrically acceptable scales.
Phelps & Schilling (2004)	To develop survey measures of the CK teachers need to teach elementary reading.	1542 in-service teachers – Elementary	Test (multiple choice format)	Reading	• CK for teaching reading included multiple dimensions, defined both by topic and by how teachers use knowledge in teaching practice. • Items within these constructs formed reliable scales.
Capraro et al. (2005)	To explore the nexus between mathematics CK and pedagogical knowledge in developing PCK.	193 pre-service teachers - Elementary	Test (a four-item, open-ended, rubric)	Mathematics	• The results indicated that previous mathematics ability and post-test performance were valuable predictors to student success on all portions of the state-mandated teacher certification exam. • The qualitative data indicated that mathematically competent pre-service teachers exhibited progressively more PCK as they were exposed to mathematics pedagogy during their mathematics methods course.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Hill et al. (2005)	To explore whether and how teachers' mathematical knowledge for teaching contributes to gains in students' mathematics achievement.	699 in-service teachers - 1190 1st Grade and 1,773 3rd Grade students – Elementary	Test (multiple-choice format)	Mathematics (and reading)	• Teachers' mathematical knowledge was significantly related to student achievement gains in both first and third grades after controlling for key student- and teacher-level covariates.
Rice (2005)	To examine and compare the science subject matter knowledge of pre-service and in-service elementary teachers.	414 pre-service and 67 in-service teachers – Elementary	Test (5 multiple-choice questions, 6 true–false questions, 2 short answer questions)	Physical sciences	• The results revealed a serious gap in respondents' knowledge of the basic science concepts. • Both pre-service and in-service teachers experienced deficiencies in their 'conceptual understanding as elaborated knowledge' or reasoning ability.
Arzi & White (2008)	To explore the changes in teachers' knowledge of subjects they teach from pre-service training through 17 years of professional experience.	22 science teachers – Secondary	Interviews, concept profiles (a word-association method)	Physical sciences (biology, chemistry, or physics)	• Change was found to be multifaceted, with details of unused content fading from memory, alongside growth that results from improved understanding and reorganization of structure more than from accretion of new material. • The required curriculum was found to be the single most powerful determinant of teacher knowledge, serving as both its organizer and source.
Garet et al. (2008)	To test the effectiveness of two PD interventions in improving the knowledge and practice of teachers and the reading achievement of their students in high-poverty schools.	270 in-service teachers and 5,530 2nd Grade students – Elementary School	Test (30 multiple-choice questions and short answer items)	Early reading	• Although there were positive impacts on teachers' knowledge of scientifically based reading instruction, neither PD intervention resulted in significantly higher student test scores at the end of the one-year treatment. • The added effect of the coaching intervention on teacher practices in the implementation year was not statistically significant. • There were no statistically significant impacts on measured teacher or student outcomes in the year following the treatment.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Hill et al. (2008b)	To explore how teachers' mathematical knowledge for teaching (particularly two elements of teachers' mathematical knowledge: teachers' common and specialized content knowledge) is associated with the mathematical quality of instruction.	5 in-service teachers - Elementary	Test (multiple-choice format)	Mathematics	• A significant, strong, and positive association was found between levels of mathematical knowledge for teaching and the mathematical quality of instruction. • A number of factors were found to mediate this relationship (i.e., either supporting or hindering teachers' use of knowledge in practice).
Krauss et al. (2008)	To investigate the validity of the COACTIV (Cognitive Activation) constructs of PCK and CK by administering the COACTIV test to various "contrast populations".	198 mathematics teachers, 90 candidate mathematics teachers (end of university education), 137 mathematics students (end of university education), 16 teachers of biology and chemistry, and 30 advanced school students	Test (open-ended items that tap conceptual or procedural skills)	Mathematics	• Mathematics teachers' CK and PCK were well above those of biology/chemistry teachers and school students. • Mathematics teachers' CK was comparable with that of candidate mathematics teachers and students majoring in mathematics, and unexpectedly, their PCK was also close to that of the participants of the latter group.
Carlisle et al. (2009)	To examine the contribution of first- through third-Grade teachers' knowledge about early reading to their students' improvement on tests of word analysis and reading comprehension.	747 in-service teachers – The exact number of participating students is not stated – Elementary	Test (multiple-choice and true-false format)	Reading	• The test of teachers' knowledge had adequate psychometric characteristics. • Performance on this measure of teachers' knowledge did not significantly explain students' improvement on the two reading subtests.
Khourey-Bowers & Fenk (2009)	To explore the relationship between teachers' participation in constructivist chemistry PD and enhancement of CK, PCK, and personal science teaching self-efficacy (PSTE).	69 in-service teachers – Elementary/Secondary	Test (open-ended, semi-structured and multiple-choice questions)	Physical sciences (chemistry)	• Elementary teachers gained CK, PCK, PSTE, and designed lessons to advance thinking from macroscopic to abstract models. • Middle/secondary teachers gained PSTE, PCK, and introduced macroscopic models to develop understanding of previously taught abstract models.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Lane et al. (2009)	To examine the role of teacher knowledge about reading fluency in students' fluency growth.	117 in-service teachers (27 kindergarten teachers, 29 first-grade teachers, 20 second-grade teachers, and 24 third-grade teachers) and 1,717 students (Grades K-3) – Kindergarten/ Elementary	Test (open-ended questions)	Reading	• Results demonstrated that teacher knowledge about reading fluency was a significant predictor of first-grade students' decoding growth and second-grade students' oral reading fluency growth. Effects on third-grade students' reading growth were less pronounced.
Baumert et al. (2010)	To investigate the influence of teachers' CK and PCK on instructional quality and student progress in secondary-level mathematics.	181 in-service mathematics teachers and 4,353 10th Grade students – Secondary	Test (open-ended items that require complex mathematical argumentation or proofs)	Mathematics	• The analysis revealed a substantial positive effect of PCK on students' learning gains that was mediated by the provision of cognitive activation and individual learning support.
Garet et al. (2011)	To examine the cumulative impact of a two-year PD program on teacher knowledge and student achievement.	92 in-service mathematics teachers and 2,132 7th Grade students – Secondary	Test (multiple-choice questions and short answer items)	Mathematics	• At the end of the second year of implementation, the PD program did not have a statistically significant impact on teacher knowledge and on average student achievement in rational numbers.
Heller et al. (2012)	To investigate and compare the effects of three PD models on teacher science CK and on student achievement.	271 in-service teachers and their 4th Grade students (the exact number of students is not specified) – Elementary	Test (20 multiple-choice questions, 9 yes/no questions – 2 of which included a justification of the answer selected – and 2 open-ended questions)	Physical sciences	• Each course improved teachers' and students' scores on selected-response science tests well beyond those of controls, and effects were maintained a year later. • Only 'Teaching Cases' and 'Looking at Student Work' courses improved the accuracy and completeness of students' written justifications of test answers in the follow-up, and only 'Teaching Cases' had sustained effects on teachers' written justifications.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Buchholtz et al. (2013)	To develop an instrument valid for Eastern and Western countries and to use this instrument to examine the professional knowledge (i.e., CK and PCK) of pre-service mathematics teachers in elementary mathematics from an advanced standpoint.	345 pre-service teachers – Secondary	Test (multiple-choice and open-ended questions)	Mathematics	• There were systematic differences among the participating countries; for example, the Korean future teachers outperform their counterparts in other countries. • The future teachers did not seem to be able to link school and university knowledge systematically.
Diamond et al. (2013)	To examine relationships between measures of teacher science CK using multiple instruments.	203 in-service 5th Grade teachers – Elementary	Test (24 multiple-choice and six short or extended response items), self-reported questionnaire, classroom observations	Physical sciences	• Significant positive correlations were found between science test scores and both self-reported science knowledge and classroom observation scores and between science courses taken and self-reported science knowledge. • Test scores and observations were not correlated with courses taken, nor were observations correlated with self-reported science knowledge.
Faulkner & Cain (2013)	To measure the effects of a PD course designed to improve educators' mathematical knowledge.	69 in-service general teachers and 77 in-service special education teachers – Elementary	Test (multiple-choice format)	Mathematics	• No difference was found prior to the PD in mathematical CK between special education teachers and general education teachers. • Results revealed that participating teachers made significant gains in mathematical CK.
Jüttner et al. (2013)	To develop a reliable, objective, and valid instrument to measure biology teachers' CK and PCK and to measure the biology-specific CK and PCK of biology teachers using the instruments developed.	158 in-service biology teachers – Secondary	Test (short answer items, multiple-choice items, open-ended items)	Physical sciences (Biology)	• The results indicate that the instruments measured teachers' CK and PCK in an objective, valid, and reliable way.
Gilbert & Gilbert (2013)	To examine the connection between teachers' CK for teaching mathematics and classroom practice.	2 in-service teachers – Secondary	Test (multiple-choice format)	Mathematics	• The results illustrated that the content can be taught effectively by teachers across the spectrum of CK levels.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Greene et al. (2013)	To examine changes in teachers' science CK following a two–week PD program.	34 (study 1) and 24 (study 2) in-service science teachers – Secondary	Concept map	Physical sciences	• A repeated measures analysis of six quantitative scores showed statistically significant increases in knowledge representation. • Quantitative and qualitative scoring methods indicate that concept maps are effective for assessing teacher knowledge gains from PD.
Groth & Bergner (2013)	To describe a model for mapping cognitive structures related to CK for teaching.	31pre-service teachers – Elementary/ Secondary	Writing prompts on assigned teacher-oriented articles (5 items), identifying and addressing children's errors in analyzing nominal categorical data (1 item)	Statistics	• In some cases, the participants constructed all knowledge elements targeted in the course. • In many cases, however, their knowledge structures had missing, incompatible, and/or disconnected elements preventing them from carrying out recommendations for teaching elementary nominal categorical data analysis in an optimal manner.
Kleickmann et al. (2013)	To investigate how teachers' CK and PCK differs across the three phases of teacher education in Germany: from the beginning to the end of university studies, to the end of the induction period, and finally during in-service teaching.	782 pre-service and 198 in-service mathematics teachers – Secondary	Test (open-ended items that require complex mathematical argumentation or proofs)	Mathematics	• The largest differences in CK and PCK were found between the beginning and the end of initial teacher education. • Differences in the structures of teacher education were reasonably well reflected in participants' CK and PCK.
Nowicki et al. (2013)	To determine the accuracy of science content presented in elementary science lessons in relation to the teacher's science background, content preparation, and use of instructional materials.	27 pre-service teachers and their cooperating teachers/mentors – Elementary	Test (multiple-choice format), lesson observations (videotaped), post-lesson self-reflections	Physical sciences	• Our results showed that 74 % of experienced teachers and 50% of student teachers presented science lessons with greater than 90 % accuracy. • Science content accuracy was highly correlated with the use of kit-based resources supported with PD, a preference for teaching science, and grade level. • There was no correlation between the accuracy of science content and some common measures of teacher CK (e.g., number of college science courses or scores on a general science content test).

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Sadler et al. (2013a)	To develop and validate a unique bank of test items designed to assess the conceptual understanding of each of the life sciences concepts incorporated into the K-8 National Research Council standards.	181 in-service physical science teachers – 30,594 students – Secondary	Test (multiple-choice format): physical science concepts – students' misconceptions	Physical sciences	• Teachers were found to generally overestimate their own students' performance and to have a high level of awareness of the particular misconceptions that their students hold on the K–4 standards, but a low level of awareness of misconceptions related to the 5–8 standards.
Sadler et al. (2013b)	To examine the relationship between teacher knowledge (i.e., teacher CK and knowledge of students' misconceptions - PCK) and student learning.	181 in-service physical science teachers – 9,556 7th/8th Grade students – Secondary	Test (multiple-choice format): physical science concepts – students' misconceptions	Physical sciences	• For items that had a very popular wrong answer, the teachers who could identify this misconception had larger classroom gains, much larger than if the teachers knew only the correct answer. • On items on which students did not exhibit misconceptions, teacher subject matter knowledge alone accounted for higher student gains.
Steele (2013)	To describe a set of assessment tasks designed to measure teachers' mathematical knowledge for teaching geometry and measurement in a nuanced way.	25 teachers: 12 pre-service teachers; 10 in-service teachers; and 3 teacher leaders – Elementary/Secondary	Test (6 rich, open-response items)	Mathematics	• The findings illustrated the important connections between CCK and SCK and the ways in which CCK can influence how teachers make use of SCK.
Bartos & Lederman (2014)	To discern teachers' knowledge structures for nature of science (NOS) and scientific inquiry (SI) and determine how congruent these conceptions were with those knowledge structures communicated through their classroom practice.	4 in-service physical science teachers – Secondary	A "free-form" questionnaire which asked teachers to represent their understandings of NOS and SI in any manner of their choosing	Physical sciences	• The results indicated limited congruence between teachers' knowledge structures for NOS and SI and those espoused in their classroom practice. Most notable was the dearth of connections evidenced between constituent aspects in the latter.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Diamond et al. (2014)	To determine the effect of a curricular and PD intervention on teachers' science CK, and the effect of teachers' science CK on student achievement.	227 in-service teachers and 5,784 5th Grade students – Elementary	Test (24 multiple-choice and six short response items), self-reported questionnaire, classroom observations	Physical sciences	• The intervention had a significant effect on the treatment group teachers' science knowledge test scores and questionnaire responses compared to the control group, but not on the classroom observation ratings. • Teachers' scores on the science knowledge test were found to be the largest significant teacher-level predictor of student achievement outcomes regardless of participation in the intervention.
Steenbrugge et al. (2014)	To analyse: (a) the extent to which pre-service teachers' knowledge of fractions mirrors students' knowledge of fractions and (b) pre-service teachers' ability to explain the rationale of a procedure or the underlying conceptual meaning.	290 pre-service teachers (184 first and 106 last-year trainees) – Elementary	Test (52 multiple-choice items; for 7 multiple-choice items the test respondents were required to explain the underlying rationale)	Mathematics	• The results revealed that preservice teachers' knowledge of fractions was limited and that last-year preservice teachers did not perform better than first-year preservice teachers.
Aslan-Tutak & Adams (2015)	To explore differences in geometry CK between pre-service teachers who received regular mathematics methods course instruction and pre-service teachers who received experimental mathematics methods course instruction.	102 pre-service teachers – Elementary	Test (multiple-choice format)	Mathematics	• The analysis showed a significant change in treatment group participants' geometry content knowledge. • The results indicated a significant main effect of knowledge but no significant interaction between geometry CK and grouping. Even though treatment group participants' geometry CK growth was significant, the difference between treatment group and control group participants' growth in geometry CK was not significant.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Casey & Wasserman (2015)	To investigate teachers' subject matter knowledge relevant to the teaching of informal line of best fit.	11 pre-service and 8 in-service mathematics teachers – Secondary/Elementary	Task-based interviews	Statistics	• Teachers had a relatively strong ability to place lines of best fit accurately. • However, their varying conceptions and criteria, which at times were inaccurate despite producing relatively good approximations for placing a line of best fit, pointed to some significant gaps in their knowledge.
Ekawati et al. (2015)	To develop an instrument for assessing teachers' mathematics CK on ratio and proportion and to examine the profile of primary teacher's mathematics CK on this topic.	271 in-service teachers – Elementary	Test (multiple-choice items, complex multiple-choice items, open-ended items)	Mathematics	• The mathematics CK instrument was found to have good acceptability in the reliability analysis with 3 factor components—meaning of proportional and non-proportional situations, number structures in situation, and figural representation. • With respect to the 3 factors, the teachers in the 3 assigned categories ("Good," "Middle," or "Low") showed consistent performance on the items of the 3 factors. In particular, the results indicated that in-service primary teachers had difficulty with the factor on figural representation, but they performed best on number structures in situation representing products of proportional reasoning.
Fauskanger (2015)	To explore the types of knowledge that are made visible in teachers' responses to the Mathematical Knowledge for Teaching multiple-choice items and in their associated constructed responses, and the relationship(s) that can be identified between the two kinds of responses.	30 in-service teachers (they taught different grade levels) –Elementary/ Secondary	Test (multiple-choice questions and associated open-ended questions)	Mathematics	• Findings indicate that the teachers' constructed responses do not always support their multiple-choice responses.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Maerten-Rivera et al. (2015)	To describe the development and validation of a paper-based test of elementary teachers' science CK, using data from two multiyear teacher PD projects.	359 (project 1) and 287 (project 2) in-service teachers – Elementary	Test (24 multiple-choice and 6 constructed response items)	Physical sciences	• Results from Project 1 demonstrated that the SCK test had acceptable person reliability at baseline; at later time points the test was easy for the teachers and person reliability was below acceptable. • Results from Project 2 demonstrated that the test had acceptable reliability across two time points and was a better match to teachers' SCK.
Auslander et al. (2016)	To explore (a) the mathematical beliefs and CK of two groups of students in distinct mathematics content courses, and (b) their perspectives on knowing, teaching, and learning mathematics as experienced in these courses.	12 pre-service teachers – Elementary	Test (multiple-choice format)	Mathematics	• The findings revealed differences in SCK and mathematical beliefs between the two groups upon completion of the teacher preparation program.
Charalambous (2016)	To empirically validate the argument that pure mathematical knowledge alone is not sufficient for the work of teaching by considering a set of teaching practices.	312 in-service teachers, 168 pre-service teachers, and 164 university students studying in mathematically intensive departments – Elementary/ Secondary	Test (multiple-choice format)	Mathematics	• Results showed significant differences among the study's groups, largely in the first two practices.
Duguay et al. (2016)	To describe the development of an instrument to measure teachers' knowledge of vocabulary development and instruction.	35 teachers were teaching to Grades 6-8 and 15 teachers to Grade 2 - Secondary/Elementary	Test (true–false format)	Vocabulary instruction	• Teachers' performance in the Teacher Knowledge of Vocabulary Survey (TKVS) was found to correlate with the experts' predicted difficulties of the items. • Initial analyses provide evidence for the content and construct validity of the TKVS as a measure of teacher knowledge of vocabulary development and effective instruction.

Table G1 Continued

Author	Research purpose	Participants – Educational level	Research methods used to capture teachers' CK	Content	Main findings
Guberman (2016)	To determine the levels of arithmetic thinking of elementary school pre-service mathematics teachers at the beginning and end of an arithmetic course, in order to suggest a way to design an appropriate arithmetic course.	96 pre-service mathematics teachers – Elementary	Test (multiple-choice format)	Mathematics	• Analysis of findings indicated that considering the learners' level of thinking development might lead to meaningful learning in arithmetic course for pre-service mathematics teachers.
Tchoshanov et al. (2017)	To examine an association between cognitive types of teachers' mathematical CK and students' performance.	90 in-service teachers and 6,478 students – Secondary	Test (multiple-choice format)	Mathematics	• The most substantial finding was the correlation between teachers' total score on the teacher CK survey and student performance (Pearson's $r = .2903$, $p = .0055 < .01$).

Table G2

Studies that Investigated CK in PE

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Kim (1996)	To study the relationships among volleyball CK, pedagogical knowledge (PK), and teaching performance in volleyball.	Siedentop (1989/2002)	15 pre-service PE teachers – Secondary	Test (multiple choice format): skills, tactics, and rules	Descriptive statistics, correlational analysis, multiple regression	Volleyball	• No significant relationship was found between CK and PK. A low relationship was found between CK and ALT-PE (rs = 0.33). A significant relationship was found between PK and time in transitions (rs = 0.64, $\rho < .01$), knowledge (rs = 0.57, $\rho < .05$), qualitative cues provided (rs = 0.64, $\rho < .01$), and predictor variables such as management, transition, and waiting ($R2 = 0.58$, $\rho <.05$). • CK and PK were positively related to Total QMTPS ($R2 = 0.41$, $\rho <.05$), while no relationship existed among CK and PK and ALT-PE.
Miller & Housner (1998)	To assess the health-related fitness (HRF) knowledge of pre-service and in-service physical educators and graduate students in PE and exercise physiology.	No definition	23 in-service PE teachers, 54 pre-service teachers and 21 graduate students in PE and exercise physiology – Elementary /Secondary	Test (multiple choice format): Fitness concepts	Descriptive statistics and inferential analysis	HRF	• Results indicated that exercise physiology graduate students surpassed all other groups of participants. They achieved a mean total score of 83.18%, while other participants scored lower with mean total scores ranging between 54.27% and 71.75%. • The knowledge progressively increased with experience in the teacher education program.
Hart (2005)	To assess the influence of a PE method course on the knowledge of elementary education majors.	No definition	98 pre-service generalist teachers – Elementary	Test (open-ended): listing fundamental movement skills and explaining their importance	Inferential analysis	Movement skills	• The completion of a PE methods course positively influenced elementary education majors' knowledge of fundamental movement skills.

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Castelli & Williams (2007)	To examine what teachers know about HRF and how confident they are in their knowledge.	Shulman (1986, 1987)	73 in-service PE teachers – Secondary	Test (open-ended questions): identifying fitness components, setting fitness goals and designing a fitness program	Descriptive statistics, correlational and inferential analysis	HRF	• Teachers were very confident in their knowledge of HRF; however, their actual HRF test scores did not meet the standard of achievement expected of a ninth-grade student as assessed by the South Carolina Physical Education Assessment Program. • Further investigation of the influence of teacher characteristics related to HRF knowledge revealed that age and years of teaching experience significantly related to self-efficacy but not to HRF knowledge.
Stuhr et al. (2007)	To examine the relationship between prior experience of undergraduate and their CK in basketball and soccer.	Ward (2009)	96 pre-service PE teachers	Test (multiple choice format): CCK and SCK	Descriptive statistics	Basketball & Soccer	• Findings indicated deficiencies in basketball and soccer CK. • The teachers with more playing experience in a content area possess a higher CK level in the specific content area.
Santiago, Morales, & Disch (2009)	To examine teachers' CK level on appropriate PA and HRF and to see how they relate to gender and teaching experience.	No definition	50 in-service PE teachers – Elementary	Test: concepts and principles of HRF	Descriptive statistics and inferential analysis	PA and HRF	• The overall mean score (55.46%) for the survey indicated deficiencies on teacher CK, which could relate to their efficacy in achieving the desirable standards. • Further, characteristics such teaching experience and gender did not influence appropriate PA and HRF knowledge

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Kim (2011)	To investigate the effects of a CK workshop on teachers' PCK and student achievement.	Ward (2009)	2 in-service PE teachers and 48 students – Secondary	A CK workshop served as an intervention: CCK and SCK – Practice trials	Descriptive statistics and inferential analysis	Badminton	• The improved teachers' PCK as a function of CK influence the increase of student's correct trials and the decrease of students' incorrect trials in badminton. • Teachers' PCK variables including task maturity, task appropriateness and task adaptations can be changed from immature to mature as a function of teachers' CK.
Lee (2011)	To investigate the effects of a CK workshop on teachers' PCK and student learning.	Ward (2009)	2 in-service PE teachers and 190 students – Secondary	A CK workshop served as an intervention: CCK and SCK – Practice trials	Descriptive statistics	Soccer	• These differences demonstrated that teachers showed more mature PCK following the CK workshop than before the workshop. • The findings also (a) validate the assumption that PCK is exists on a continuum from immature to mature and (b) provide descriptive evidence that improving CK can improve PCK.
Santiago, Disch, & Morales (2012a)	To examine elementary PE teachers' CK of PA and HRF and to see how they relate to teacher characteristics.	No definition	89 in-service PE teachers – Elementary	Test (multiple choice format): concepts, facts, definitions, assessments and guidelines for PA and HRF	Descriptive statistics and inferential analysis	PA and HRF	• Results indicated that the mean percentage score for the test was 57.6%. • Results from the ANOVA indicated gender and level of education were unrelated to CK of PA and HRF. Years of teaching experience was found to significantly influence CK of PA and HRF.
Santiago, Morales, & Disch (2012b)	To assess in-service and pre-service physical educators' CK of PA and HRF.	No definition	89 in-service and 61 pre-service PE teachers – Elementary	Test (multiple choice format): concepts, facts, definitions, assessments and guidelines for PA and HRF	Descriptive statistics and inferential analysis	PA and HRF	• Inservice teachers total percentage score was 57.5%, whereas preservice teachers total percentage score was 54.8%. • Independent *t* test, $t(2, 148) = -1.68$, $p = .095$, revealed no significant differences between inservice and preservice physical educators' CK.

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Hunuk et al. (2013)	To examine the effects of a community of practice on (a) physical educators' and their students' HRF CK and (b) the physical educators' HRF PCK construction process.	Shulman (1986, 1987)	12 in-service PE teachers and 278 students – Secondary	Test (open-ended questions): knowledge of HRF assessment techniques and knowledge of optimum exercise frequency, intensity, time and type for each component	Descriptive statistics and repeated ANOVA	HRF	• Results demonstrated that treatment group teachers and their students improved HRF CK from pre- to post-test (p<.05). • Findings indicated that teacher participation in a CoP changed their teaching practices and teaching culture by focusing on their students' needs, increased their engagement in PE and triggered continued learning toward personal professional needs.
Li et al. (2013)	To validate a basketball CK test and examine how CK varies as a function of playing, coaching, and teaching experience.	Ward (2009)	277 in-service PE teachers and college students majoring in PE and other areas	Test (multiple-choice format): CCK and SCK	IRT and inferential analysis	Basketball	• Results showed good model – data fit according to infit and outfit statistics, well-spread difficulty (-2.07 to 2.74 logits), and students' basketball knowledge (2.68 to -2.58 logits). • Overall MANOVA showed that basketball CK significantly varied by gender and league-playing experience. Men and those with more league-playing experience scored better on Domains a, b, and c, thus further supporting validity of basketball CK test.
Stefanou (2014)	To assess the level of generalist teachers' CK in basketball and identify possible factors that can explain variation thereof.	Ball et al. (2008); Ward (2009)	249 pre-service generalist teachers - Elementary	Test (multiple-choice format items and items involving sequencing of four options in such a way so that a reasonable progression of PE tasks be developed): CCK and SCK	IRT and inferential analysis	Basketball	• Findings indicated deficiencies in basketball CK. • Pre-service teachers' gender, prior playing experience in basketball, along with the number of PE methods courses taken at the university contributed to differences in teachers' knowledge.

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Stefanou et al. (2015)	To validate a basketball CK test and to assess the level of generalist teachers' CK in basketball.	Ball et al. (2008); Ward (2009)	249 in-service generalist teachers – Elementary	Test (multiple-choice format items and items involving sequencing of four options in such a way so that a reasonable progression of PE tasks be developed): CCK and SCK	IRT and inferential analysis	Basketball	• Findings indicated deficiencies in basketball CK. • SCK items were significantly more difficult than the CCK items. • In-service teachers' gender, along with the number of PE content and methods courses taken at the university contributed to differences in teachers' knowledge.
Ward et al. (2015)	To examine the efficacy of a CK workshop on the enacted PCK of teachers and in turn the effects on student learning.	Ball et al. (2008); Ward (2009)	4 in-service PE teachers and 96 students – Secondary	A CK workshop served as an intervention: CCK and SCK – Practice trials	Descriptive statistics and inferential analysis	Badminton	• The enacted PCK of the participants was changed from immature to mature as a function of learning CK and this change had a significant and meaningful impact on student learning.
Iserbyt et al. (2016)	To investigate how a teacher's enacted PCK differed as a function of CK and Sport Education, and to investigate the relative contribution of CK and Sport Education (SE) to student learning.	Ball et al. (2008); Ward (2009)	One in-service PE teacher and 74 students – Secondary	Two workshops served as an intervention: (a) Sport Education workshop; (b) swimming CK workshop (predominately SCK) - Amount of strokes over 50 m, 50 m sprint time, swimming volume (laps)	Descriptive statistics and inferential analysis	Swimming	• Results showed that the teacher's PCK differed as a function of improved CK and this had a significant impact on student learning.
Kim (2016)	To critically explore how a teacher's teaching practices used to teach the content are transformed by improving CK, and how these transformed teaching practices influence student learning in a real teaching setting.	Ball et al. (2008); Ward (2009)	One in-service PE teacher and 24 students – Secondary	A CK workshop served as an intervention: predominately SCK - Game Performance Assessment Instrument (GPAI), student daily content quizzes	Descriptive and constant comparative analyses	Volleyball	• The teacher used more task progressions, integrated skill practices, small-sided games, content adaptations, and diverse verbal instructional repertoires after developing CK. • These changes ultimately impacted the students' game performance and involvement as well as cognitive understanding of content.

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Sinelnikov et al. (2016)	To investigate the effect of professional development, in the form of a CK workshop, on the quality of instruction and student learning.	Ball et al. (2008); Ward (2009)	Two beginning in-service PE teachers and 48 students – Secondary	A CK workshop served as an intervention: CCK and SCK – Practice trials	Descriptive statistics and inferential analysis	Badminton	• Both teachers used more correct task representations and more mature tasks by using more diverse forms of visual and verbal representations in teaching after the badminton CK workshop. • Most students rarely performed the skills correctly in the comparison classes, whereas the students tended to perform the skills correctly in the experimental classes.
Iserbyt et al. (2017)	To examine changes in PCK and concomitant changes in student performance as a function of CK (predominately SCK).	Ball et al. (2008); Ward (2009)	One in-service PE teacher and 64 students – Secondary	A CK workshop served as an intervention: predominately SCK – Pracitce trials	Descriptive statistics and inferential analysis	Badminton	• The results showed that the teacher's PCK was substantively different before and after the workshop. • Student performance was also significantly different. Participants in the experimental group performed a higher percentage of correct trials and less incorrect trials relative to those in the comparison group. • Students from all skill levels in the experimental groups performed significantly better than those in the comparison groups.
Kim & Ko (2017)	To measure pre-service teachers' knowledge of instructional tasks for teaching three manipulative skills.	Ball et al. (2008); Ward (2009)	55 pre-service PE teachers	Instructional task assessment form	Descriptive statistics	Manipulative skills	• The results of this study showed that (a) preservice teachers' entry and exit levels of task knowledge for teaching elementary content were insufficient and varied across programs and (b) the improvement in task knowledge from entry to exit of the elementary content courses was small.

Table G2 Continued

Author	Research purpose	Definition of CK	Participants – Educational Level	Research methods used to capture/manipulate teachers' CK and student achievement	Analysis	PE content	Main findings
Ward et al. (2017)	To validate content maps as a CK measurement tool, to examine new categories of instructional tasks to describe content development, and to validate formulae that can be used to evaluate depth of content development.	Ward (2009)	Various samples (pre-service and in-service PE teachers) in order to establish the reliability and validity of content maps as a CK measuring tool – Secondary/ Elementary	Content map	Descriptive statistics	-	• The reliability and validity of content maps was established. • The new categories allowed for a finer analysis of content development. • All formulae differentiated among different content expertise.
Webster (2017)	To examine the effects of an educational gymnastics course on PETE students' motor skill proficiency and health-related fitness components.	No definition - Motor skill proficiency is considered as a form of CK	22 pre-service PE teachers	Four individual skills tests and the FitnessGram test battery	Descriptive statistics and inferential analysis	Educational gymnastics	• Findings suggest that an educational gymnastics course can improve pre-service PE trachers' CK/motor skill proficiency. • A relationship may exist between certain fitness indicators and motor skill level in educational gymnastics.

Appendix H: Features of Content-Based PD Programs in General Education and in PE

Table H1

Features of Content-Based PD Programs in General Education

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (e.g., addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Hill & Ball (2004) - One group pre-test/post-test design	Mathematics – Elementary (K-6th Grade)	Content-focused training	Not specified	Forging links to practice and state standards	• Summer workshops of one to three weeks and follow-up seminars during the school year • 40-120 hours plus 80 hours of follow-up over a year	Not specified	• teachers received stipends for their participation
Garet et al. (2008) – Randomized controlled trial	Early reading – Elementary (2nd Grade)	Content-focused seminars with five components: phonemic awareness, phonics, fluency, vocabulary, and comprehension (CCK and SCK)	• analysis of students' work • individual, small-group, and whole-group active learning experiences (e.g., discussions linking the PD content to teachers' own students, developing teaching activities, summarizing articles about reading research and presenting them to the whole group, practicing instructional strategies) • planning, being observed and receiving feedback on instruction (coaching intervention only)	Directly connected to the core reading program used in the district (i.e., similarity in content focus, the sequencing and pacing of topics covered, and the use of teachers' basal texts in some PD activities and exercises)	Two PD interventions: • an eight-day series of in-service institutes and follow-up seminars (about 48 hours over a year) • the institute and follow-up seminar series plus intensive in-school coaching (about 110 hours over a year)	Groups of teachers teaching the same subject to the same grade	• in-school coaching • substitute teacher fees for PD events held on a school day, or teacher stipends for PD events held on weekends or during the summer (outside of regular contract hours)

Table H1 Continued

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (e.g., addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Khourey-Bowers & Fenk (2009) – One group pre-test/post-test design	Chemistry – Elementary/ Secondary (4th – 9th Grade)	A wide variety of instructional methods were used to enhance CK (including facts, concepts, and ways of thinking) and PCK	• discussions • laboratory experiences (i.e., a combination of open-inquiry, guided inquiry, and problem-based methods) • assignments (e.g, content reviews focused on scientific principles, a paper describing implementation of a conceptual change lesson, unit plan organizing a full week of science lessons)	Science activities and discussions correlated with state and national content standards	• a five-semester graduate course – 11 sessions • 80 hours over two years	Not specified	The PD was grounded on constructivism (representational thinking, conceptual change)
Garet et al. (2011) – Randomized controlled trial	Mathematics – Secondary (7th Grade)	Content-focused PD program: knowledge of rational number topics (i.e., CCK), including SCK (e.g., identifying and addressing student misconceptions, and using representations of rational number concepts)	• solving mathematics problems individually and in groups • make short oral presentations • receiving feedback on how they solved and presented their solutions • discussions about the most common student misconceptions associated with relevant topics • planning lessons that they would teach	Not specified	• a summer institute, a series of one-day follow-up seminars held during the school year, and in-school coaching visits • 114 hours over two years or 58 hours (for teachers who entered the study in the second year)	Groups of teachers teaching the same subject to the same grade	• in-school coaching

Table H1 Continued

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (e.g., addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Heller et al. (2012) – Randomized controlled trials	Physical sciences – Elementary (4th Grade)	In-depth focus on science content in activities typical of classroom instruction in three different PD programs (e.g., deepening teacher conceptual understanding of core science concepts, readings of common misconceptions)	• All PD programs: hands-on science investigations, sense-making discussions • *Teaching Cases PD*: discussions of prestructured written cases of classroom practice • *Looking at Student Work PD*: involving analysis of teachers' own student work in conjunction with concurrent teaching • *Metacognitive Analysis PD*: involving metacognitive reflection on teachers' own learning experience	Coherence and alignment between the teacher curriculum and standards-based student curricula the teachers were responsible for addressing in their classrooms	• Eight three-hour sessions • 24 hours over a year	Group work during which teachers engage in professional discourse and critical reflection	The teachers received a stipend plus additional stipends if they participated in intensive or follow-up data collection
Faulkner & Cain (2013) - Quasi-experimental design	Mathematics – Elementary, Secondary and Special Education	The training focused particularly on a model for number sense designed to develop teachers' mathematical CK and ability to deliver a coherent mathematical message through instruction	Discussions	Consistent with the common core standards	• a five-day PD module • 40 hours over 2-3 months	• group work	• lecture-based workshop • homework assignments to connect workshops' ideas to instructional practice

Table H1 Continued

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (e.g., addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Greene et al. (2013) - One group pre-test/post-test design	Life, physical and earth sciences - Secondary (6th - 12th Grade)	The PD focused on engaging teachers in scientific research, which considered to be an effective way of encouraging knowledge of both inquiry pedagogy and CK	• hands-on inquiry activities • discussions that integrated their authentic experiences, science classroom activities, and technology • the activities continued through the school year (e.g., lesson planning, lesson study activities, reflective practice, observations)	Alignment with the national science education standards	• two weeks of PD (the reported results concern theses two weeks) • the exact number of conduct hours during these two weeks is not reported	Groups of teachers teaching the same subject	-
Diamond et al. (2014) – Maerten-Rivera et al. (2015) – Cluster randomized controlled trial	Life, physical and earth sciences - Elementary (5th Grade)	Teacher workshops focused on CK and how students learn that content	• hands-on activities (i.e., performing the labs as learners) • discussion (e.g., asking questions, clarify misconceptions) • opportunities to observe and be observed teaching (i.e., co-teaching) • lesson planning	Based on state science content standards	• five days of workshop throughout the school year • four to six school site support visits • 30+ hours over a year	Groups of teachers from the same school, grade, and subject	• school site support for curriculum implementation (e.g., planning lessons, co-teaching) • treatment schools were provided with complete class sets of curriculum materials • teachers received stipends for attending the summer workshop, and schools received payments for substitute teachers during the school year

Table H2

Features of Content-Based PD Programs in PE

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (e.g., addressing needs, autonomy)
		Content focus (provided CK)	**Active learning**	**Coherence**	**Sustained duration (delivery, contact hours, duration)**	**Collective participation**	
Kim (2011) – Quasi-experimental design	Badminton – Secondary (6^{th}-8^{th} Grade)	• Play Practice principles • CCK for teaching badminton (e.g., badminton rules, technique and tactics) • SCK for teaching badminton (e.g., students' common errors, set of task progressions, cues)	• receiving feedback on each lesson	Not specified	• a three-hour badminton CK workshop • 3+ hours over two days	None	-
Lee (2011) – Quasi-experimental design	Soccer – Secondary (6^{th}-8^{th} Grade)	• Play Practice principles • CCK for teaching soccer (e.g., soccer rules, technique and tactics) • SCK for teaching soccer (e.g., critical elements, students' common errors, set of task progressions)	• teaching the various tasks to two assistants • receiving feedback on each lesson	Not specified	• a three-hour soccer CK workshop • 3+ hours over three sessions (days)	None	-
Hunuk et al. (2013) – Mixed-method design (including quasi-experimental design)	Health-related fitness (HRF) – Elementary (6^{th}-7^{th} Grade)	CK of HRF: • anatomy • exercise physiology • health • training principles • exercise psychology • health promotion	Discussion groups with different focuses: • program goals • CK of HRF • instructional alignment • unit and lesson plan preparation • teaching styles etc.	Consistent with Primary Physical Education Curriculum	• a six-week CoP - each CoP meeting lasted approximately 1.5-2.5 hours per week (after school) • about 12 hours over six weeks	Group of teachers that teach the same subject (i.e., these teachers shared a common interest and collectively pursued that interest)	CoP facilitator: presenting key topics to the discussion groups, listening to participants' voices and keeping the discussions focused

Table H2 Continued

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Ward et al. (2015) – Quasi-experimental design	Badminton – Secondary (6th-8th Grade)	• Play Practice principles • CCK for teaching badminton (e.g., badminton rules, technique and tactics) • SCK for teaching badminton (e.g., students' common errors, set of task progressions, cues)	• receiving feedback on each lesson	Not specified	• a four-hour badminton CK workshop • 4+ hours over one or two days (depending on the teachers' preferences)	None	-
Iserbyt et al. (2016) – Randomized controlled trial	Swimming – Secondary (10th Grade)	• the ten Sport Education features • CCK for teaching front crawl (e.g., front crawl technique) • SCK for teaching front crawl (e.g., set of task progressions, cues)	• planning the Sport Education infrastructure to be implemented in the swimming unit • receiving feedback on a trial implementation	Not specified	• a three-hour Sport Education workshop and a three-hour swimming CK workshop • 6+ hours over two weeks	None	-
Kim (2016) – Mixed-method design	Volleyball – Secondary (8th Grade)	• Play Practice principles • Tactical games approach principles • CCK for teaching volleyball (e.g., on-the-ball skills and off-the-ball movements) • SCK for teaching volleyball (e.g., students' common errors, set of task progressions, cues)	• developing lesson plans	Not specified	• A three-hour volleyball CK workshop	None	-

Table H2 Continued

Author - Study design	Content area - Educational level	Features (Desimone, 2009)					Other features (addressing needs, autonomy)
		Content focus (provided CK)	Active learning	Coherence	Sustained duration (delivery, contact hours, duration)	Collective participation	
Sinelnikov et al. (2016) – Randomized controlled trial	Badminton – Secondary (6th-8th Grade)	• Play Practice principles • CCK for teaching badminton (e.g., badminton rules, technique and tactics) • SCK for teaching badminton (e.g., students' common errors, set of task progressions, cues)	None	Not specified	• a two-hour badminton CK workshop • 2 hours over a day	None	-
Iserbyt et al. (2017) – Quasi-experimental design	Badminton – Secondary (10th Grade)	• Play Practice principles • CCK for teaching badminton (e.g., badminton rules, technique and tactics) • SCK for teaching badminton (e.g., students' common errors, task progression, cues)	• teaching the various tasks to two assistants • receiving feedback on each lesson	Not specified	• a four-hour badminton CK workshop • 4+ hours over two days	None	-

Notes. In all the studies (with the exception of Hunuk et al., 2013) prior to the start of the workshop the teacher(s) thoroughly reviewed the knowledge packet (i.e., a body of knowledge that presents the CCK and SCK that is necessary to teach the selected skills and tactics).

References

Adams, R. J., & Khoo, S. T. (1996). *Quest: The interactive test analysis system*. Camberwell, Victoria: ACER.

Andrich, D. (1988). A general form of Rasch's extended logistic model for partial credit scoring. *Applied Measurement in Education, 1*(4), 363-378. doi:10.1207/s15324818ame0104_7

Antoniou, P., & Kyriakides, L. (2011). The impact of a dynamic approach to professional development on teacher instruction and student learning: Results from an experimental study. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice, 22*(3), 291-311. doi:10.1080/09243453.2011.577078

Antoniou, P., & Kyriakides, L. (2013). A dynamic integrated approach to teacher professional development: Impact and sustainability of the effects on improving teacher behaviour and student outcomes. *Teaching and Teacher Education, 29*(1), 1-12. http://dx.doi.org/10.1016/j.tate.2012.08.001

Appleton, K. (2008). Developing science pedagogical content knowledge through mentoring elementary teachers. *Journal of Science Teacher Education*, *19*(6), 523-545. doi:10.1007/s10972-008-9109-4

Armour, K. M., & Duncombe, R. (2004). Teachers' continuing professional development in primary physical education: Lessons from present and past to inform the future. *Physical Education and Sport Pedagogy, 9*(1), 3-21. doi:10.1080/1740898042000208098

Armour, K. M., & Yelling, M. R. (2004a). Continuing professional development for experienced physical education teachers: Toward effective provision. *Sport, Education and Society*, *9*(1), 95-114. doi:10.1080/1357332042000175836

Armour, K. M., & Yelling, M. (2004b). Professional development and professional learning: Bridging the gap for experienced physical education teachers. *European Physical Education Review, 10*(1), 71-93. doi:10.1177/1356336X04040622

Armour, K. M., & Yelling, M. (2007). Effective professional development for physical education teachers: The role of informal, collaborative learning. *Journal of Teaching in Physical Education, 26*(2), 177–200.

Arzi, H., & White, R. T. (2008). Changes in teachers' knowledge of subject matter: A 17–year longitudinal study. *Science Education*, *92*(2), 221–251. doi:10.1002/sce.20239

Ashy, M., & Humphries, C. A. (2000). "Don't use balloons on windy days": Elementary education majors' perceptions of teaching physical education. *Action in Teacher Education*, *22*(1), 59-71. doi:10.1080/01626620.2000.10462993

Ashy, M. H., Lee, A. M., & Landin, D. K. (1988). Relationship of practice using correct technique to achievement in a motor skill. *Journal of Teaching in Physical Education*, *7*(2), 115-120.

Aslan-Tutak, F., & Adams, T. L. (2015). A study of geometry content knowledge of elementary preservice teachers. *International Electronic Journal of Elementary Education*, *7*(3), 301-318.

Auslander, S. S., Smith, S. Z., Smith, M. E., Hart, L. C., & Carothers, J. (2016). A case study of two groups of elementary prospective teachers' experiences in distinct mathematics content courses. *SRATE Journal, 25*(2), 1-15.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10-20. doi:10.1016/j.tate.2010.08.007

Ayvazo, S., & Ward, P. (2011). Pedagogical content knowledge of experienced teachers in physical education: Functional analysis of adaptations. *Research Quarterly for Exercise and Sport, 82*(4), 675-684.

Ayvazo, S., Ward, P., & Stuhr, T. P. (2010). Teaching and assessing content knowledge in preservice physical education. *Journal of Physical Education, Recreation & Dance, 81*(4), 40-44. doi:10.1080/07303084.2010.10598463

Ball, D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond and G. Sykes (Eds.), *Teaching as the learning profession* (pp. 3–31). San Francisco, CA: Jossey-Bass.

Ball, D. L., Lubienski, S. T., & Mewborn, D. S. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 433-456). Washington, DC: American Educational Research Association.

Ball, D. L., Thames, M. H., & Phelps, G. (2005, April). *Knowledge of mathematics for teaching: What makes it special?* Paper presented at the AERA annual conference, Montreal, Canada.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389-407. doi:10.1177/0022487108324554

Barnett, L. M., Morgan, P. J., van Beurden, E., Ball, K., & Lubans, D. R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine & Sciences in Sports & Exercise, 43*(5), 898-904.

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2010). Gender differences in motor skill proficiency from childhood to adolescence. *Research Quarterly for Exercise and Sport, 81*(2), 162-170. doi:10.1080/02701367.2010.10599663

Barrett, K. R., Sebren, A., & Sheehan, A. M. (1991). Content development patterns over a 2-year period as indicated from written lesson plans. *Journal of Teaching in Physical Education,11*(1), 79–102. https://doi.org/10.1123/jtpe.11.1.79

Bartos, S. A., & Lederman, N. G. (2014). Teachers' knowledge structures for nature of science and scientific inquiry: Conceptions and classroom practice. *Journal of Research in Science Teaching, 51*(9), 1150-1184. doi:10.1002/tea.21168

Baturo, A., & Nason, R. (1996). Student teachers’ subject matter knowledge within the domain of area measurement. *Educational Studies in Mathematics*, *31*(3), 235–268.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., … & Tsai, Y. M. (2010). Teachers’ mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal*, *47*(1), 133-180. doi:10.3102/0002831209345157

Bautista, A., & Ortega-Ruíz, R. (2015). Teacher professional development: International perspectives and approaches. *Psychology, Society and Education, 7*(3), 240-251.

Beckstead, J. W. (2012). Isolating and examining sources of suppression and multicollinearity in multiple linear regression. *Multivariate Behavioral Research, 47*(2), 224-246. doi:10.1080/00273171.2012.658331

Begle, E. G. (1979). *Critical variables in mathematics education: Findings from a survey of the empirical literature*. Washington, DC: Mathematical Association of America and the Council of Teachers of Mathematics.

Birman, B. F., Desimone, L., Porter, A. C., & Garet, M. S. (2000). Designing professional development that works. *Educational Leadership, 57*(8), 28–33.

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences* (2nd ed.). New York, NY: Routledge.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, *33*(8), 3–15.

Bos, C., Mather, N., Dickson, S., Podhajski, B., & Chard, D. (2001). Perceptions and knowledge of preservice and inservice educators about early reading instruction. *Annals of Dyslexia*, *51*, 97-120.

Boyd, D. J., Grossman, P. L., Lankford, H., Loeb, S., &Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*, 31(4), 416–440. doi:10.3102/0162373709353129

Braga, L., Jones, E., Bulger, S., & Elliott, E. (2017). Empowering teachers to implement innovative content in physical education through continuous professional development. *Teacher Development*, *21*(2), 288-306. doi:10.1080/13664530.2016.1235608

Brewer, J., & Hunter, A. (1989). *Multimethod research: A synthesis of styles*. Newbury Park: Sage Publications.

Bruner, J. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Buchholtz, N., Leung, F. K., Ding, L., Kaiser, G., Park, K., & Schwarz, B. (2013). Future mathematics teachers' professional knowledge of elementary mathematics from an advanced standpoint. *ZDM Mathematics Education*, *45*(1), 107-120. doi:10.1007/s11858-012-0462-6

Buck, M., Harrison, J. M., & Bryce, G. R. (1990). An analysis of learning trials and their relationship to achievement in volleyball. *Journal of Teaching in Physical Education*, *10*(2), 134-152.

Capps, D. K., Crawford, B. A., & Constas, M. A. (2012). A review of empirical literature on inquiry professional development: Alignment with best practices and a critique of the findings. *Journal of Science Teacher Education*, *23*(3), 291-318. doi:10.1007/s10972-012-9275-2

Capraro, R. M., Capraro, M. M, Parker, D., Kulm, G., & Raulerson, T. (2005). The mathematics content knowledge role in developing preservice teachers' pedagogical content knowledge. *Journal of Research in Childhood Education*, *20*(2), 102-118. doi:10.1080/02568540509594555

Carlisle, J. F., Correnti, R., Phelps, G., & Zeng, J. (2009). Exploration of the contribution of teachers' knowledge about reading to their students' improvement in reading. *Reading and Writing*, *22*(4), 457-486.doi:10.1007/s11145-009-9165-y

Casey, S. A., & Wasserman, N. H. (2015). Teachers' knowledge about informal line of best fit. *Statistics Education Research Journal*, *14*(1), 8-35.

Castelli, D., & Williams, L. (2007). Health-related fitness and physical education teachers' content knowledge. *Journal of Teaching in Physical Education*, *26*(1), 3-19.

Charalambous, C. Y. (2016). Investigating the knowledge needed for teaching mathematics: An exploratory validation study focusing on teaching practices. *Journal of Teacher Education*, *67*(3), 220-237. doi:10.1177/0022487116634168

Charalambous, C. Y., Kyriakides, L., & Philippou, G. N. (2012). Developing a test for exploring student performance in a complex domain: Challenges faced, decisions made, and implications drawn. *Studies in Educational Evaluation*, *38*(3-4), 93-106. http://dx.doi.org/10.1016/j.stueduc.2012.08.00

Chen, W. (2004). Learning the skill theme approach: Salient and problematic aspects of pedagogical content knowledge. *Education, 125*(2), 194-213.

Chow, J. Y., & Atencio, M. (2014). Complex and nonlinear pedagogy and the implications for physical education. *Sport, Education and Society, 19*(8), 1034-1054. https://doi.org/10.1080/13573322.2012.728528

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cohen, J. (1994). The earth is round (p < .05). *American Psychologist, 49*(12), 997–1003.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.

Cools, W., De Fraine, B., Van den Noortgate, W., & Onghena, P. (2009). Multilevel design efficiency in educational effectiveness research. *School Effectiveness and School Improvement*, *20*(3), 357-373. doi:10.1080/09243450902850176

Coulter, M., & Woods, C. B. (2012). Primary teachers' experience of a physical education professional development programme. *Irish Educational Studies*, *31*(3), 329-343. http://dx.doi.org/10.1080/03323315.2012.710062

Creemers, B. P. M., Kyriakides, L., & Antoniou, P. (2013). *Teacher professional development for improving quality in teaching*. Dordrecht, the Netherlands: Springer.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks, CA: Sage Publications.

D'Agostino, J. V., & Powers, S. J. (2009). Predicting teacher performance with test scores and grade point average: A meta-analysis. *American Educational Research Journal*, *46*(1), 146–182. doi:10.3102/0002831208323280

Darling-Hammond, L. (2000). Teacher quality and student achievement. *Education Policy Analysis Archives*, *8*(1), 1-44.

Darling-Hammond, L. (2010). Teaching for deeper learning: Developing a thinking pedagogy. In A. P. C. Avila, C. Hui, J. H. Lin, J. C. Peng Tam, & J. C. Lim (Eds.), *Rethinking educational paradigms: Moving from good to great. CJ Koh Professorial Lecture Series No. 5* (pp. 13-18). Singapore: Office of Education Research, National Institute of Education.

Darling-Hammond, L., Chung Wei, R., & Andree, A. (2010). How high-achieving countries develop great teachers. *Stanford Center for Opportunity Policy in Education ~ Research Brief*, 1-8.

Darling-Hammond, L., & McLaughlin, M. W. (2011). Policies that support professional development in an era of reform. *Phi Delta Kappan, 92*(6), 81-92.

Decorby, K., Halas, J., Dixon, S., Wintrup, L., & Janzen, H. (2005). Classroom teachers and the challenges of delivering quality physical education. *The Journal of Educational Research*, *98*(4), 208-221. doi:10.3200/JOER.98.4.208-221

Deglau, D., & O'Sullivan, M. (2006). Chapter 3: The effects of a long-term professional development program on the beliefs and practices of experienced teachers. *Journal of Teaching in Physical Education*, *25*(4), 379–396.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199. doi:10.3102/0013189X08331140

Desimone, L. M., & Garet, M. S. (2015). Best practices in teachers' professional development in the United States. *Psychology, Society and Education, 7*(3), 252-263.

Desimone, L. M., & Pak. K. (2017). Instructional coaching as high-quality professional development. *Theory into Practice*, *56*(1), 3-12. doi:10.1080/00405841.2016.1241947

Diamond, B. S., Maerten-Rivera, J., Rohrer, R., & Lee, O. (2013). Elementary teachers' science content knowledge: Relationships among multiple measures. *Florida Journal of Educational Research*, *51*, 1-20.

Diamond, B. S., Maerten-Rivera, J., Rohrer, R. E., & Lee, O. (2014). Effectiveness of a curricular and professional development intervention at improving elementary teachers' science content knowledge and student achievement outcomes: Year 1 results. *Journal of Research in Science Teaching, 51*(5), 635-658. doi:10.1002/tea.21148

Duguay, A., Kenyon, D., Haynes, E., August, D., & Yanosky, T. (2016). Measuring teachers' knowledge of vocabulary development and instruction. *Reading and Writing*, *29*(2), 321-347. doi:10.1007/s11145-015-9598-4

Educational Service Commission (2016). *Annual report 2015*. Retrieved from http://www.eey.gov.cy/Portals/0/ektheseis/ekthesi_2015.pdf

Ekawati, R., Lin, F. L., & Yang, K. L. (2015). Developing an instrument for measuring teachers' mathematics content knowledge on ratio and proportion: A case of Indonesian primary teachers. *International Journal of Science and Mathematics Education*, *13*(1), 1-24. doi:10.1007/s10763-014-9532-2

Elliot, D. L., Atencio, M., Campbell, T., & Jess, M. (2013). From PE experiences to PE teaching practices? Insights from Scottish primary teachers' experiences of PE, teacher education, school entry and professional development. *Sport, Education and Society*, *18*(6), 749-766. doi:10.1080/13573322.2011.609165

Elliot, D. L., & Campbell, T. (2015). 'Really on the ball': Exploring the implications of teachers' PE-CPD experience. *Sport, Education and Society*, *20*(3), 381-397. doi:10.1080/13573322.2013.765400

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.) (pp. 119-161). New York, NY: MacMillan Press.

Even, R. (1993). Subject-matter knowledge and pedagogical content knowledge: Prospective secondary teachers and the function concept. *Journal for Research in Mathematics Education*, *24*(2), 94–116.

Faucette, N., Nugent, P., Sallis, J. F., & McKenzie, T. L. (2002). "I'd rather chew on aluminum foil:" Overcoming classroom teachers' resistance to teaching physical education. *Journal of Teaching in Physical Education*, *21*(3), 287-308.

Faulkner, V. N., & Cain, C. R. (2013). Improving the mathematical content knowledge of general and special educators: Evaluating a professional development module that focuses on number sense. *Teacher Education and Special Education*, *36*(2), 115-131. doi:10.1177/0888406413479613

Fauskanger, J. (2015). Challenges in measuring teachers' knowledge. *Educational Studies in Mathematics, 90*(1), 57-73. doi:10.1007/s10649-015-9612-4

Fernéndez-Balboa, J. M., Barrett, K., Solomon, M., & Silverman, S. (1996). Perspectives on content knowledge in physical education. *Journal of Physical Education, Recreation & Dance*, *67*(9), 54-57.

FIBA (2012). *Official basketball statisticians' manual*. Retrieved from http://www.fiba.com/downloads/Miscellaneous/FIBA_Stats_Manual20120920.pdf

FIBA (2014). *Official basketball rules*. Retrieved from https://www.fiba.com/downloads/Rules/2014/Official_Basketball_Rules_2014_Y.pdf

Fletcher, T., & Mandigo, J. (2012). The primary schoolteacher and physical education: A review of research and implications for Irish physical education. *Irish Educational Studies*, *31*(3), 363-376. doi:10.1080/03323315.2012.710063

Flintoff, A., & Scraton, S. (2006). Girls and physical education. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *The handbook of physical education* (pp. 767-783). London: Sage Publications.

Franke, M. L., Carpenter, T. P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal,38*(3), 653–689.

Garet, M. S., Cronen, S., Eaton, M., Kurki, A., Ludwig, M., Jones, W., ... Silverberg, M. (2008). *The impact of two professional development interventions on early reading instruction and achievement* (NCEE 2008-4030). Washington, DC: National Center for

Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–945.

Garet, M., Wayne, A., Stancavage, F., Taylor, J., Eaton, M., Walters, K., … & Doolittle, F. (2011). *Middle school mathematics professional development impact study: Findings after the second year of implementation* (NCEE 2011-4024). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Gilbert, M., & Gilbert, B. (2013). Teacher knowledge and classroom practice: Examining the connection. *PNA*, *7*(2), 51-61.

Goldhaber, D. D., & Brewer, D. J. (2001). Evaluating the evidence on teacher certification: A rejoinder. *Educational Evaluation & Policy Analysis, 23*(1), 78–86.

Graber, K. C., Locke, L. F., Lambdin, D., & Solmon, M. A. (2008). The landscape of elementary school physical education. *Elementary School Journal*, *108*(3), 151–159.

Green, K. E., & Frantom, C. G. (2002, November). *Survey development and validation with the Rasch model*. Paper presented at the International Conference on Questionnaire Development, Evaluation, and Testing, Charleston, SC.

Greene, B. A., Lubin, I. A., Slater, J. L., & Walden, S. E. (2013). Mapping changes in science teachers' content knowledge: Concept maps and authentic professional development. *Journal of Science Education and Technology*, *22*(3), 287-299. doi:10.1007/s10956-012-9393-9

Griffin, L. L., Mitchell, S. A., & Oslin, J. L. (1997). *Teaching sport concepts and skills: A tactical games approach*. Champaign, IL: Human Kinetics.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York, NY: Teacher College Press.

Grossman, P., Schoenfeld, A., & Lee, C. (2005). Teaching subject matter. In L. Darling-Hammond, & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 201-231). San Francisco, CA: Jossey-Bass.

Groth, R. E., & Bergner, J. A. (2013). Mapping the structure of knowledge for teaching nominal categorical data analysis. *Educational Studies in Mathematics*, *83*(2), 247-265. doi:10.1007/s10649-012-9452-4

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Communication and Technology Journal*, *29*(2), 75–91.

Guberman, R. (2016). Development of arithmetical thinking: Evaluation of subject matter knowledge of pre-service teachers in order to design the appropriate course. *International Journal of Science and Mathematics Education*, *14*(4), 739-755. doi:10.1007/s10763-014-9600-7

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press.

Guskey, T. R. (2003). What makes professional development effective? *Phi Delta Kappan*, *84*(10), 748-750.

Guskey, T. R., & Yoon, K. S. (2009). What works in professional development? *Phi Delta Kappan*, *90*(7), 495-500.

Haladyna, T. M. (2004). *Developing and validating multiple-choice test items* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum & Associates.

Halperin, I., Pyne, D. B., & Martin, D. T. (2015). Threats to internal validity in exercise science: A review of overlooked confounding variables. *International Journal of Sports Physiology and Performance*, *10*(7), 823-829. https://doi.org/10.1123/ijspp.2014-0566

Han, H. S. (2014). Supporting early childhood teachers to promote children's social competence: Components for best professional development practices. *Early Childhood Education Journal*, *42*(3), 171-179. doi:10.1007/s10643-013-0584-7

Hardman, K. (2005). Rhetoric and reality school physical education in Europe: The evidence of research. In F. Carreiro Da Costa, M. Cloes & M. Gonzalez Valeiro (Eds.), *The art and science of teaching in physical education and sport* (pp. 63–87). Lisbon, Portugal, Faculdade de Motricidate Humana.

Hardman, K., & Marshall, J. J. (2001). World-wide survey on the state and status of physical education in schools. In G. Doll-Tepper (Ed.), *Proceedings of the World Summit on Physical Education* (pp. 15–37). Berlin, Germany: International Council of Sport Science and Physical Education.

Hardman, K., & Marshall. J. (2009). *Second world-wide survey of school physical education: Final report*. Berlin: ICSSPE/CIEPSS.

Hardman, K., Murphy, C., Routen, A., & Tones, S. (2013). *World-wide survey of school physical education: Final report*. Paris: UNESCO.

Hart, M. A. (2005). Influence of a physical education methods course on elementary education majors' knowledge of fundamental movement skills. *Physical Educator, 62*(4), 198-204.

Heller, J. I., Daehler, K. R., Wong, N., Shinohara, M., & Miratrix, L. W. (2012). Differential effects of three professional development models on teacher knowledge and student achievement in elementary science. *Journal of Research in Science Teaching*, *49*(3), 333-362. doi:10.1002/tea.21004

Herold, F., & Waring, M. (2017). Is practical subject matter knowledge still important? Examining the Siedentopian perspective on the role of content knowledge in physical education teacher education. *Physical Education and Sport Pedagogy, 22*(3), 231-245. doi:10.1080/17408989.2016.1192592

Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education*, *35*(5), 330-351.

Hill, H. C., Ball, D. L. & Schilling, S. G. (2008a). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of student. *Journal for Research in Mathematics Education, 39*(4), 372-400.

Hill, H., Blunk, M., Charalambous, C., Lewis, J., Phelps, G., Sleep, L., & Ball, D. (2008b). Mathematical knowledge for teaching and the mathematical quality of instruction: An exploratory study. *Cognition and Instruction , 26*(4), 430-511. doi:10.1080/07370000802177235

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406. doi:10.3102/00028312042002371

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *Elementary School Journal, 105*(1), 11-30.

Hogg, M. A., & Vaughan, G. M. (2008). *Social psychology* (4th ed.). Harlow: Prentice Hall.

Hopkins, D. R., Shick, J., & Plack, J. J. (1984). *AAHPERD basketball skill test manual*. Reston, VA: AAHPERD.

Hoz, R., Tomer, Y., & Tamir, P. (1990). The relations between disciplinary and pedagogical knowledge and the length of teaching experience of biology and geography teachers. *Journal of Research in Science Teaching, 27*(10), 973–985.

Hunuk, D., Ince, M. L., & Tannehill, D. (2013). Developing teachers’ health-related fitness knowledge through a community of practice: Impact on student learning. *European Physical Education Review, 19*(1), 3-20. doi:10.1177/1356336X12450769

Hunzicker, J. (2011). Effective professional development for teachers: A checklist. *Professional Development in Education, 37*(2), 177-179. doi:10.1080/19415257.2010.523955

Iserbyt, P., Ward, P., & Li, W. (2017). Effects of improved content knowledge on pedagogical content knowledge and student performance in physical education. *Physical Education and Sport Pedagogy, 22*(1), 71-88. doi:10.1080/17408989.2015.1095868

Iserbyt, P., Ward, P., & Martens, J. (2016). The influence of content knowledge on teaching and learning in Traditional and Sport Education contexts: An exploratory study. *Physical Education and Sport Pedagogy, 21*(5), 539-556. doi:10.1080/17408989.2015.1050662

Jenkins, J. M., & Veal, M. L. (2002). Preservice teachers’ PCK development during peer coaching. *Journal of Teaching in Physical Education, 22*(1), 49-68.

Jensen, M. (1980). Teaching: An open skill, implications for teacher training. *Quest, 32*(1), 60-70.

Jüttner, M., Boone, W., Park, S., & Neuhaus, B. J. (2013). Development and use of a test instrument to measure biology teachers’ content knowledge (CK) and pedagogical content knowledge (PCK). *Educational Assessment, Evaluation and Accountability, 25*(1), 45-67. doi:10.1007/s11092-013-9157-y

Karim, A. A., Shah, P. M., Din, R., Ahmad, M., & Lubis, M. A. (2014). Developing information skills test for Malaysian youth students using Rasch analysis. *International Education Studies, 7*(13), 112-122. doi:10.5539/ies.v7n13p112

Kennedy, A. (2014). Models of continuing professional development: A framework for analysis. *Professional Development in Education*, *40*(3), 336-351. doi:10.1080/19415257.2014.929293

Kennedy, M. (1998). *Form and substance of inservice teacher education* (Research Monograph No. 13). Madison, WI: National Institute for Science Education, University of Wisconsin–Madison.

Kerlinger, F. N., & Pedhazur, E. J. (1973). *Multiple regression in behavioral research*. New York: Holt, Rinehart & Winston.

Khourey-Bowers, C., & Fenk, C. (2009). Influence of constructivist professional development on chemistry content knowledge and scientific model development. *Journal of Science Teacher Education*, *20*(5), 437-457. doi:10.1007/s10972-009-9140-0

Kim, D. (1996). *Relationships among content knowledge, pedagogical knowledge and teaching performance of physical education student teachers* (Unpublished doctoral dissertation). Ohio State University, Ohio.

Kim, I. (2011). *The effects of a badminton content knowledge workshop on middle school physical education teachers' pedagogical content knowledge and student learning* (Unpublished doctoral dissertation). Ohio State University, Ohio.

Kim, I. (2016). Exploring changes to a teacher’s teaching practices and student learning through a volleyball content knowledge workshop. *European Physical Education Review*, *22*(2), 225-242. doi:10.1177/1356336X15599009

Kim, I., & Ko, B. (2017). Measuring preservice teachers' knowledge of instructional tasks for teaching elementary content. *Physical Educator, 74*(2), 296-314. https://doi.org/10.18666/TPE-2017-V74-I2-7366

Kirk, D. (2005). Physical education, youth sport and lifelong participation: The importance of early learning experiences. *European Physical Education Review*, *11*(3), 239-255. doi:10.1177/1356336X05056649

Kirk, D., & Oliver, K. L. (2014). The same old story: The reproduction and recycling of a dominant narrative in research on physical education for girls. *Apunts. Educació Física i Esports*, (116), 7-22. http://dx.doi.org/10.5672/apunts.2014-0983.es.(2014/2).116.01

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013). Teachers' content knowledge and pedagogical content knowledge: The role of structural differences in teacher education. *Journal of Teacher Education*, *64*(1), 90-106. doi:10.1177/0022487112460398

Knapp, N. F., & Peterson, P. L. (1995). Teachers' interpretations of "CGI" after four years: Meanings and practices. *Journal for Research in Mathematics Education*, *26*(1), 40–65.

Knight, P. (2002). A systemic approach to professional development: Learning as practice. *Teaching and Teacher Education*, *18*(3), 229-241. https://doi.org/10.1016/S0742-051X(01)00066-X

Koellner, K., & Jacobs, J. (2015). Distinguishing models of professional development: The case of an adaptive model's impact on teachers' knowledge, instruction, and student achievement. *Journal of Teacher Education*, *66*(1), 51-67. doi:10.1177/0022487114549599

Kolovelonis, A., Goudas, M., & Dermitzaki, I. (2012). Students' performance calibration in a basketball dibbling task in elementary physical education. *International Electronic Journal of Elementary Education*, *4*(3), 507-517.

Konstantopoulos, S. (2011). Constructing a more powerful test in three-level cluster - randomized designs. *Journal of Research on Educational Effectiveness*, *4*(4), 354-369. doi:10.1080/19345747.2010.519824

Krause, J. V. (2000). *Interactive Basketball Skills & Drills*. [CD-ROM]. Champaign, IL: Human Kinetics Software.

Krause, J. V. (2008). *Basketball Skills & Drills*. [CD-ROM]. Champaign, IL: Human Kinetics Software.

Krause, J. V., Meyer, D., & Meyer, J. (2008). *Basketball skills and drills* (3rd ed.). Champaign, IL: Human Kinetics.

Krauss, S., Baumert, J., & Blum, W. (2008). Secondary mathematics teachers' pedagogical content knowledge and content knowledge: Validation of the COACTIV constructs. *ZDM Mathematics Education*, *40*(5), 873-892. doi:10.1007/s11858-008-0141-9

Kyriakides, L., Creemers, B. P. M. & Antoniou, P. (2009). Teacher behaviour and student outcomes: Suggestions for research on teacher training and professional development. *Teaching and Teacher Education, 25*(1), 12-23. doi:10.1016/j.tate.2008.06.001

Kyriakides, L., Kaloyirou, C., & Lindsay, G. (2006). An analysis of the revised Olweus bully/victim questionnaire using the Rasch measurement model. *British Journal of Educational Psychology*, *76*(4), 781-801. doi:10.1348/000709905X53499

Kyriakides, L., & Tsangaridou, N. (2008). Toward the development of generic and differentiated models of educational effectiveness: A study on school and teacher effectiveness in physical education. *British Educational Research Journal, 34*(6), 807-838. doi:10.1080/01411920802041467

Lacy, A. C. (2011). *Measurement and evaluation in physical education and exercise science* (6th ed.). San Francisco, CA: Pearson Education.

Lane, H. B., Hudson, R. F., Leite, W. L., Kosanovich, M. L., Strout, M. T., Fenty, N. S., & Wright, T. L. (2008). Teacher knowledge about reading fluency and indicators of students' fluency growth in reading first schools. *Reading & Writing Quarterly*, *25*(1), 57-86. doi:10.1080/10573560802491232

Launder, A., & Piltz, W. (2013). *Play practice: Engaging and developing skilled players from beginner to elite* (2nd ed.). Champaign, IL: Human Kinetics.

Lee, Y. S. (2011). *The effects of a content knowledge workshop on teachers' pedagogical content knowledge and student learning in a soccer unit in middle school physical education* (Unpublished doctoral dissertation). Ohio State University, Ohio.

Lee, O., & Choi, E. (2015). The influence of professional development on teachers' implementation of the teaching personal and social responsibility model. *Journal of Teaching in Physical Education*, *34*(4), 603-625. http://dx.doi.org/10.1123/jtpe.2013-0223

Leinhardt, G., & Smith, D. A. (1985). Expertise in mathematics instruction: Subject matter knowledge. *Journal of Educational Psychology, 77*(3), 247–271.

Li, W., Ward, P., Lehwald, H., Stuhr, P. T., Ressler, J., Boiarskaia, E., & Sutherland, S. (2013, March). Basketball content knowledge: Playing, coaching, and teaching experience [Abstract]. *Research Quarterly for Exercise and Sport*, *84*(Suppl. 1), A-4. doi:10.1080/02701367.2013.791604

Linacre, J. M. (2017). *A user's guide to Winsteps: Ministep Rasch-model computer programs*. Retrieved from http://www.winsteps.com/winman/index.htm.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. London: Sage Publications.

Lindsay, E. L. (2014). Effective teaching in physical education: The view from a variety of trenches. *Research Quarterly for Exercise and Sport, 85*(1), 31-37. doi:10.1080/02701367.2014.873330

Linn, R., Bond, L., Darling-Hammond, L., Harris, D., Hess, F., & Shulman, L. (2011). *Student learning, student achievement: How do teachers measure up*. Arlington, VA: National Board for Professional Teaching Standards.

Locke, L. F. (1977). Research on teaching physical education: New hope for a dismal science. *Quest*, *28*(1), 2-16.

Luke, D. A. (2004). *Multi-level modeling: Quantitative applications in the social sciences*. Newbury Park: Sage Publications.

Lund, J., & Veal, M. L. (2013). *Assessment-driven instruction in physical education: A standards-based approach to promoting and documenting learning*. Champaign, IL: Human Kinetics.

Maerten-Rivera, J. L., Huggins-Manley, A. C., Adamson, K., Lee, O., & Llosa, L. (2015). Development and validation of a measure of elementary teachers' science content knowledge in two multiyear teacher professional development intervention projects. *Journal of Research in Science Teaching*, *52*(3), 371-396. doi:10.1002/tea.21198

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education, 41*(3), 3-11.

Marra, R. M., Arbaugh, F., Lannin, J., Abell, S., Ehlert, M., Smith, R., ... & Rogers, M. P. (2011). Orientations to professional development design and implementation: Understanding their relationship to PD outcomes across multiple projects. *International Journal of Science and Mathematics Education*, *9*(4), 793-816.

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Maykut, P., & Morehouse, R. (2005). *Beginning qualitative research: A philosophical and practical guide*. London: The Falmer Press.

McCaughtry, N., & Rovegno, I. (2003). Development of pedagogical content knowledge: Moving from blaming students to predicting skillfulness, recognizing motor development, and understanding emotion. *Journal of Teaching in Physical education, 22*(4), 355-368.

McKenzie, T. L., & van der Mars, H. (2015). Top 10 research questions related to assessing activity and its context using systematic observation. *Research Quarterly for Exercise and Sport, 86*(1), 13-29. doi:10.1080/02701367.2015.991264

McKim, A. C. (2017). The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research, 11*(2), 202-222. doi:10.1177/1558689815607096

Mertens, D. M. (2014). *Research and evaluation in education and psychology* (4th ed.). Thousand Oaks, CA: Sage publications.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Miller, A., Christensen, E., Eather, N., Gray, S., Sproule, J., Keay, J., & Lubans, D. (2016). Can physical education and physical activity outcomes be developed simultaneously using a game-centered approach? *European Physical Education Review*, *22*(1), 113-133. doi:10.1177/1356336X15594548

Miller, A., Christensen, E. M., Eather, N., Sproule, J., Annis-Brown, L., & Lubans, D. R. (2015). The PLUNGE randomized controlled trial: Evaluation of a games-based physical activity professional learning program in primary school physical education. *Preventive Medicine*, *74*, 1-8. http://dx.doi.org/10.1016/j.ypmed.2015.02.002

Miller, A., Eather, N., Gray, S., Sproule, J., Williams, C., Gore, J., & Lubans, D. (2017). Can continuing professional development utilizing a game-centred approach improve the quality of physical education teaching delivered by generalist primary school teachers? *European Physical Education Review*, *23*(2), 171-195. doi:10.1177/1356336X16642716

Miller, M. G., & Housner, L. (1998). A survey of health-related fitness knowledge among preservice and inservice physical educators. *The Physical Educator, 55*(4), 176–186.

Miniscalco, K., & Kot, G. (2009). *Survival guide for coaching youth basketball*. Champaign, IL: Human Kinetics.

Ministry of Education and Culture (2010). *Physical education curriculum*. Retrieved from http://archeia.moec.gov.cy/mc/2/fysiki_agogi.pdf

Ministry of Education and Culture (2013). *Outline of the content of physical education curriculum*. Retrieved from http://archeia.moec.gov.cy/mc/1/dee_dim_fysiki_agogi.pdf

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Revie*w, 13(2), 125-145.

Morgan, D.L. (1988). *Focus groups as qualitative research.* Newbury Park, CA: Sage Publications.

Morgan, P., & Bourke, S. (2008). Non-specialist teachers' confidence to teach PE: The nature and influence of personal school experiences in PE. *Physical Education and Sport Pedagogy*, *13*(1), 1-29. doi:10.1080/17408980701345550

Morgan, P., & Hansen, V. (2007). Recommendations to improve primary school physical education: Classroom teachers' perspective. *The Journal of Educational Research*, *101*(2), 99-108. doi:10.3200/JOER.101.2.99-112

Morrow, J. R., Jr., Jackson, W., Disch, J. G, & Mood, D. P. (2011). *Measurement and evaluation in human performance* (4th ed.). Champaign, IL: Human Kinetics.

Mullens, J. E., Murnane, R. J., & Willett, J. B. (1996). The contribution of training and subject matter knowledge to teaching effectiveness: A multilevel analysis of longitudinal evidence from Belize. *Comparative Education Review*, *40*(2), 139–157.

Murphy, F., & O'Leary, M. (2012). Supporting primary teachers to teach physical education: Continuing the journey. *Irish Educational Studies*, *31*(3), 297-310. http://dx.doi.org/10.1080/03323315.2012.710065

Nesbit, J. C., & Adesope, O. O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research*, *76*(3), 413–448.

Nettleton, B. (1985). *The image of a physical education teacher: Fiction and fact*. Eastwood, South Australia: ACHPER Publications.

Ni Chróinín, D., & O'Sullivan, M. (2016). Elementary classroom teachers' beliefs across time: Learning to teach physical education. *Journal of Teaching in Physical Education*, *35*(2), 97-106. http://dx.doi.org/10.1123/jtpe.2015-0030

Novak, J. D., & Cañas, A. J. (2008). *The theory underlying concept maps and how to construct and use them*. Retrieved from http://eprint.ihmc.us/5/2/TheoryUnderlyingConceptMaps.pdf

Novak, J. D, & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambridge University Press. doi:10.1017/CBO9781139173469

Nowicki, B. L., Sullivan-Watts, B., Shim, M. K., Young, B., & Pockalny, R. (2013). Factors influencing science content accuracy in elementary inquiry science lessons. *Research in Science Education*, *43*(3), 1135-1154. doi:10.1007/s11165-012-9303-4

Oliver, K. L., & Kirk, D. (2016). Toward an activist approach to research and advocacy for girls and physical education. *Physical Education and Sport Pedagogy*, *21*(3), 313-327. http://dx.doi.org/10.1080/17408989.2014.895803

Olosová, G., & Zapletalová, L. (2015). Immediate and retention effects of teaching games for understanding approach on basketball knowledge. *Acta Facultatis Educationis Physicae Universitatis Comenianae*, *55*(1), 39-45. doi:10.1515/afepuc-2015-0005

Osborne J. W., & Waters, E. (2002). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research & Evaluation*, *8*(2), 1-5.

O’Sullivan, M., & Deglau, D. (2006). Chapter 7: Principles of professional development. *Journal of Teaching in Physical Education, 25*(4), 441–449.

Pain, R., Whitman, G., & Milledge, D. (2011). *Participatory action research tool kit: An introduction to using PAR as an approach to learning, research and action research.* Retrieved from http://communitylearningpartnership.org/wp-content/uploads/2017/01/PARtoolkit.pdf

Park Rogers, M. A., Abell, S. K., Marra, R. M., Arbaugh, F., Hutchins, K. L., & Cole, J. S. (2010). Orientations to science teacher professional development: An exploratory study. *Journal of Science Teacher Education*, *21*(3), 309–328. doi:10.1007/s10972-009-9179-y

Parker, M., Patton, K., Madden, M., & Sinclair, C. (2010). From committee to community: The development and maintenance of a community of practice. *Journal of Teaching in Physical Education*, *29*(4), 337–357.

Parker, M., Patton, K., & Tannehill, D. (2012). Mapping the landscape of Irish physical education professional development. *Irish Educational Studies*, *31*(3), 311–327. http://dx.doi.org/10.1080/03323315.2012.710067

Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Beverly Hills, CA: Sage Publications.

Patton, K., & Parker, M. (2015). “I learned more at lunchtime”: Guideposts for reimagining professional development. *Journal of Physical Education*, *Recreation and Dance*, *86*(1), 23-29. doi:10.1080/07303084.2014.978421

Patton, K., Parker, M., & Tannehill, D. (2015). Helping teachers help themselves: Professional development that makes a difference. *NASSP Bulletin*, *99*(1), 26-42. doi:10.1177/0192636515576040

Paye, B., & Paye, P. (2013). *Youth basketball drills* (2nd ed.). Champaign, IL: Human Kinetics.

Pedagogical Institute of Cyprus (2016). *Evaluation and needs assessment concerning the two-day professional development program in primary education*. Retrieved from http://enimerosi.moec.gov.cy/archeia/1/ypp4046a

Pedhazur, E. J. (1997). *Multiple regression in behavioral research* (3rd ed.). Fort Worth, TX: Harcourt Brace.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach*. Hillside, NJ: Lawrence Erlbaum.

Petrie, K. (2010). Creating confident, motivated teachers of physical education in primary schools. *European Physical Education Review*, *16*(1), 47–64. doi:10.1177/1356336X10369200

Petrie, K. C., & McGee, C. (2012). Teacher professional development: Who is the learner? *Australian Journal of Teacher Education*, *37*(2), 59-72.

Phelps, G., & Schilling, S. (2004). Developing measures of content knowledge for teaching reading. *The Elementary School Journal*, *105*(1), 31-48.

Reise, P. S., & Revicki, A. D. (2015). *Handbook of item response theory modeling: Applications to typical performance assessment*. New York, NY: Routledge.

Republic of Cyprus (2012). *Amending regulations for the operation of public schools*. Retrieved from http://www.moec.gov.cy/dde/nomothesia/dimotiki/kanonismoi_2012_tropopoiitikoi.pdf

Rice, D. C. (2005). I didn't know oxygen could boil! What preservice and inservice elementary teachers' answers to 'simple' science questions reveals about their subject matter knowledge. *International Journal of Science Education*, *27*(9), 1059-1082. doi:10.1080/09500690500069426

Rink, E. J. (2010). *Teaching physical education for learning* (6th ed.). New York, NY: McGraw Hill.

Rossi, J. C. (1990). Statistical power of psychological research: What have we gained in 20 years? *Journal of Consulting and Clinical Psychology, 58*(5), 646–656.

Rowan, B., Chiang, F., & Miller, R. J. (1997). Using research on employees' performance to study the effects of teachers on students' achievement. *Sociology of Education, 70*(4), 256–284.

Sadler, P. M., Coyle, H., Smith, N. C., Miller, J., Mintzes, J., Tanner, K., & Murray, J. (2013a). Assessing the life science knowledge of students and teachers represented by the K–8 National Science Standards. *CBE-Life Sciences Education, 12*(3), 553-575. doi:10.1187/cbe.12-06-0078

Sadler, P. M., Sonnert, G., Coyle, P. H., Cook-Smith, N., & Miller, L. J. (2013b). The influence of teachers' knowledge on student learning in middle school physical science classrooms. *American Educational Research Journal, 50*(5), 1020-1049. doi:10.3102/0002831213477680

Safrit, M. J., Cohen, A. S., & Costa, M. G. (1989). Item response theory and the measurement of motor behavior. *Research Quarterly for Exercise and Sport, 60*(4), 325-335. doi:10.1080/02701367.1989.10607459

Santiago, A. J., Disch G. J., & Morales, J. (2012a). Elementary physical education teachers' content knowledge of physical activity and health-related fitness. *The Physical Educator, 69*(4), 395-412.

Santiago, J. A., Morales, J., & Disch, J. G. (2009). Physical activity and health-related fitness knowledge of physical education teachers [Abstract]. *Research Quarterly for Exercise and Sport, 80*(Suppl. 1), A72-A73. doi:10.1080/02701367.2009.10599542

Santiago, J. A., Morales, J., & Disch, J. G. (2012b). Content knowledge differences between inservice and preservice physical education teachers [Abstract]. *Research Quarterly for Exercise and Sport*, *83*(Suppl. 1), A60-A61. doi:10.1080/02701367.2012.10599840

Schempp, P. (1997). Developing expertise in teaching and coaching. *Journal of Physical Education, Recreation & Dance*, *68*(2), 29. doi:10.1080/07303084.1997.10604891

Schempp, P. G., Manross, D., Tan, S. K., & Fincher, M. D. (1998). Subject expertise and teachers' knowledge. *Journal of Teaching in Physical Education*, *17*(3), 342-356.

Schon, D.A. (1983). *The reflective practitioner*. New York: Basic Books.

Schulze, S. (2003). Views on the combination of quantitative and qualitative research approaches. *Progressio*, *25*(2), 8-20.

Schwab, J. (1961/1978). *Science, curriculum, and liberal education: Selected essays.* Chicago: University of Chicago Press.

Sedlmeier, P., & Gigerenzer, G. (1989). Do studies of statistical power have an effect on the power of studies? *Psychological Bulletin*, *105*(2), 309–316.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Belmont, CA: Wadsworth Cengage Learning.

Shallcross, T., Spink, E., Stephenson, P., & Warwick, P. (2002). How primary trainee teachers perceive the development of their own scientific knowledge: Links between confidence, content and competence? *International Journal of Science Education*, *24*(12), 1293-1312. doi:10.1080/09500690110110106

Shavelson, R. J. (1996). *Statistical reasoning for the behavioral sciences* (3rd ed.). Needham Heights, MA: Allyn & Bacon.

Shenton, K. A. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75.

Shulman, L. S. (1983). Autonomy and obligation: The remote control of teaching. In L. S. Shulman & G. Sykes (Eds.), *Handbook of teaching and policy* (pp. 484-504). New York: Longman.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Shymansky, J. A., Woodworth, G., Norman, O., Dunkhase, J., Matthews, C., & Liu, C. T. (1993). A study of changes in middle school teachers' understanding of selected ideas in science as a function of an in-service program focusing on student preconceptions. *Journal of Research in Science Teaching*, *30*(7), 737–755.

Siedentop, D. (2002). Content knowledge for physical education. *Journal of Teaching in Physical Education, 21*(4), 368-377.

Silverman, S. (1985). Relationship of engagement and practice trials to student achievement. *Journal of Teaching in Physical Education*, *5*(1), 13-21.

Sinelnikov, O. A. (2009). Sport education for teachers: Professional development when introducing a novel curriculum model. *European Physical Education Review*, *15*(1), 91-114. doi:10.1177/1356336X09105213

Sinelnikov, O. A., Kim, I., Ward, P., Curtner-Smith, M., & Li, W. (2016). Changing beginning teachers' content knowledge and its effects on student learning. *Physical Education and Sport Pedagogy*, *21*(4), 425-440. doi:10.1080/17408989.2015.1043255

Sloan, S. (2010). The continuing development of primary sector physical education: Working together to raise quality of provision. *European Physical Education Review*, *16*(3), 267–281. doi:10.1177/1356336X10382976

Statistical Service of the Republic of Cyprus (2015). *Demographic report*. Retrieved from http://www.mof.gov.cy/mof/cystat/statistics.nsf/All/70008808DEA438F8C22578330034 02FB/$file/DEMOGRAPHIC_REPORT-2015-301116.pdf?OpenElement

Steele, M. D. (2013). Exploring the mathematical knowledge for teaching geometry and measurement through the design and use of rich assessment tasks. *Journal of Mathematics Teacher Education*, *16*(4), 245-268. doi:10.1007/s10857-012-9230-3

Stefanou, L. (2014, July). *Assessing subject matter knowledge of preservice generalist teachers: The case of physical education.* Paper presented at the 18th conference of the junior researchers of EARLI (JURE), Nicosia, CY.

Stefanou, L., Tsangaridou, N., Charalambous, C., & Kyriakides, L. (2015, November). *Assessing content knowledge of in-service generalist teachers: The case of basketball*. Paper presented at the 1st physical education and physical activity conference of the Cyprus Pedagogical Association, Nicosia, CY.

Stöckel, T., Weigelt, M., & Krug, J. (2011). Acquisition of a complex basketball-dribbling task in school children as a function of bilateral practice order. *Research Quarterly for Exercise and Sport*, *82*(2), 188-197. http://dx.doi.org/10.1080/02701367.2011.10599746

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research*. London: Sage Publications.

Strauss, R. P., & Sawyer, E. A. (1986). Some new evidence on teacher and student competencies. *Economics of Education Review*, *5*(1), 41–48.

Strong, M. (2011). *The highly qualified teacher: What is teacher quality and how do we measure it?* New York, NY: Teachers College Press.

Stuhr, P. T., Lee, Y. S., Ressler, J., Rodrigues-Neto, M., Zhang, P., & Ward, P. (2007, November). *The relationship between prior soccer experience and current soccer content knowledge.* Paper presented at the annual meeting of the Ohio Association for Health, Physical Education and Recreation, Columbus, OH.

Tatto, M. T., Nielsen, H. D., Cummings, W., Kularatna, N. G., & Dharmadasa, K. H. (1993). Comparing the effectiveness and costs of different approaches for educating primary school teachers in Sri Lanka. *Teaching and Teacher Education*, *9*(1), 41–64.

Tchoshanov, M., Cruz, M. D., Huereca, K., Shakirova, K., Shakirova, L., & Ibragimova, E. N. (2017). Examination of lower secondary mathematics teachers' content knowledge and its connection to students' performance. *International Journal of Science and Mathematics Education*, *15*(4), 683-702. doi:10.1007/s10763-015-9703-9

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2015). *Research methods in physical activity* (7th ed.). Champaign, IL: Human Kinetics.

Tinning, R. (2004). Rethinking the preparation of HPE teachers: Ruminations on knowledge, identity, and ways of thinking. *Asia-Pacific Journal of Teacher Education*, *32*(3), 241-253.

Tinning, R. I. (2006). Theoretical orientations in physical education teacher education. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *The handbook of physical education* (pp. 369-385). London: Sage Publications.

Tinning, R., Macdonald, D., Wright, J., & Hickey, C. (2001). *Becoming a physical education teacher: Contemporary and enduring issues.* French Forest, N.S.W.: Pearson Education.

Tom, A., & Valli, L. (1990). Professional knowledge for teachers. In W. R. Houston, M. Haberman, & J. Sikula (Eds.), *Handbook of research on teacher education*, (pp. 373-392). New York: Macmillan.

Tsangaridou, N. (2002). Enacted pedagogical content knowledge in physical education: A case study of a prospective classroom teacher. *European Physical Education Review*, *8*(1), 21-36.

Tsangaridou, N. (2005). Classroom teachers' reflections on teaching physical education. *Journal of Teaching in Physical Education*, *24*(1), 24-50.

Tsangaridou, N. (2006). Teachers' knowledge. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *The handbook of physical education* (pp. 502-515). London: Sage Publications.

Tsangaridou, N. (2016). Moving toward effective physical education teacher education for generalist primary teachers: A view from Cyprus. *Education 3-13*, *44*(6), 632-647. doi:10.1080/03004279.2014.952757

Tsangaridou, N., & Polemitou, I. (2015). Exploring pre-service classroom teachers' reflections on teaching physical education. *European Physical Education Review*, *21*(1), 66-82. doi:10.1177/1356336X14550941

Tsangaridou, N., & Siedentop, D. (1995). Reflective teaching: A literature review. *Quest*, *47*(2), 212-237.

Tsangaridou, N., & Yiallourides, G. (2008). Physical education and education through sport in Cyprus. In G. Klein, & K. Hardman (Eds.), *Physical Education and Sport Education in European Union* (pp. 69-83). Paris: Editions Revue EP.S.

Van Steenbrugge, H., Lesage, E., Valcke, M., & Desoete, A. (2014). Preservice elementary school teachers' knowledge of fractions: A mirror of students' knowledge? *Journal of Curriculum Studies*, *46*(1), 138-161. http://dx.doi.org/10.1080/00220272.2013.839003

Ward, P. (2009). Content matters: Knowledge that alters teaching. In L. D. Housner, M. W. Metzler, P. G. Schempp, & T. J. Templin (Eds.), *Historic traditions and future directions of research on teaching and teacher education in physical education* (pp. 345-356). Morgantown, WV: Fitness Information Technology.

Ward, P. (2011). The future direction of physical education teacher education: It's all in the details. *Japanese Journal of Sport Education Studies*, *30*(2), 63-72.

Ward, P. (2013). The role of content knowledge in conceptions of teaching effectiveness in physical education. *Research Quarterly for Exercise and Sport*, *84*(4), 431-440. doi:10.1080/02701367.2013.844045

Ward, P., Ayvazo, S., & Lehwald, H. (2014). Using knowledge packets in teacher education to develop pedagogical content knowledge. *Journal of Physical Education, Recreation & Dance, 85*(6), 38-43. doi:10.1080/07303084.2014.926843

Ward, P., Dervent, F., Lee, Y. S., Ko, B., Kim, I., & Tao, W. (2017). Using Content Maps to Measure Content Development in Physical Education: Validation and Application. *Journal of Teaching in Physical Education*, *36*(1), 20-31. http://dx.doi.org/10.1123/jtpe.2016-0059

Ward, P., He, Y., Wang, X., & Li, W. (2018). Chinese secondary physical education teachers' depth of specialized content knowledge in soccer. *Journal of Teaching in Physical Education*, *37*(1), 101-112. https://doi.org/10.1123/jtpe.2017-0092

Ward, P., Kim, I., Ko, B., & Li, W. (2015). Effects of improving teachers' content knowledge on teaching and student learning in physical education. *Research Quarterly for Exercise and Sport*, *86*(2), 130-139. doi:10.1080/02701367.2014.987908

Ward, P., Tsuda, E., Dervent, F., & Devrilmez, E. (2018). Differences in the content knowledge of those taught to teach and those taught to play. *Journal of Teaching in Physical Education*, *37*(1), 59-68. https://doi.org/10.1123/jtpe.2016-0196

Wayne, A. J., & Youngs, P. (2003). Teacher characteristics and student achievement gains: A review. *Review of Educational research, 73*(1), 89-122.

Webster, L. (2017). Effects of an educational gymnastics course on the motor skills and health-related fitness components of PETE students. *Physical Educator*, *74*(2), 198-219. https://doi.org/10.18666/TPE-2017-V74-I2-7203

Wenger, E. (2006). *Communities of practice: A brief introduction*. Retrieved from http://wenger-trayner.com/wp-content/uploads/2015/04/07-Brief-introduction-to-communities-of-practice.pdf

Wilson, S., Floden, R. E., & Ferrini-Mundy, J. (2001). *Teacher preparation research: Current knowledge, gaps and recommendations.* Washington, DC: Center for the Study of Teaching and Policy.

Xiang, P., Lowy, S., & McBride, R. (2002). The impact of a field-based elementary physical education methods course on preservice classroom teachers' beliefs. *Journal of Teaching in Physical Education*, *21*(2), 145-161.

Yoon, K. S., Duncan, T., Lee, S. W. Y., Scarloss, B., & Shapley, K. L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement.* Washington, DC: National Center for Educational Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Zeichner, K.M. (1983). Alternative paradigms of teacher education. *Journal of Teacher Education*, *34*(3), 3–9.