

The Physics Assessment and Study Site – An online means to assessing and maintaining course prerequisites.

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Abstract

A common and obvious goal of education is student success in a selected course. From an instructional standpoint, two important factors in determining this success. Firstly, whether the student possesses the appropriate and necessary prerequisite skills required by the course and secondly maintains those skills if the selected course does not immediately follow the prerequisite course or courses. As a means of addressing these two factors in physics education, an online *Physics Assessment and Study Site (PASS)* website consisting of assessment instruments and study areas was developed. More specifically, the *PASS* website was designed with the following objectives - 1) to provide a mathematics and a physics assessment via an online examination of the student's required prerequisite skills, 2) to provide remediation as indicated by the assessments via links to websites study areas containing such items as textual materials, simulations, interactive problem solving, and virtual laboratories, and 3) to investigate the nature of the relationship between the existing level of prerequisite skills and course success. This paper describes the structure and use of the *PASS* website, including the design, scoring, and use of the mathematics and physics assessment instruments to determine what remediation is required and the categories and samples of the online materials that comprise the study areas. In addition, preliminary information available on the relationship between prerequisite skills and course success will be presented in the paper, along with the use of the *PASS* website as a teaching aide.

Keywords

Monitoring and Performance, Evaluation, Teaching Packages, Distance Learning

Introduction

A possible important factor in determining student success in a current course is whether the student has achieved and maintained, at an acceptable level, the necessary prerequisite skills and knowledge from previous course work. Indeed, high levels of achievement in prior course work may diminish with the passage of time, if those skills and knowledge are not regularly exercised. Thus, success in prior course work may not automatically lead to success in the future. Such is the case for the prerequisite courses required for the University Physics taught at the author's institution, a course which requires previously acquired skills and knowledge in both physics (high school level or the equivalent) and mathematics (first semester calculus). Students planning to take this course may have successfully completed the necessary previous courses, but due to scheduling conflicts, employment responsibilities, or personal situations, the necessary skills and knowledge may not be up to the level required for success. Therefore, as a way of addressing the preparedness of a student, a *Physics Assessment and Study Site*, or *PASS*, website was developed. In particular, the goals of the *PASS* website are to

- 1) Provide an *online mathematics and physics assessment* to determine whether a student who has previously taken mathematics or physics/physical science courses possesses at acceptable levels, the skills and knowledge demanded by the College or University Physics courses,
- 2) Provide *study areas* in the form of links to websites providing learning activities in those topics identified by the math and physics assessments as needing maintenance or remediation, and
- 3) Provide information from which a possible *predictor* between pre-requisite knowledge and student success in current course work may be found.

In achieving these goals, the benefits of the *PASS* website would be to provide students with a more accessible assessment which may taken at home, school, etc., a more accurate placement into University Physics course or possibly lower level course, and online links to additional resources and information pertinent to the course. In terms of the institution, a major benefit would be improved retention rates, resulting in fewer dropouts and need for remedial courses.

Description of the *PASS* website

The *PASS* website consists of two components; the mathematics and physics assessment instruments and the study areas as shown in Figures 1a and 1b.

Figure 1a. Structure of the *PASS* website.

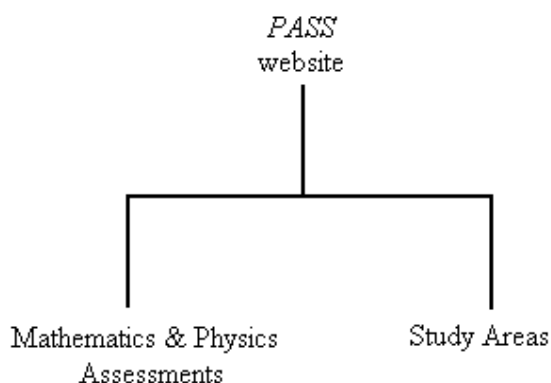
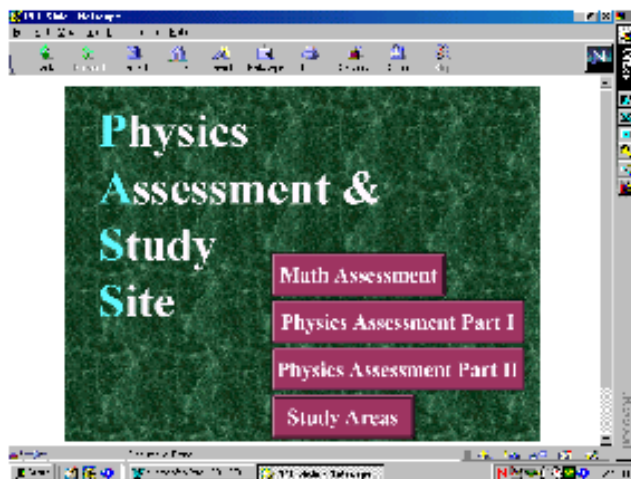


Figure 1b. The *PASS* website on-line.



The mathematics assessment instrument consists of questions from eight content areas; arithmetic, conversions, algebra, exponents and logarithms, trigonometry, graphs, vectors, and calculus. The student starts by entering his or her name and email address and then begins the assessment by clicking on an answer from the choices given after the statement of each problem (Figure 2). If a student does not have knowledge of the concept used in the problem, the choice of “Not familiar with this concept” is selected. In total, there are 104 questions are in the eight content areas. The assessment has no time limit although it is necessary for it to be completed in one sitting.

The physics assessment instrument is divided into two parts, physics I and physics II, corresponding to the topics covered in the prerequisite physics courses. In the physics I assessment, the six content areas are kinematics, Newton's Laws, work and energy, momentum, rotation, waves, and sound. The six content areas for the physics II assessment are fluids, heat and thermodynamics, electricity, magnetism, light and optics, and atomic and nuclear physics. Similar to the mathematics assessment, the student starts with the entry of name and email address and then proceeds to answer the questions, as shown in Figure 3 for the case of the physics I assessment.

Figure 2. Mathematics Assessment

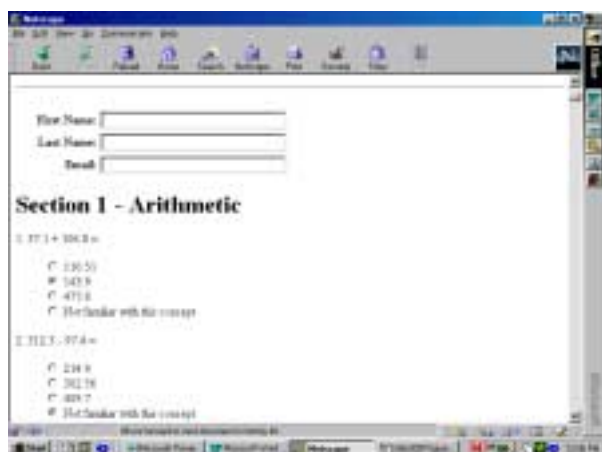


Figure 3. Physics I Assessment



There are 88 questions in the physics I assessment and 104 questions in the physics II assessment and, as before, there is no time limit and the each assessment is to be completed in one sitting.

The study areas, as illustrated in Figure 4, consist of four general mathematics topics (algebra, trigonometry, calculus, and vectors) and twelve physics topics (kinematics, Newton's Laws, work and energy, momentum, rotation, waves, and sound, fluids, heat and thermodynamics, electricity, magnetism, light and optics, and atomic and nuclear physics). The topic of each area is selected to correspond to the concepts covered in the respective mathematics and physics assessments.

Figure 4. The PASS study areas.



Figure 5. The study area categories.



As illustrated in Figure 5, each study area consists of specific sub-topics and four categories covering different instructional applications: Introduction, Demonstrations, Practice, and Applications. These categories, in turn, provide links to websites associated with the sub-topic. In particular, the following four categories and their descriptions are

- 1) Introduction - In this category, preliminary information about the sub-topic is presented in the form of textual material, tutorials, figures, equations, graphs, etc.
- 2) Demonstrations - Resources such as animations, interactive demonstrations, charts, and tables are presented in this category to provide a visual description and reinforcement of the sub-topic.
- 3) Practice – Basic mathematical applications (interactive, when possible) of the sub-topic are included in this category as a means of providing an opportunity to apply equations or concepts to a problem related to the sub-topic.
- 4) Applications – When possible, simulations involving student input of variables or interactive problems solving are included in this category and are used to demonstrate the applicability of the sub-topic to typical situations.

Before inclusion in a category, a potential website is assessed according to the following four selection criteria.

- 1) Appropriateness – The website identified should specifically address the sub-topic with a minimum of other non-pertinent information included and the terminology used should be consistent with that used in the course.
- 2) Accessibility – The website identified should be readily usable with clear instructions and descriptions so that the student may focus on learning the sub-topic material and not on learning how to use the link.
- 3) Interactivity – The website identified should engage the student by encouraging, when appropriate, interactivity with the sub-topic.
- 4) Validity – The effectiveness of the website identified should be, when possible, part of a reviewed group of similar sites.

If an identified website meeting the above criteria is located, its inclusion into the study area is indicated by a check mark in the appropriate category box, as shown in Figure 5.

Interpretation of Assessment results

After completion of an assessment, the results are forwarded via email to the instructor for interpretation. An assessment result form similar to the one shown in Figure 6 is then used to determine what actions (recommendations) are required.

Figure 6. Assessment result form

Student Name:		
Email:		
Math Skills Assessment Results:		
	Questions answered incorrectly/"Not familiar"	Percent answered incorrectly/"Not familiar"
Section 1 – Arithmetic		
Section 2 – Conversions		
Section 3 – Algebra		
Section 4 – Exponents/Logarithms		
Section 5 – Trigonometry		
Section 6 – Graphs		
Section 7 – Vectors		
Section 8 – Calculus		
Action/Recommendation Table		
% answered incorrectly	% answered "Not familiar"	Action
0 to 25	0 to 25	Recommended to review indicated Study Area topics for maintenance or improvement of skills
25 to 50	0 to 25	Recommended to review indicated Study Area topics for maintenance and improvement of skills; Retake appropriate assessment sections
0 to 25	25 to 50	Recommended to review indicated Study Area topics for maintenance and acquisition of skills; Retake appropriate assessment sections
25 to 50	25 or higher	Recommended to take or retake appropriate pre-requisite course
> 50	0 to 25	Recommended to take or retake appropriate pre-requisite course
> 50	25 or higher	Recommended to take or retake appropriate pre-requisite course

As illustrated in the figure, the number and percentages of questions answered incorrectly or “Not familiar with this concept” are reported. By using the percentages and table accompanying page one of the form, the appropriate action (recommendation) may be made on page two and sent to the student via the student response form (Figure 7).

Figure 7. Student response form

Student name:

Math Assessment Recommendation:

Algebra Study Area: It is recommended that you review the indicated topics in this study area for maintenance, improvement, acquisition of the required skill levels and retake this section of the assessment :

- Linear equations
- Quadratic equations
- Exponents
- Logarithms
- Graphing

Trigonometry Study Area: It is recommended that you review the indicated topics in this study area for maintenance, improvement, acquisition of the required skill levels and retake this section of the assessment:

- Functions
- Identities
- Graphing
- Pythagorean Theorem

Vector Study Area: It is recommended that you review the indicated topics in this study area for maintenance, improvement, acquisition of the required skill levels and retake this section of the assessment:

- Graphical Addition
- Components
- Unit Vectors
- Scalar Products
- Vector Products

Calculus Study Area: It is recommended that you review the indicated topics in this study area for maintenance, improvement, acquisition of the required skill levels and retake this section of the assessment:

- Limits
- Differentiation
- Integration

It is recommended that you take or retake the following prerequisite course(s):

- Developmental Mathematics
- Intermediate Algebra
- College Algebra and Trigonometry
- Calculus I

Send result to student.

Implementation of the *PASS* website

Work was begun on the *PASS* website during the summer of 2000 as a special project funded by the author's institution. During that time, the mathematics and physics assessments were developed, programmed, and any necessary corrections made. In the fall of 2000, work continued on the website, with the study areas topic links identified and assessed for inclusion.

Due to the need for revisions, the mathematics and physics assessments could not be administered prior to the start of the fall 2000 semester, but rather were taken during the initial weeks of that semester. In all, 16 students took the mathematics and physics assessments, with comments from the students used to further revise the assessments in terms of errors or unclear statements of questions. It was not possible for work on the assessment result form (Figure 6) and the student response form (Figure 7) to be completed for use with the first group of students taking assessments. However, with the revisions and improvements in the assessments and completion of the above-mentioned forms, the *PASS* website is expected to be in full operation for the start of the fall 2001 semester.

Preliminary outcomes and future plans for the *PASS* website

In terms of the objectives proposed for the website, the provision for a means of assessing prerequisite knowledge and remediation were achieved. The assessment result form (Figure 6) and the student response form (Figure 7) were not available for use with the inaugural group of students. Thus, a quantitative analysis of prerequisite knowledge and course success could not be performed at this time. With the anticipated incorporation of the assessment result form and the student response form into the *PASS* website, the third objective of determining what relationship, if any, exists between prerequisite knowledge and course success may then be addressed. The investigation into this relationship is planned for the fall 2001 semester. However, a preliminary qualitative review of the assessment results obtained suggests that a stronger background in mathematics may be more crucial to course success than prerequisite knowledge in physics. This tentative result will be examined more closely as part of the previously mentioned investigation.

One additional and unintended outcome of the development and implementation of the *PASS* website was its use as an instructional resource. The use of the sub-topic categories - Introduction, Demonstration, Practice, and Application - provided a pedagogically consistent way of presenting specific course material in the classroom. Hence, the website could be used as a teaching tool, while at the same time demonstrating to students its use as a location for both study and review.

The author expresses his sincerest gratitude for the work performed by colleagues Lori Wushensky and Jason Wertz in developing the *PASS* website and putting it in operation on-line. Without their efforts, the completion of the project would not have been possible.

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