THE IMPACT OF AN ENVIRONMENTAL EDUCATION BASED INFORMATICS MODULE ON THE ATTITUDES OF STUDENTS IN GRADES 5 AND 6 TOWARDS THE ENVIRONMENT

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ABSTRACT
This paper reports data from a case study project aimed at examining the effect of an environmental education-based Informatics module on the attitudes of students in grades 5 and 6 towards a series of environmental issues. Firstly, the two major innovations currently under way in Greece are briefly described and the resulting challenges for educators are discussed: (a) primary schools are being equipped with computers and (b) a new cross-disciplinary curriculum has been issued. Secondly, a module developed to meet these challenges is presented and the rationale for its design is analyzed drawing on educational technology, learning psychology, and environmental education. Environmental education served as the overall context for making computer literacy meaningful and coherent since the starting point was an authentic task to the realization of which technology was essentially instrumental. Thirdly, a module outline is presented which included three main activities: (a) writing a letter to the city mayor describing environmental problems of the neighborhood, (b) conducting a neighborhood survey to inquire the attitudes of adult residents towards the problems identified by the students, and (c) presenting both the letters and the survey results to the mayor in an one hour special event. One hundred and four students participated in the study which took place at a public elementary school in the city of Rethimno during the school year 2001-02. A pretest-treatment-posttest design was employed, students completing the CHEAKS questionnaire in October 2001 and June 2002 respectively. Results indicated that the module developed and implemented was very effective in improving student attitudes along several environmental dimensions. Nevertheless, a differential response pattern to the instructional treatment was observed. Finally, the findings of the study are further discussed in terms of whether it is possible to introduce computer literacy into elementary grades following a cross-disciplinary approach.

KEYWORDS
computer literacy, environmental education, authentic task, cross-disciplinary approach

INTRODUCTION - GENERAL CONTEXT OF THE STUDY

There are currently two major educational innovations under way in Greece. First, primary schools all over the country are being equipped with computers. Second, a new cross-disciplinary curriculum has been put into effect. These two innovations definitely create a new reality for educators who must adapt and will eventually employ computers in their teaching and teach according to the standards set by the new curriculum.

Regarding the first innovation, Greece initially adopted the vertical model for the introduction of computers in education (i.e. Informatics as a subject) and, consequently, computers were introduced into secondary schools as a separate subject (Makrakis, 1988). Nowadays, the potential of computers and the new information and communication technologies (ICT) in general for enhancing learning is being acknowledged and, as a result, computers are being introduced into primary schools The

government plans to have no schools without computers by the end of 2004, in compliance with the EU e-Learning initiative.

Regarding the second innovation, a new cross-disciplinary curriculum has been issued by the ministry of education in October 2001. The new curriculum promotes a different approach to learning which aims to make it less fragmented and more meaningful. This is to be achieved mainly through project work which will combine concepts from diverse academic subjects. On the one hand, the new curriculum places strong emphasis on the development of specific computer skills. On the other hand, the curriculum promotes the use of computers for the teaching of other curriculum subjects. Even though Informatics is not to be taught as a separate subject, the new curriculum specifies computer literacy skills for every school grade. These skills are to be developed through the use of technology in the other school subjects. Thus, in the new curriculum technology is basically seen as an aid for the teaching of other school subjects.

As a result of these two ongoing innovations, teachers are facing considerable challenges. On the one hand, teachers should use computers in their teaching and this presupposes both computer skills and knowledge of how to incorporate computers in their daily teaching work. Because this need has been recognized by the state, 75000 educators are scheduled to attend one 50 hour in-service computer literacy course. Of course, knowing what a computer is and how to work with one does not help with the pedagogical, psychological or academic content matters surrounding the incorporation of computers in the teaching and learning process. On the other hand, the fact that for every grade specific computer literacy skills are identified which must be developed through the application of computers in other curricular subjects, presupposes that teachers know how to approach computers as an instructional and learning medium and integrate it effectively in their practice.

Taken as a whole, these two innovations call for new forms of teaching practice, new approaches to learning, new methods of organizing instruction, and new ways of supporting learning which is cross-disciplinary in character. The work reported in this paper addresses these challenges by presenting a project in which computers were introduced into the teaching and learning practice employing a cross-disciplinary approach.

SPECIFIC CONTEXT OF THE STUDY

In September 2001, the first author was assigned to teach Informatics (computer literacy) to students in grades 5 & 6 in an elementary school in the city of Rethimno, Crete, for the academic school year 2001-02. Neither the existing nor the new national curriculum designated the teaching of Informatics as an separate curricular subject for the elementary grades. The initiative of incorporating Informatics in the elementary school curriculum belonged to the school principals and the regional education director. The fact that no specific Informatics curriculum was provided allowed great latitude for devising, setting up, and implementing an instructional module which was aimed at developing computer literacy skills for students in grades 5-6. Informatics was scheduled to be taught for a 45' period once a week throughout the school year. Since it is well established in the literature that technocentric approaches have been associated with several shortcomings (Salmon & Perkins, 1996) we followed a markedly different approach. In line with contemporary approaches which suggest that the focus should not be on what technology can offer but in what learning needs that technology can support and facilitate (Bransford, Brown & Cocking, 1999; Bransford, Brophy & Williams, 2000), we approached the computer as an instrument, as a tool for performing a certain activity. In the module we devised, technology was essentially transparent in the sense that the starting point was the activity in which technology would be incorporated. Thus, as opposed to being an end in and of itself (as would have been the case e.g. with the teaching of Informatics), technology was merely instrumental for carrying out an activity. The bottom line of our approach was that by employing technology as a means to achieve a certain end the primary focus was on the activity which rendered the learning of Informatics concepts and the development of computer skills more meaningful and relevant.

THE MODULE

The module we devised was entitled "Problems of my neighborhood". We selected the particular topic because it is a subject students have a fair knowledge about and is not as distant as e.g. the destruction of the rain forest. This particular topic was related to environmental education and was cross-disciplinary in nature. The module aimed at developing students' ICT skills in an Environmental Education (EE) context using a cross-disciplinary approach. In the remainder of this section we explain (a) which computer skills we aimed at developing, (b) which cognitive skills were called into play due to our cross-disciplinary approach, and (c) which environmental attitudes we focused on improving given the environmental education context of our module.

Objectives

The Informatics concepts and skills targeted were the following: (a) *computer hardware* (CPU, storage devices, input & output devices, peripheral devices), (b) *operating system, GUI & file management* (desktop, windows explorer, folder/file creation, deletion, renaming, and moving), (c) *word processor* (creating, accessing, and saving a document, text input and editing, font/paragraph formatting, word art, tables and table formatting, printing), and (d) *spreadsheet* (creating, accessing, and saving a worksheet, cell, data input, math operations, functions, graph creation and formatting, data and graph printing).
The project was cross-disciplinary and, thus, next to the development of computer literacy skills in an environmental education context, several other cognitive skills were called into play, including: (a) *observation* (awareness of environmental issues), (b) *oral and written communication* (practice in a written genre, the formal letter), (c) *logic of inquiry* (need for research, research questions, research design), (d) *data collection* (types of research, questionnaire administration, data collection), (e) *data analysis* (average, percentage, pie charts and bar graphs), (f) *conclusions* (making sense of and interpreting results), (g) *presentation* (determining and communicating important points). These skills are derived from various subjects such as Language, Physics, Math, and Social Studies.

Finally, the theme of the activity had a very strong Environmental Education flavor and it would provide the setting for the development of the computer and cognitive skills mentioned above. Since students would be thinking about and dealing with specific environmental problems of their neighborhood the module was also aimed at developing their awareness of and attitudes towards these problems. The present paper focuses exclusively on the issue of attitudes and explores how they were affected by student participation in the whole instructional activity.

Contents

The module was comprised of several activities and sub-activities three of which are briefly summarized: (a) *write a letter to the city mayor* describing problems of the neighborhood where students lived; (b) *conduct a neighborhood survey* to determine what the attitudes of adult neighbors are towards the problems identified in the first activity. (c) *present the letters and the survey results to the mayor* in a one hour special school-held event. More information regarding what each activity included is to be provided at a later section of this paper.

Rationale

The module was designed by taking into consideration findings from the educational technology, learning psychology, and environmental education literature. More specifically, the general guidelines used in the design of the module are explained below.

(a) *instrumental approach*: Technology was approached as a means to achieve a given end. The module revolved around the three specific activities mentioned above and technology was to be used as a tool to perform these activities. Learning was the starting point for our approach, as we designed the activities first and then turned to technology to examine how it can support them (Bransford, Brown & Cocking, 1999; Bransford, Brophy & Williams, 2000). The instrumental nature of technology for EE purposes is also evident in the long history of ICT approaches to EE (i.e. Geographical information systems - GIS,

GLOBE, GREEN) which suggests that the goals of ecological, scientific and computer literacy are compatible and interdependent (Moore & Huber, 2001).

(b) *Cooperative work:* Group work at the computer was meant to be a very important element of the module. Students were to work in small groups of two (or three depending on class size and the availability of computers). This decision was taken because both psychological theory (Vygotsky, 1987) and research (Slavin, 1995) clearly suggest that cooperative work is a very effective instructional strategy whether students work at the computer (e.g. Crook, 1994; Littleton & Light, 1999) or not.

(c) *Discussion rules:* A set of explicit discussion rules were devised for use in the discussion sessions. The main discussion rule was the following: as far as discussion topics are concerned there are no "right" or "wrong" answers. All answers (or viewpoints) are acceptable provided that they are sufficiently justified (i.e. specific reasoning is provided for every thought or proposal) regardless of whether they sound plausible or not. On the other hand, all answers (or viewpoints) are unacceptable if, regardless of whether they seem to be very persuasive and logical, no reasons are provided to justify them. This decision was made of the basis of research showing that the presence of explicit discussion rules improves the cognitive outcome of classroom and/or group discussions (e.g. Wegerif, Mercer, & Dawes, 1999; Mercer, 2000).

(d) *Real life problem & cross-disciplinary approach*: The topic of the whole module centered around a real life problem and was essentially an authentic task. The task we selected had meaning and relevance for students' lives. Thus, our starting point was students' experiences and encounters with neighborhood environmental problems and these problems were dealt with from a holistic perspective. This decision was taken because it is now widely accepted that the encapsulation of knowledge is one of the main problems which impedes learning in schools and leads to the acquisition of fragmented and isolated pieces of knowledge which has little real life relevance or meaning (Resnick, 1987; Engeström, 1991). Moreover, evidence suggests that conducting real-life research enhances students' critical thinking and problem solving skills, feelings of empowerment, and science understanding (Mordock & Krasny, 2001).

(e) School-community contact: An important feature of the module concerned the school-community link. By means of their participation in the activity students were to reach out to the community and more specifically to communicate with the local community authority. The presentation of the student letters and the survey results was meant to be public and receive extensive coverage by city newspapers and regional TV channels. Research suggesting that the contact of students with other community members and professionals changes the nature of what learning is and transforms the way it is effected (Brown et al., 1993) led us to this decision. Furthermore, there evidence indicating that such activities which afford the sharing of experiences and knowledge with other community members (i.e. friends, parents etc) considerably help increasing students' self-esteem (Rickinson, 2001; Milton et al., 1995).

(f) Duration: The module was designed to last for a whole school year, even though it could in principle be completed in less time had the emphasis been different. Our decision was based on the fact that there is evidence to suggest that the duration of a project is a very decisive factor for its effectiveness (Zeleny, 1999).

(g) Out of school activities: According to the design of the module, one of the activities students were to be engaged in was to take place outside the school even though it was prepared at school under the guidance of the first author. It basically involved the administration of a survey questionnaire students to adult neighbours. Even though there is no evidence to suggest that out of classroom activities yield better learning outcomes as far as environmental education is concerned (Rickinson, 2001; Dettmann-Easler & Pease, 1999; Zelenzy, 1999), we nevertheless believed that such an activity could play an important part in changing student attitudes towards environmental problems, since students must contact community members, explain to them what it is they are doing, and convince them that it is worth answering the questionnaire.

Research question
The objective of the study was to examine the effect of an eight month-long environmental education based Informatics module on student attitudes. This paper focuses on the effect of the intervention on grades 5 and 6 student attitudes towards a series of environmental issues and mainly addresses the following question:

Are student attitudes toward a series of environmental issues improved and to what extent as a result of their participation in the environmental education based Informatics module?

METHOD

Subjects
104 elementary school students (58 males, 46 females) attending a suburban primary school in the study of Rethimno participated in the study. Of those students, 76 were grade five students while the other 28 were grade six students. The majority of students came from a middle socioeconomic background.

Materials and Instruments
Instructional materials
We did not make any use of specific instructional materials for the study. Most of the materials used were public artifacts actually "developed" by the students themselves (i.e. the letters they wrote to the mayor). Conventional classroom instruments e.g. blackboard were used while the main instructional "material" was the computer. Most of the lessons were conducted at the computer lab while discussion sessions were held in students' classrooms. Approximately 95% of all instructional time was spent at the school computer lab while the lesson involved out of school activities as well. There were eleven computers available at the school computer lab: one Microsoft Windows NT 4.0 server, and ten workstations running Microsoft Windows 98. The NT server provided both www and email services (Microsoft Internet Information Server and Exchange Server) while Microsoft Office version 97 was set up in every workstation.

Instrument
The CHEAKS (Children's Environmental Attitude and Knowledge Scale) test was used to assess student attitudes (see Leeming et al., 1995, for more details). The instrument consists of two separate sub-scales, Attitudes and Knowledge, which can be used independently. For the present study we only used the attitudes scale because the overwhelming majority of the Knowledge items were completely irrelevant for the context of the study. The attitude subscale of the instrument comprises 36 items measuring students' attitudes towards environmental issues: 12 items reflecting verbal commitment, 12 actual commitment, and 12 affect. These attitudinal items are derived from six content dependent sub-domains, hence 2 items from each sub-domain. These sub-domains are: animals, energy, pollution, recycling, water, and general issues. Agreement towards an item was scored with 1 point while disagreements were scored with 0. Specific information regarding the reliability and validity of the Greek version of the CHEAKS test, which was the one used in the study, is provided elsewhere (Malandrakis & Chatzakis, submitted).

Treatment
Initially students were informed about the objective and the contents of the lesson. In the first two class periods a discussion was held in which the students were guided by the first author to determine what the problems of their neighborhood were. When several problems were identified, the students were instructed to write a letter to the city mayor using paper and pencil, describing in detail the problems their neighborhood faced and kindly ask the mayor to take some measures to solve these problems.
Secondly, students conducted a neighborhood survey to determine what the attitudes of adult neighbors are towards the problems students themselves identified. Students were introduced to the concept of evidence and research. After some discussion, it was concluded that if they were to be taken seriously by the mayor and the municipality officials, their opinions definitely counted but were not as significant as those of adults. After all, because of their age students were 'just kids'. This brought in the necessity

of conducting research which would provide evidence that indeed the problems students identified are also generally accepted by most people living in that neighborhood as being important. Students constructed a questionnaire with nine items and administered it to their neighbors. In total, 83 questionnaires were returned by the students and these were analyzed to determine what the attitudes of adults were.

Finally, the student letters and the survey results were presented to the mayor who was informed about the project, delighted with the initiative and eager to visit the school for a special one hour event. Each class section selected two representatives for the event. One representative presented the problems expressed in the student letters while the other presented the findings of their research. After the presentations were concluded, the mayor addressed all the problems mentioned by the students, acknowledged that they were indeed important, and promised to look into them in the near future. Finally, the students asked the mayor several very difficult questions to which he eloquently responded. After the mayor visit, one final discussion session was held to discuss the outcomes of the project and draw conclusions.

Design & Procedure
A pre-test, treatment, post-test design was employed. The CHEAKS questionnaire was administered in the beginning of the school year (October 2001), the series of Informatics lessons followed with all the activities described above, and the same questionnaire was administered again at the end of the school year (June 2002).

ANALYSIS

Since data analysis was not quite possible with individual item scores, we computed a series of new variables from the individual item scores which were used in further analyses. Firstly, we aggregated the item scores for verbal commitment and created a new variable called verbal commitment, ranging from 0 to 12. The same procedure was followed with items for actual commitment and affect which resulted in the creation of two new variables: actual commitment and affect which also ranged from 0 to 12. Secondly, we aggregated all item scores for the three new variables and created another variable which reflected the overall attitude of students, ranging from 0 to 36. Thirdly, we created six new variables by aggregating items for each of the six component sub-domains: general issues, pollution, recycling, animals, energy, and water, each variable ranging from 0 to 6.

Data analysis was carried out in three main steps. Firstly, to determine whether the treatment had any effect on student attitudes, pre test scores for each of the variables created above were compared with their posttest counterparts. Additionally, to assess whether the treatment had any effect on student attitudes related to the specific sub-domains, pretest mean scores were compared with the posttest ones for all sub-domain variables: general issues, pollution, recycling, animals, energy, and water. Secondly, to obtain a measure of how effective the treatment was in improving student attitudes towards the environmental problems examined, effect sizes were computed for verbal commitment, actual commitment, affect and overall attitudes as well as for the six sub-domains: general issues, pollution, recycling, animals, energy, and water. Finally, to examine the extent to which the treatment contributed to posttest attitudes, posttest scores were regressed on pretest ones.

RESULTS

Pretest and posttest scores for verbal and actual commitment, affect and overall attitude are presented in table 1.

Table 1. Means and Standard deviations for verbal commitment, actual commitment, affect and overall attitudes

	Pre test		Post test	
Attitudes	**Mean**	**sd**	**Mean**	**sd**
Verbal	7,71	*2,38*	8,48	*2,16*
Actual	5,18	*1,92*	5,40	*1,88*
Affect	8,80	*2,92*	9,69	*2,38*
Overall	21,47	*6,06*	23,48	*4,70*

Table 1 shows an increase from pre to posttest mean scores for all attitude variables involved. This improvement was statistically significant for verbal commitment (t-value= -3,359, df=86, p=0.001), affect (Wilcoxon z-value= -2,673, p=0.008) and overall attitude (Wilcoxon z-value= -3,447, p=0.001). Nevertheless, the pre-posttest mean score difference for the variable of actual commitment did not turn out to be statistically significant (t-value= -1,018, df=89, p=0.311).
Pre and posttest scores for the six sub domains are presented in table 2.

Table 2. Means and standard deviations for the six sub-domains

	Pretest		Posttest	
Content sub-domains	**Mean**	**sd**	**Mean**	**sd**
General issues	4,08	*1,54*	4,26	*1,33*
Pollution	3,84	*1,53*	4,00	*1,44*
Recycling	3,05	*1,39*	3,70	*1,33*
Animals	4,01	*1,36*	4,25	*1,23*
Energy	3,00	*1,21*	3,41	*1,08*
Water	3,75	*1,45*	4,28	*1,02*

As can be seen from table 2, posttest means scores are higher than the corresponding pretest ones. The posttest mean scores were found to be significantly higher compared to the pretest ones for three domain attitudes: energy (t-value: -2,685, df=89, p=0.009), recycling (t-value: -3,928, df=91, p=0.000), and water (Wilcoxon z-value: -3,260, p=0.001). The rest of the differences between pre and posttest scores were not statistically significant: general issues (Wilcoxon z-value: -1,104, p=0.270), pollution (t-value: -1.033, df=92, p=0.304), and animals (t-value: -1,640, df=88, p=0.104).

To assess the magnitude of the treatment effect we computed the effect size d following Cohen's (1988) approach. On the one hand, the treatment effect size turned out to be negligible for actual commitment (d_{actual}=0.12) while it was small for verbal commitment, affect, and overall attitudes (d_{verbal}=0.34, d_{affect}=0.33 and $d_{overall}$=0.37). On the other hand, as far as the specific attitudes of the six sub-domains are concerned, the treatment effect size was negligible for pollution ($d_{pollution}$=0.11), small for animals, energy, and general issues ($d_{animals}$=0.18, d_{energy}=0.36, $d_{general}$=0.36), while it was medium for the cases of recycling and water ($d_{recycling}$=0.47, d_{water}=0.42).

Finally, to assess how much of the posttest variance is uniquely accounted for by the pretest scores, posttests were regressed on pretest ones. The results of this analysis are presented in table 3.

Table 3. Regression analysis of posttest scores on pre-test ones

Predictor	Criterion	R^2	F	Beta	t
Verbal pretest	Verbal posttest	0,31	38,511***	0,56	6,206***
Actual pretest	Actual posttest	0,17	17,414***	0,41	4,173***
Affect pretest	Affect posttest	0,20	21,481***	0,45	4,635***
Overall pretest	Overall posttest	0,18	17,487***	0,42	4,182***

*** $p < 0.001$

Table 3 shows that pretest attitude scores can account for small portions of variance of the posttest attitude scores at a statistically significant level. More specifically, the pretest scores for the variables of actual commitment, affect, and overall attitudes explain about 1/5 of the variance of the corresponding posttest attitude scores. On the other hand, in the case of verbal commitment the posttest variance explained by the pretest attitude scores is much higher, approximately 1/3. The regression analysis for affect should be interpreted with caution because the condition of homoscedacity was not met.

DISCUSSION

In this paper we described an approach in which we set out to develop computer literacy skills by using an environmental activity to make Informatics learning more meaningful. The environmental topic: "Problems of my Neighborhood" provided the context for the development of Informatics skills. The present paper focuses on the impact of the environmental education based Informatics module on students' attitudes towards a series of environmental issues. The main research question addressed in this work concerned the effect of the treatment on student attitudes towards a series of environmental problems.

On the one hand, results indicate that, as a whole, the instructional intervention was very successful in increasing students' awareness on a number of environmental topics. Overall, the attitudes improved from pre to post test which attests to the effectiveness of the instructional intervention. Nevertheless, the treatment seemed to be particularly effective for verbal commitment and affect attitudes only while not for attitudes related to actual commitment. Even though it is very encouraging that the students were moved by the activities (i.e. affect) and explicitly expressed their commitment (i.e. on a verbal level), as far as the essence of EE is concerned, i.e. deeds vs. words, the posttest attitude scores were no different than the pretest ones. While this finding seems to be rather negative, it should be borne in mind that the module was more goal-oriented than behavior-oriented. As a consequence, the students did not take any action to actually minimize the environmental problems of their neighborhood. On the contrary, most of the time was devoted to increasing awareness of these problems and requesting solutions from the local authorities (i.e. mayor). Despite the significant increase in attitudes for these three variables, the corresponding effect sizes suggest that the treatment effect was rather small, i.e. the improvement was not substantial.

On the other hand, with respect to the specific content sub-domains, the results suggest a differential response to the treatment by the students, as improvement was not uniform for all sub-domains. More particularly, there was a statistically significant improvement from pre to post test for three variables: recycling, energy, and water, which suggests that the treatment was very successful as far as these are concerned. Moreover, the effect sizes suggest that, as far as the attitudes towards recycling and water are concerned, the magnitude of the treatment was medium which is a promising finding in that it indicates that the observed improvement is substantial.

Finally, regression analysis showed that pretest scores could account for statistically significant but small portions of the variance of the corresponding posttest scores for each variable. The highest percentage of variance explained was about 30% and it involved verbal commitment, while the percentage of variance explained for the other three variables ranged from 17-20%. This finding suggests that the greatest portion of the variance (70%-83%) for each of the variables is accounted for

by the treatment and, thus, it is the treatment which must be credited with the recorded improvement. Had the students not been exposed to any instruction, pretest performance should have accounted for most of posttest variance.

To conclude, by virtue of its environmental education flavor and in addition to providing an opportunity to develop computer literacy skills, the module we developed and implemented was found to be very effective for improving student attitudes on several environmental dimensions measured, even though a differential response pattern to the treatment emerged. What the outcomes of the present case study suggest is that it is indeed possible to introduce computer literacy in the elementary grades in a cross-disciplinary manner. It rests upon future research to both enrich and further develop computerized instructional implementations of this type.

REFERENCES

Bransford, J., Brophy, S. & Williams, S. (2000). When computer technologies meet the learning sciences: issues and opportunities. Journal of Applied Developmental Psychology, 21(1), 59-84.

Bransford, J.D., Brown, A.L. & Cocking, R.R. (1999). How people learn. Brain, mind, experience, and school (expanded edition). Washington, DC: National Academy Press.

Brown, A.L., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A. & Campione, J.C. (1993). Distributed expertise in the classroom. In G. Salomon (Ed.), Distributed cognitions. Psychological and educational considerations (pp. 188-228). NY: Cambridge University Press.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Crook, C. (1994). Computers and the collaborative experience of learning. London: Routledge.

Dettmann-Easler, D. & Pease, J. L. (1999). Evaluating the effectiveness of residential environmental education programs in fostering positive attitudes toward wildlife, Journal of Environmental Education, 31(1), pp.33-39.

Engeström. Y. (1991). Non scolae sed vitae discimus: Toward overcoming the encapsulation of school learning. Learning and Instruction, 1, pp. 243-259.

Leeming, F.C, Dwyer, W.O. & Bracken, B.A. (1995). Children's Environmental Attitude and Knowledge Scale: Construction and Validation, The Journal of Environmental Education, 26(3):22-31.

Littleton, K. & Light, P. (1999). Learning with computers. Analysing productive interaction. London: Routledge.

Makrakis, V. (1988). Computers in School Education: The cases of Sweden and Greece. Stockholm: Institute of International Education.

Malandrakis, G. N., & Chatzakis, S. A., Environmental Attitudes and Knowledge of 5th and 6th Grade Greek Children. A CHEAKS' Implementation. Journal of Environmental Education. Manuscript submitted for publication.

Mercer, N. (2000). Words & Minds. How we use language to think together. London: Routledge.

Milton, B., Cleveland, E. & Bennett-Gates, D., (1995). Changing perceptions of nature, self, and others: a report on a Park/School Program, Journal of Environmental Education, 26(3), pp.32-39.

Moore, C. J. & Huber, R. A. (2001). Support for EE from the National Science Education Standards and the Internet, The Journal of Environmental Education, 32(3):21-25.

Mordock, K. & Krasny, M.E. (2001). Participatory Action Research: A Theoretical and Practical Framework for EE, The Journal of Environmental Education, 32(3), 15-20.

Resnick, L. (1987). Learning in school and out. Educational Researcher, 16(9), 13-20.

Rickinson, M., (2001), Learners and Learning in Environmental Education: a critical review of the evidence, Environmental Education Research, Special Issue 7(3).

Salomon, G. & Perkins, D. (1996). Learning in wonderland: what do computers really offer education? In S.T. Kerr (Ed.). Technology and the future of schooling. 95th yearbook of the national society for the study of education, part II (pp. 111-130). Chicago: The University of Chicago Press.

Slavin, R.E. (1995). Cooperative learning: Theory, Research, and Practice (2nd Ed.). Boston: Allyn & Bacon.

Vygotsky, L.S. (1987). The collected works of L.S. Vygotsky. Vol.1: Problems of general psychology. Including the volume Thinking and speech. (R.W. Rieber & A.S. Carton, Eds., N. Minick, Trans.). New York: Plenum Press.

Wegerif, R. Mercer, N. & Dawes, L. (1999). From social interaction to individual reasoning: an empirical investigation of a possible socio-cultural model of cognitive development. Learning and Instruction, 9(6), 493-516.

Zelezny, L. C. (1999). Educational interventions that improve environmental behaviours: a meta-analysis, Journal of Environmental Education, 31(1):5-14.

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