ENVIRONMENTAL EDUCATION:
IMPROVING STUDENT ACHIEVEMENT

by

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ABSTRACT

Environmental education:
improving student achievement

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The present research, being one strand of the Environmental Education Consortium's longer research effort, aims to study the impact of environmental education (EE) programs on student achievement in traditional subjects such as math, reading and writing. By comparing "environmental schools" and schools with traditional curricula and analyzing their teaching and learning environments, the present research aims to obtain statistical evidence of the positive impact of EE on student learning and to make an educational case for environmental education.

The research compares two groups of schools selected by the author after consulting with various EE providers, and other EE and educational experts: a group of EE schools that have been fully implementing EE for at least three years, and a group of comparison (or non-EE) schools which do not have an environmental education program or are only starting to develop it. Schools were paired using US census and OSPI information.

To evaluate the impact of the EE programs on student achievement, data about WASL and ITBS tests from the OSPI web site were used. WASL and ITBS data were analyzed through several statistical tests (t-tests, discriminant analysis, longitudinal analysis, etc.) Also in order to evaluate the schools' teaching and learning environments an electronic survey was administered.

According to the results, schools that undertake systemic environmental education programs consistently have higher test scores on the state standardized tests over comparable "non-EE" schools. The mean percentages of the students who meet standards on WASL and ITBS tests are higher in WASL and ITBS in the schools with environmental programs. There were no EE schools that had lower percentage of students who meet or above standards in all six areas. Overall, 73 pairs out of 77 EE schools had higher scores in ***at least*** one subject. Also the research shows a pattern indicating that in schools with environmental educational programs, teachers tend to use natural areas more; have more EE professional development/training; have more support from parents, community and administration; and see more value in environmental education.

To conclude, the author believes that the present research shows the correlation between level of implementation of environmental education and student achievement and emphasizes the necessity of more in-depth studies of this issue.

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Table of contents

List of Tables

List of Figures

List of Appendices

Introduction

Environmental education (EE) has been developing for about a century. Some researchers and practitioners believe that it continues traditions of outdoor and nature education. However, although many states require EE to be taught in all grades and subjects, EE has not become an integral part of school curricula. Teachers and EE professionals name various reasons for the lack of environmental education in their classrooms. Lack of time, money and training, lack of support and other curriculum pressures are only some of them. In Washington State one more reason was added to the list several years ago. Teachers are required to prepare students to the Washington Assessment of Student Learning test (WASL), a new standardized test administered in elementary, middle and high school.

The supporters of environmental education believe that although the benefits of EE have been known for a long time, there has not been enough evidence that environmental education can be helpful in improving student learning. The concern has been expressed in several state and national reports, which state that most of research on this topic is anecdotal in nature.

Four years ago, a group of several state, non-profit, business and educational organizations in Washington State, known as the Environmental Education Consortium (EEC), started a project that aimed to prove the benefits of environmental education and integrate it into Washington school curricula. This research, one strand of the EEC's longer effort, aims to study the impact of environmental education programs on student achievement in traditional subjects such as math, reading and writing. By comparing "environmental schools" and schools with traditional curricula and analyzing their teaching and learning environments, the present research aims to obtain statistical evidence of the positive impact of EE on student learning and to make an educational case for environmental education.

1. Environmental education: background

1.1. Development of the terms, definitions and objectives of EE

Many authors name the 1960s as the decade when environmental education (EE) started to develop in response to the world's growing awareness about environmental problems. Others believe that EE grew from movements that existed from the beginning of the last century such as nature study, conservation and outdoor education (NACD 1998). In general, the history of the development of the main terms and definitions of environmental education has been studied by different authors. According to Disinger (1983) the term "Environmental Education" appeared for the first time in 1948 at the meeting of the International Union for the Conservation of Nature and Natural Resources. Gough (1997), Palmer (1997, 1998), and Sterling and Cooper (1992) date the appearance of the definition of EE to the end of the 1960s when this term began to be used and discussed on the international level.

According to Stapp *et al.* (1969, p. 30), environmental education is a process aimed to produce "a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution." This definition as well as main objectives of environmental education were developed by Stapp and his graduate students at the Department of Resource Planning and Conservation, University of Michigan (MacGregor 2003). Among the goals of EE Stapp *et al*. (1969) named the development of *knowledge and understanding* of biophysical environment and interrelations of all its components, and *awareness* and *concerns* for environmental quality as well as the development of *responsible behavior* patterns. Development of specific skills and values necessary for solving environmental problems was not mentioned directly in this definition.

One of the most widely accepted definitions of EE was given in the Tbilisi Declaration which was developed at the international conference of environmental educators, sponsored by UNESCO in 1977 (MacGregor 2003). There, environmental education was defined as "a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action" (UNESCO 1978). According to the Declaration, environmental education is seen as a life-long process that is interdisciplinary and holistic in nature and application. It concerns the interrelationship between human and natural systems and encourages the development of an environmental ethic, awareness, understanding of environmental problems, and development of critical thinking and problem-solving skills. MacGregor (2003) believes that the Tbilisi definition was based on the definition developed by Stapp *et al*. (1969) given above, because of William Stapp's influence in creating and shaping the Tbilisi EE conference.

Palmer (1997, 1998) gives another definition of environmental education that slightly differs from the definition given above. She defines EE as "the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings" (Palmer 1998, p. 27). Like Stapp *et al.* (1969), Palmer stresses the importance of interconnections between man, his culture and nature. In addition, EE should also include practice in decision-making processes, the development of self-cognition, the formation of environmental ethics and environmental behavior, and the development of skills for environmental assessment. Palmer concludes that the special feature of EE is that the knowledge of environmental laws and principles of functioning of the natural systems are studied *within* the environment which helps to develop practical skills and the ability to make an assessment of the state of the environment.

An analysis of the works of Bergeson *et al.* 2000, Klimov and Ukolov (1994), Palmer (1997, 1998), Stapp *et al*. (1969), Sterling and Cooper (1992), Volk and McBeth (1998), and others reveals that the goals, objectives, principles and content of environmental education have been clearly defined in many regional and international studies and official documents. The main approaches identified in the works mentioned above are in consensus that the objective of EE is to develop the system of scientific knowledge and a positive attitude towards the environment, to form an understanding of the necessity of nature protection, to increase awareness of the problems in this field as well as possible solutions, and to form a positive attitude towards the environmental laws of society. Although this set of principles is discussed by many researchers, it should be stated that all of them use Recommendation 2 of the Tbilisi Intergovernmental Conference, 1977 as a basis (UNESCO 1978).

According to the European Resolution on Environmental Education[1] which has been taken as a basis for many EE programs and actions in Europe, the goals of environmental education are "to increase the public awareness of the problems which exist in this field, as well as possible solutions, and to lay the foundations for a fully informed and active participation of the individual in the protection of the environment and the prudent and rational use of natural resources" (Giolitto *et al.* 1997, p. 37). Giolitto *et al*. (1997) drew a conclusion that although in different countries of European Union the emphasis can vary from one point to another, there are four major aims of environmental education which are 1) the transmission of knowledge, 2) the creation of new behavior patterns, 3) the development of values, attitudes and skills necessary to protect and improve the environment, and 4) the development of awareness of the necessity to protect the nature and the environment and of the complexity both of the environment and the interactions between man and nature.

[1] Resolution of the Council and the Ministers of Education meeting within the Council on Environmental Education (May 24, 1988)

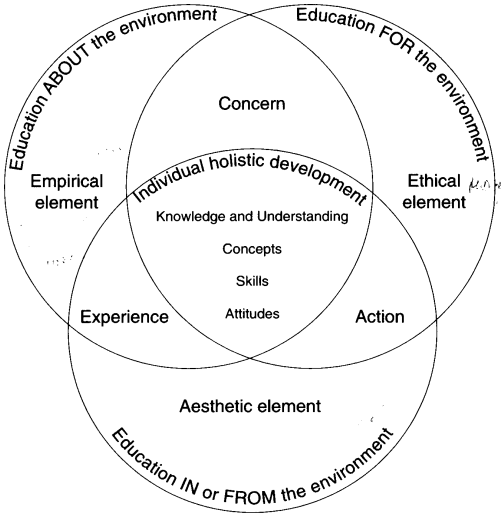
In American EE literature, a lot of attention is given to the development of responsible citizenry. Educators and researchers see educating of citizens who actively protect the environments, and feel their responsibility to do so, as one of the main goals of environmental education (Hines *et al*. 1986; Hoody 1995; Hungerford *et al*. 1980; Moody 1994, Stapp *et al*. 1969, etc.). According to MacGregor (2003), leading environmental educators such as Stapp and Hungerford emphasized that the field of environmental education differs from outdoor, nature and conservation education because it focuses on environmental *problems* and aims to find solutions to them. If so, then environmental education should help to develop patterns of responsible behavior as well as awareness, skills, knowledge and attitudes necessary to act on behalf of the environment. Stapp *et al.* (1969) believe that "citizens should realize that the responsibility for the solutions to [environmental problems] belongs to them and to the governments which represent them" (p. 31). Thus, environmental education should reach citizens of all ages and help them to understand how to play an effective role in solving environmental problems. As mentioned in NAAEE's *Excellence in Environmental Education-Guidelines for Learning (K-12),* EE should help learners to develop questioning and analysis skills, knowledge of environmental processes and systems, skills necessary for understanding and addressing environmental issues (such as decision-making, investigation, and citizenship skills) and personal and civic responsibility (NAAEE 1999). Hungerford *et al* (1980) see the main aim of environmental education "… to aid citizens in becoming environmentally knowledgeable and above all, skilled and dedicated citizens who are willing to work, individually and collectively, towards achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment" (p. 43). The authors believe that it should provide learners with ecological knowledge, develop conceptual awareness and environmental action skills, as well as skills for investigation and evaluation.

1.2. Models of environmental education

An effective model of EE implementation was needed to achieve all the above- mentioned goals. One of the first attempts was made in Europe in the middle of the1970s. The 3-dimensional model was suggested in 1974 by the Schools' Council in UK and later published by Lucas (1979). It has been mentioned frequently by different researchers (e.g. Palmer (1997, 1998), Uzzel (1999), etc.) and adapted according to the development of society. As mentioned by Palmer (1997, 1998), Sterling and Cooper (1992), Uzzel (1999) and others, there are three components in the model, which are used for EE organization and planning. They are education ***About, For*** and ***Through /In /From*** environment (Fig 1).

According to Palmer (1997, 1998), the model consists of two subsystems - formal and informal education - both of which include the three above-mentioned components. The description of the components given below is done on the basis of the definitions and descriptions found in the works by Palmer (1997, 1998), Schools' Council (1974), Sterling and Cooper (1992), and Uzzel (1999).

Figure 1. A 3-dimensional model of environmental education by Palmer (1998)

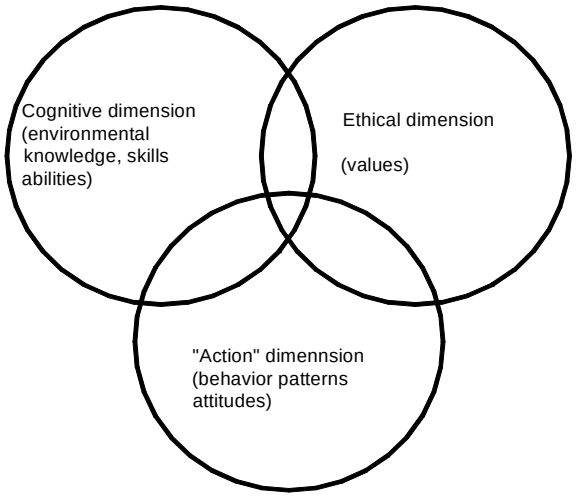


Education ***About*** the environment is usually a part of formal education and has an empirical character. The main aim is to develop knowledge about nature and natural systems using research activities and to form an understanding of the environment, its values and the complex interactions of the elements of the natural and human systems.

Education ***Through/In/From*** the environment sees nature as a tool and resource of the learning process in order to develop research activities of a child, to form the individual experience, to develop a wide range of skills of investigation and communication. The aesthetic element predominates here. This component is a part both of formal and informal education.

Education ***For*** the environment reflects the ethical element of EE. It puts the emphasis on the development of a personal ethic, a sense of responsibility and informal concern for environment. Its aim is to form positive caring attitude towards the environment.

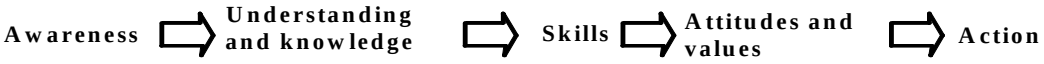
Figure 2. A model of EE by Giolitto *et al*. (1997)



Since the 1970s different authors have worked out different models of environmental education. Thus, Giolitto *et al.* (1997) suggested a static model according to which there are three dimensions in environmental education: cognitive, ethical and "action" dimensions (Fig. 2). The first - cognitive - dimension includes the level of environmental knowledge and skills, which can help to learn, understand and protect the environment. The second one – ethical - assumes the development of values. The last dimension – "action" – includes the development of special behavior patterns and positive attitudes towards the environment.

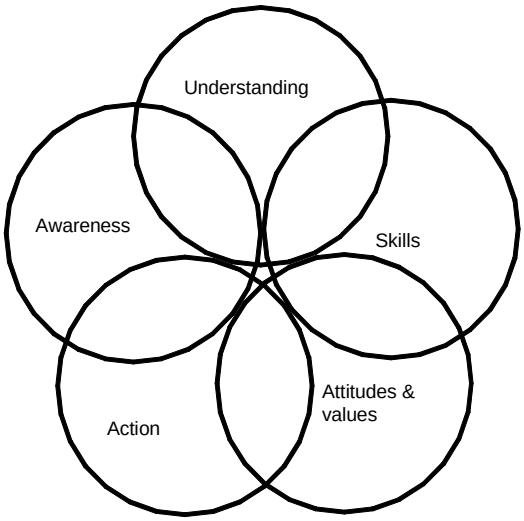
Sterling and Cooper (1992) presented two models for the process through which individuals progress as they become environmentally educated. Both models include all five categories mentioned in the Tbilisi Declaration. The first model is linear (Fig. 3). It assumes that the person passes the stages of environmental education in a strict order one by one.

Figure 3. A linear model of EE by Sterling and Cooper (1992)



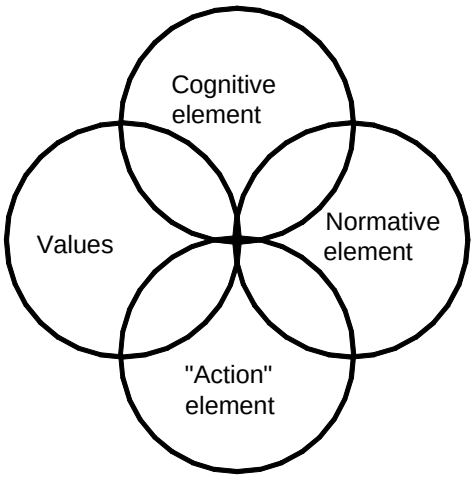
But, as the authors mentioned, a person may go through the stages of the process in a different order. A student can complete one or several stages simultaneously. It proves that EE is more complex and interrelated than the suggested linear model. Thus, Sterling and Cooper (1992) present another version of the model (Fig. 4) in which all elements are interrelated and mutually reinforcing.

Figure 4. A non-linear model of environmental education by Sterling and Cooper (1992)



Ukrainian researchers Klimov and Ukolov (1994) suggested another model of ecological education[2] according to which the system of ecological education consists of four components: cognitive, normative, "values" and "action" (Fig. 5).

Figure 5. Elements of environmental education by Klimov and Ukolov (1994)

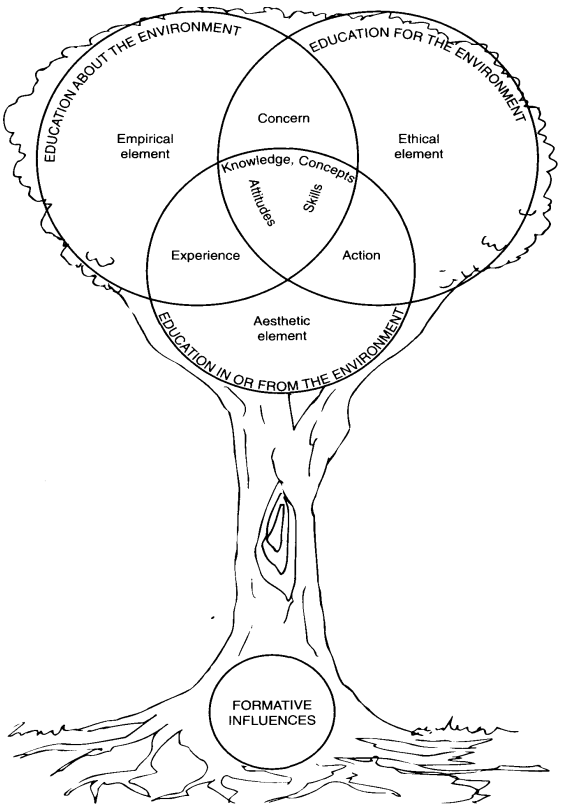


[2] The term "ecological education" is used as a synonym to "environmental education" in Ukraine as well as in many countries of the former Soviet Union and Central and Eastern Europe (Sterling and Cooper 1992; Subbotina 2000).

The cognitive element assumes fundamental knowledge about the interaction of man and the environment, basic understanding of the aims and goals of nature conservation process, and global environmental problems and the ways of solving them. **Values** include the understanding of value of the environment itself (cognitive, ethical, practical values, etc.), the ability to manage human activities within the environment and to foresee the possible changes in the environment as the result of these activities at different levels. **The normative element** presupposes the ethical, aesthetical and ecological norms of the usage of the environment and the behavior patterns for individuals, groups and society in the environment. **The "action" element** assumes the activities and methods directed toward the development of cognitive, practical and behavioral ecological skills (an ability to evaluate the situation, the choosing of the solution, the development of personal features of the student, etc.).

It is necessary to mention that it was Palmer (1998) who first stated that for the development of EE it is necessary to use not a static but dynamic variant of the model that takes into account individual peculiarities and personal experiences of students (Fig. 6). In this case three areas of the model are spheres which rotate constantly. The other difference is that the key element of the model is "formative influences." This element can become more important than the influence of the formal educational programs because it represents the combination of personal experience and formal education. Without taking this factor into account it is impossible to develop a sufficient level of knowledge, skills and values which will form environmental ethics and awareness. Although formative influences use the experience of formal educational programs, they exist independently from programs. That is why it should be considered as a basis for the whole process of EE development.

Figure 6. A dynamic model of environmental education adopted from Palmer (1998)



Another framework has been developed by the North American Association for Environmental Education, according to which EE should include seven categories: affect (or factors that allow individuals to reflect (and act) on environmental issues), ecological (or conceptual) and socio-political knowledge (which include understanding of political, cultural and social aspects of environmental issues), knowledge of environmental issues, cognitive skills (or ability to analyze, synthesize and evaluate facts and data), environmental responsible behaviors and its additional determinants (Volk and McBeth 1998).

1. 3. Environmental education in Washington State

According to Beverly Isenson, director of the `Governor's Council for Environmental Education`, the first environmental teaching in Washington State probably appeared in the early part

of the 20th century, at the time when the first Boy and Girl Scout troupes were created, and when the first YMCA programs were established (Isenson 2003). Many of these early programs focused on nature study, and on agricultural and outdoor education. Tony Angell, the first and only director of EE in Washington State, believes that in Washington State environmental education has been included in classroom instruction for more than 50 years (Bergeson *et al*. 2000). However, there is little documentation of the formal programs, and no comprehensive studies have been done to describe their EE focus, or the extend of the EE teaching.

Since the 1980s, EE has been mandated in every grade and in nearly every subject. This is a requirement of the state law adopted by the Washington State Legislature and the Washington State Board of Education (Washington Administrative Code – WAC 180-50-155), according to which "instruction about conservation, natural resources, and the environment shall be provided at all grade levels in an interdisciplinary manner through science, the social studies, the humanities, and other appropriate areas with the emphasis on solving the problems of human adaptation to the environment" (Arrasmith 1995, p. 1).

According to *Environmental education guidelines for Washington schools*, there are four goals for environmental education in the state. EE should help students

1. to develop knowledge about the environment and its components as well as understanding of interactions between them.
2. to develop understanding of the importance of social and natural systems "in supporting our physical lives, economy, and emotional well-being" (Bergeson *et al*. 2000, p. 22)
3. to understand the impact of personal decisions and actions on the environment; and
4. to develop knowledge and skills necessary to maintain and improve the environment.

Bergeson *et al*. (2000) believe that there are many opportunities for educational reform which would "engage students constructively in their environments." such as service learning projects, integrated curriculum, school site-management, and the usage of technology" (p. iii). Also,

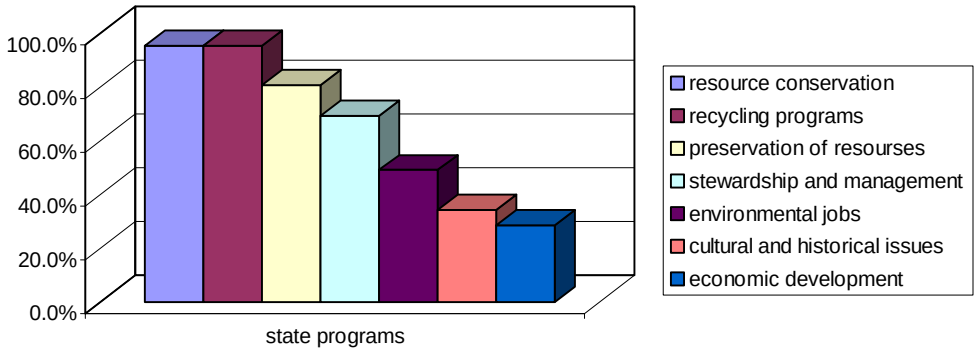
they argue that environmental education can become a tool for improving student achievement in other disciplines as well as strengthening their critical thinking and problem-solving skills.

According to the research conducted by the Northwest Regional Educational Laboratory in 1995, “less than 30 percent of the school districts in the state adopted specific policies for implementing environmental education, yet the majority of schools have environmental education included in their curriculum” (Arrasmith 1995, p.3). About 75 percent of Washington schools offer environmental education to 3rd-8th-grade students. Overall, in 1995 about 30% of students in the state were found to have been exposed to some kind of environmental education. Today according to the preliminary assessment conducted by the Washington Department of Fish and Wildlife, this number has increased. Today 53.4% of Washington schools are doing environmental education in at least one classroom (Tudor 2003).

The list of published environmental education curriculum guides that can be used in classrooms is extensive. Project WET (Water Education for Teachers), Project WILD, and Project Learning Tree are three nationally produced curricula that are very popular among WA teachers. Although these curricula have been developed nationally, they are readily adaptable to classroom applications of local natural habitat and issues.

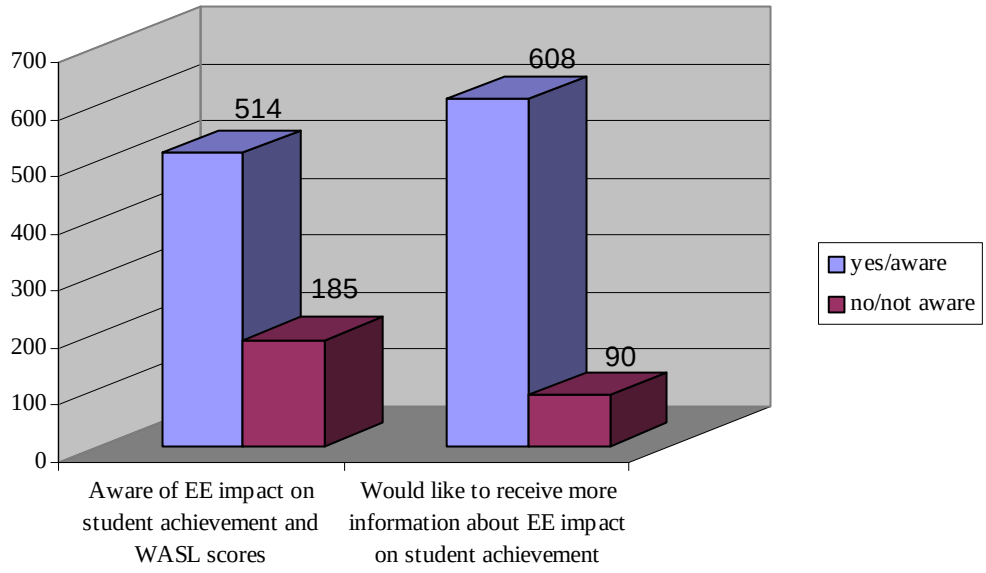
In general, 90.7% of K-12 local environmental programs in WA have science units and about 40% have social science and interdisciplinary units. As reported by Arrasmith (1995), the most popular topics are resource conservation and recycling (Figure 7). The least attention is given to economic development (28.7%) and environmental jobs (49.1%).

Figure 7. Distribution of environmental educational programs by context in Washington State (source: (Arrasmith 1995)



In 2001-2002 the Washington State Environmental Education Needs Assessment (WSEENA) was conducted by the Washington State Office of Environmental Education (WA OEE) at the Washington State Office of the Superintendent of Public Instruction (WA OSPI) to assess the status of EE in public schools in the state and to identify schools which need assistance in EE program development and implementation, as well as to determine the needs schools are facing (McWayne and Ellis 2003). The survey was sent to all 2,651 K-12 public schools in Washington State. Responses were received from 709 schools (27%). According to the survey, 23 percent of respondents are not aware of Washington State's EE Mandate (WAC 180-50-115), which requires environmental education to be taught in all subjects and grades. As shown on Figure 8 below, adopted from McWayne and Ellis (2003), 514 respondents (or 74%) said that they are aware that EE can be used as a tool for improving student achievement and either are currently using EE (40%) or would like to use it (34%) for this purpose. Also 87% mentioned that they would like to have more information about EE's impact on student learning. About half of surveyed teachers (or 47%) use environmental education to align their curriculum activities with state standards (Essential Academic Learning Requirements). According to the study, the most common use of environmental education in schools is to teach students about the natural world (91%) and to develop scientific knowledge and skills (80%) as well as to develop students' awareness of how actions affect the environment (85%) (McWayne and Ellis 2003). Only 45% of respondents mentioned that they use EE to develop student stewardship.

Figure 8. Awareness of EE impact on student achievements and need for more information around the state (adopted from McWayne and Ellis (2003))



However, although many schools in the state have some kind of environmental course, program or unit, over 60% of respondents stated that they do not have adequate resources to implement integrated education in their classroom (McWayne and Ellis 2003). In general, according to several studies, the main barriers to teaching environmental education in schools are lack of funding, lack of training and materials, and lack of time (Arrasmith 1995; McWayne and Ellis 2003). For example, about 55.6% of the respondents who participated in NREL's study[3], named lack of funding as one of the barriers for EE implementation (Arrasmith 1995). Also lack of in-service teacher training was seen as a barrier by 51.9 percent of survey participants.

Four years ago, the Washington Department of Fish and Wildlife and the Washington Forest Protection Association decided to combine their efforts in shaping EE in the state. As a result, in 1998 the Environmental Education Consortium (EEC) was created. Today it unites WA

[3] Northwest Regional Educational Laboratory

environmental educators, several state agencies, non-profit organizations and representatives of business community (Angell *et al.* 2001). One of the goals of the project is to integrate environmental education into school curricula. The EEC has developed a set of benchmarks that integrate existing academic standards into one coherent system using environmental education as a basis for integration. The benchmarks describe environment-based knowledge and skills that should be acquired by students at the 5^{th} grade, 8^{th} grade and 10-12^{th} grade level and align them with the Essential Academic Learning Requirements (state academic standards) in all subjects. The EEC also developed a package of WASL-like performance tasks based on integration of core knowledge and skills in language arts, history, civics, math, natural and social sciences, health and the arts providing scoring criteria for evaluating quality of student work. The members of this EE Consortium believe that their performance tasks based on EALR and EE benchmarks can be used to prepare students for the WASL tests, to improve their critical thinking, analytical, and inquiry skills as well as to assess knowledge and understanding of environmental concepts. Overall, the present thesis research was done as a part of the Environmental Education Assessment Project conducted by the EEC.

To conclude, although there are many terms and definitions of environmental education, they have a lot in common. All of them agree that it is necessary to develop knowledge, skills, positive attitudes toward the environment, and responsible behavior. We can use EE to develop knowledgeable and responsible citizens who understand the complexity of natural systems and interrelationships between the components of the environment, cultures and social entities, and are able to participate in solving environmental issues. Overall, the number of EE programs is growing. However, teachers who are motivated enough to respond to the surveys indicate clearly that they need more support and training to use environmental education on a more regular basis.

2. Review of research and approaches in Environmental Education

As a part of educational research in general, environmental education is affected by social and natural sciences and uses both "social" and "natural" methods. In the last 40 years the amount of EE research has varied from year to year, reflecting the changes in the interests of society in environmental problems. This chapter will review and analyze the approaches and research existing in the field of environmental education.

Wilson and Smith (1996) found that the number of environmental education articles in educational journals has *decreased*, compared to those of 20 years ago. The authors surveyed the Education Index, a cumulative index of educational publications to compare the number of EE publications over the 1970-1991 time period. According to the authors (Table 1), the number of publications in 1990-1991 was less than it was 20 years ago. Besides, only 7 educational journals out of 30 surveyed had articles addressed to any EE topic. On the basis of these findings the authors make a conclusion that EE is "far from being a priority in the schools" (p. 41).

Table 1 Education index search results comparing number of environmental education references over a 20-year span (adopted from Wilson and Smith (1996))

Date	No. of references
July 1970-June 1971	74
July 1980-June 1981	59
July 1990-June 1991	65

An opposite view is presented by the National Environmental Education & Training Program's (NEETF) report (2000), according to which the amount of EE research has *increased*

since the 1970s. The report presents supporting statistics from various research studies which show that the number of studies is growing constantly from year to year. For example, Roth (1976) identified 100 EE research studies from 1973-1976 whereas Iozzi (1981) reported 263 EE journal reports and 88 dissertations from 1970-1981. By 1990, about 500 articles and 700 dissertations had been published (NEETF 2000). One of the possible explanations is that these researchers focused on different periods of time. Wilson and Smith looked at three specific periods, each a year in length, whereas others analyzed research over longer periods of time. Also unlike Wilson and Smith who analyzed articles devoted to EE, Roth, Iozzi and others included dissertations and reports in their analyses.

2.1. Three research and teaching approaches in EE

Being a part of educational research in general, environmental educational research uses methods and models popular in this field. Robottom and Hart (1993) define three paradigms in environmental education, which influence the choice of research and teaching methods in environmental education. The first "positivist approach" to EE aims to develop knowledge "about the environment." In such learning processes teachers are the keepers of knowledge whereas students are passive recipients. The knowledge in this model is derived from experts and is for the most part objective, systematic and discipline-based. Educational research based on this approach is usually conducted by external experts. It is based on applied science methods and is instrumental, quantitative, individual and acontextual in nature. According to Robottom and Hart (1993, p. 29), this positivistic model uses an applied science approach to educational inquiry, "seeking to apply standards and methods of natural sciences to the problems of education."

The second "image" of environmental education is based on "an interpretivist model" (Robottom and Hart 1993). In it the purpose of education is to conduct activities "in the

environment", in which a teacher is an organizer of experiences and students are active learners. The source of knowledge is personal experience. The research based on this approach is constructivist and subjective in nature and is usually conducted by external experts. Unlike the positivist approach, interpretivist research takes into account the context of learning events and uses interpretivist qualitative research methods.

And finally, the third approach to environmental education, which is actively developing now, is the "critical approach". Environmental education based on this model aims to provide students with opportunities for action "for the environment", in which teachers are collaborative participants with students who are actively generating their own knowledge. Educational research based on this approach applies methods used in critical social sciences and is dialectical, qualitative and collaborative in nature. As in the previous model, it takes into account the context of the events. However, unlike the two other approaches, in this case research is conducted by internal participants.

Another researcher Tom Marcinkowski (1993) states, the great majority of research in environmental education uses natural and physical science methods of inquiry and is based on "logical" positivist views, which assume that social facts exist separately from individuals' beliefs. According to the research conducted by Roth (1976) (cited in Marcinkowski), most of environmental researchers use experimental-type studies in their works. In addition, about 90-92% of them were quantitative. As concluded by Marcinkowski (1993), the supporters of positivist approach see its power as "the extent to which it will allow one to predict, control, and/or explain the phenomena of interest." The "ultimate achievement of research is perceived as a situation in which it is possible fully to predict environmental behavior" agree Robottom and Hart (1993, p. 36).

Table 2. Summary of three paradigms in environmental education defined by Robottom and Hart (1993)

Model	Teaching	Learning	Research
Positivism	Authority-in-knowledge	Passive	Applied science Instrumental Quantitative Acontextual Objectivist Individualist
Interpretivism	Teacher - organizer of experiences in the environment	Active learners through environmental experiences	Interpretivist Constructivist Qualitative Contextual Subjectivist Individualist
Critical	Collaborative participants	Active generators of knowledge	Critical social science Reconstructivist Qualitative Contextual Dialectical Collaborative

Table 2 summarizes the description of three models in environmental education described by Robottom and Hart (1993). These models form the foundation for research and teaching approaches in this field. However, EE teaching/learning and research do not develop simultaneously. At the moment many EE practitioners see their role as organizing engaging activities in the environment for their students (interpretivist model in the table). These teachers try to provide students with hand-on experiences. Other teachers go further. They become collaborative participants of the learning process, allowing students to generate their knowledge and to self-reflect on their learning. On the other hand, most of the studies conducted in this filed are still for the most part quantitative, objective and acontextual. Thus, while teaching approaches in environmental education are evolving and maturing moving from the intepretivist model toward the critical model, approaches to research in EE have appeared to remain quite traditional.

2.2. Quantitative and qualitative methods

There appears to be a growing interest in qualitative methods of research in EE and in the field of education in general. The difference between quantitative and qualitative methods is discussed by many writers. According to Creswell (1994, (p.1-2)) (cited in Sogunro), quantitative research is "an inquiry into a social or human problems, based on testing a theory composed of variables, measured with numbers, and analyzed with statistical procedures, in order to determine whether the predictive generalizations of the theory hold true"; and qualitative research is "an inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting."

McMillan and Schumacher (1999), Marcinkowski (1993) and others state that the purposes of quantitative research can be divided into four categories: 1) to describe (using surveys, longitudinal and cross-sectional developmental studies, correlational studies); 2) to predict (using correlation and multiple correlation statistical analysis); 3) to control and 4) to explain (using experimental type designs). Table 3 below presents the synthesis of tables and discussions in Marsinkowski (1993) and Sogunro (2001) who compare quantitative and qualitative approaches.

Table 3. Comparative analysis of quantitative and qualitative approaches (sources: Marcinkowski (1993); Sogunro (2001))

Feature	Quantitative	Qualitative
Form of results	Numerical, statistical "hard" data	Narrative, description "soft" data
Origins	Derived from the natural and physical sciences and reflects the tradition of scientific inquiry	Derived from social sciences
Assumptions about the World	Social facts exists apart from individual's beliefs	Multiple realities constructed through social processes
Assumptions about Truth	Truth consists of observable and verifiable facts	There is no objective reality apart from the knower, truth consists of a complex value-laden observations and interpretations
Research purpose	Seeks to establish patterns, relationships between, and causes of social phenomena (description, prediction, explanation)	Seeks to establish understanding of social phenomena from participant perspective (exploration, description,

		grounded explanation)
Research methods and processes	A priory design of methods and research questions	Questions and design emerge or develop during study
Prototypical designs	Surveys, correlational and experimental design	Ethnographic, historic, and policy designs
Researcher's role	Detached Passive interaction	Active participation
Validity and reliability estimates	Are seen as characteristics of measurement devices. Estimates are obtained by known analysis procedures	Are seen as characteristics of the data themselves. Estimates obtained through triangulation and audit trails
Methods of data analysis	Parametric and non-parametric statistical tests	Content analysis
Impotence of research	Generalization of the results beyond the particular setting	Generalization which are specific to the particular setting of the study
Importance of theory	Theory building ad testing serve as it basic aims	If any attention is given to theorizing, it tends to emphasize the generation of grounded theory
Research variables	Small number	Larger number
Sample populations	Large population	Small population
Relationship	Distant and short term	Intense and long term
Research context	Controlled	Uncontrolled
Interpretation of information	Objective	Subjective
Nature of inquiry	Positivism	Interpretivism

The debate about the "right" methods for educational research has been going on for decades. There are supporters and defenders of both methods. However, as stated by Sogunro (2001), a researcher should know and be able to apply both methods. Sogunro used a mixed method of quantitative and qualitative tools in his study of the impact of the leadership training program on the participants. He emphasizes that "the usage of numbers and descriptions, which anchor both quantitative and qualitative research paradigms, are mutually complementary, and the strengths of both can produce a research synergy in which whole collective benefits are greater than obtained from either approach taken alone" (Sogunro 2001, p. 8-9). A similar view is presented by Firestone (1987), who states that qualitative and quantitative approaches have different descriptive strengths. "Used separately, qualitative and quantitative studies provide differing kinds of information. When focused upon the same issue, qualitative and quantitative studies can triangulate – that is use

differing methods to assess the robustness or stability of findings," believes Firestone (1987, p. 19-20). As Firestone (1987) continues, if the studies receive similar results using different methods, that means that the results are not affected by methodology. "In this case the two studies corroborate each other" (Firestone 1987, p. 20).

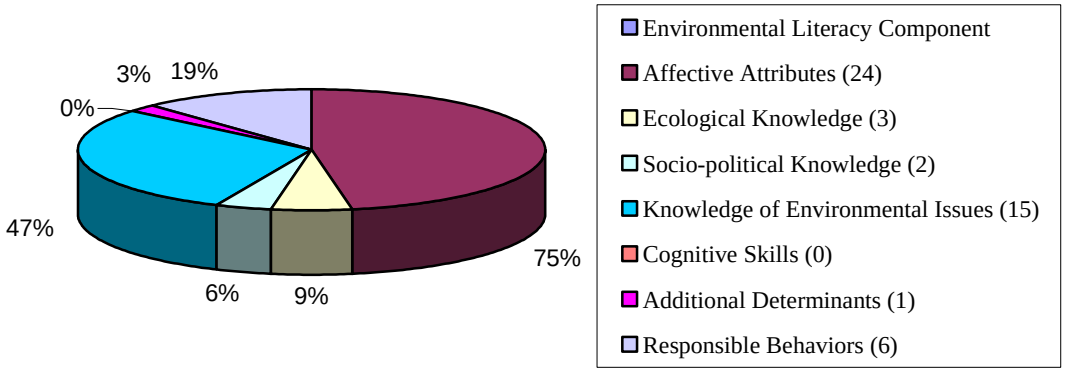
In general, as mentioned by many authors, there are many factors that affect the choice of a research method, such as the match between research purposes and methods, the researcher's training, availability of resources and information, accessibility to situations, data and sample populations, etc. All these factors should be analyzed in advance before designing and conducting a study.

2.3. What is being measured?

Volk and McBeth (1998) analyze what components of environmental education (or environmental literacy as they call it) have been researched recently. The authors use the framework developed by NAAEE's National Project for Excellence in Environmental Education, which consisted of seven components: affect, ecological knowledge, socio-political knowledge, knowledge of environmental issues, cognitive skills, additional determinants of environmental responsible behavior, and environmentally responsible behaviors. Figure 9, which was created using information in Volk and McBeth (1998), presents the number and percentage of studies that have measured each of the components named above. According to the figure, the amount of research attention is not evenly distributed. Most researchers study variables related to attitudes and environmental knowledge (75% and 47% respectively). Less then half of the studies selected by the authors, investigated environmentally responsible behavior (19%), socio-political (6%) and ecological knowledge (9%). Only 1 study looked at the additional determinants of environmentally responsible behavior and none of the studies focused on cognitive skills developments.

For my literature review besides books and monographs, I selected about 50 articles from peer-reviewed educational journals. The results of the analysis are similar to those presented by Volk and McBeth (1998). Most of the research examines knowledge, attitudes or responsible behavior or relationships between these components. Few articles discuss needs for EE, various definitions of environmental education used in this field, biographies of famous environmental educators, or opinions of EE practitioners and researchers. And only a few articles look at the impact of environmental education on student achievement.

Figure 9. Number and percentage of studies that assessed environmental literacy components (source: Volk and McBeth (1998))



2.3.1. Research to measure knowledge component

In the last decade many researchers have focused on measuring environmental knowledge of various populations. According to the articles surveyed, most of these studies show predominantly low levels of knowledge among populations studied (Gigliotti 1990; Hausbeck *et al.* 1992; Kuhlemeier *et al.* 1999; Lawrenz 1983; Wright and Floyd 1992, etc.). Blum (1987) analyzed the results of the survey of environmental knowledge and attitudes in the United States, England, Israel and Australia

and came to the conclusion that the 9th and 10th grade students in all four countries have low environmental knowledge.

Brody (1996) assessed the 4th-, 8th-, and 11th-grade students' science knowledge related to Oregon's marine resources. According to the study, the students tested showed understanding of concepts such as geological structure and process, energy, nutrients and food webs. However, students' "understanding of physical and chemical characteristics, process and effects did not progress beyond the early grade level" (p. 25). Also students showed little understanding or misunderstanding of concepts related to weather and climate. The author believes that it is necessary to conduct more research on misconceptions related to environmental science.

Gambro and Switzky (1996) examined data from the Longitudinal Study of American Youth (LSAY) conducted and described by Miller *et al.* (1991). The study was designed to assess the development of math and science attitudes and achievement of middle and high school students. According to the research, most of the students tested understood basic concepts underlying environmental issues. However, a majority of participants were not able to apply their knowledge or to suggest possible solutions or explain the consequences of the issues. Also, the authors found a very little increase in environmental knowledge in the period from 10th to 12th grade. Gambro and Switzky (1996) believe that it is necessary to develop critical thinking of students and to use students' concerns as a source of motivation. "The interdisciplinary nature of environmental problems provides an ideal opportunity for meaningful, integrated, and problem-oriented instruction," conclude the authors. Obviously, it is the complex nature of environmental problems that allows the integration of different subjects, skills and knowledge and, as a result, stimulates critical thinking and inquiry skills. Its complexity does not allow the usage of the same "standardized" or conventional pedagogical approaches. In this kind of complex teaching, questions do not have a "standard" answer. They demand that learners apply their imagination, curiosity, creativeness, thinking and knowledge.

On the other hand, many researchers found changes in environmental knowledge of students who have attended environmental and/or outdoor programs or courses. Thus, Lindemann-Matthies (2002) report an increase in students' knowledge after participation in EE programs. Gillett *et al.* (1991) also found changes in self-concept and environmental knowledge of teenagers who participated in a hiking program. Alvarez *et al.* (2002) state that students who were taught using an "experimental approach" which allowed them to investigate and research an issue, showed significantly higher environmental knowledge and attitudes compared to students exposed to traditional curriculum and teaching methods. The authors believe that this methodology should become a part of teacher training programs in EE.

At the same time, some researchers believe that there is a strong correlation between environmental knowledge and positive environmental attitudes. As reported by Bradley *et al.* (1999), Jordan *et al.* (1986), and other researchers, students who had attended environmental programs showed increased environmental behavior and awareness about environmental issues as well as their environmental knowledge. According to Bradley *et al.* (1999), student knowledge and attitudes increased by 22% and 2% respectively after participation in an environmental science course. Also the authors found a statistically significant correlation between these two components. According to the article, students with higher scores on the knowledge test had higher environmental attitudes. As concluded by the authors, "increased knowledge may help improve environmental attitudes", and this fact should be taken into account by educators. Similar results are reported by Mangas and Martinez (1997) who found significant changes in students' attitudes and their knowledge and understanding of environmental concepts after participating in a year-long environmental education course. Hsu and Roth (1996) who studied the development of environmental knowledge and attitudes of community leaders, believe that because there was a correlation between environmental knowledge and attitudes, "the development of the cognitive

domain of environmental education might be an effective means of promoting positive environmental attitudes" (p. 30).

Unlike the authors presented above, Border and Schettino (1979) state that an increase of positive attitudes toward the environment does not cause an increase of knowledge, and conversely, an increase of environmental knowledge does not always lead to greater environmental concern. According to the authors, it is the combination of these two factors that produces an environmentally responsible action of an individual.

Zimmermann (1996a) also studied the relationships between environmental knowledge and attitudes. According to this researcher, most previous studies in this area investigated how EE changes knowledge or attitudes toward the environment, analyzing these two components as separate factors. However, Zimmermann argues, "given that both knowledge and affect are necessary for active participation in environmental concerns, more research is needed to determine how existing attitudes influence knowledge acquisition and now knowledge influences attitudes" and to investigate the relationships between these two components (p. 42).

Ballantyne and Packer (1996) state that recently EE teaching and research have been focused on the attitude/value component, whereas knowledge and behavior areas seemed less important. A similar idea was expressed by Iozzi (1984) who mentions that environmental education emphasizes the affective rather that the cognitive domain. Ballantyne and Packer (1996) believe that "an approach that addresses attitude/values in isolation is no more effective…" and does not correct misconceptions in environmental knowledge. The authors propose a constructivist approach to improve EE as more successful for "achieving the goal of developing environmentally literate citizens as it supports the teaching of environmental knowledge, attitudes/values, and behavior in an integrated manner" (p. 33). Similarly, Corcoran and Sievers (1994) believe that "to realize its potential, environmental education needs to be reconceived – expanded by deep ecology, informed

by the perspectives of conservation biology, put in context through bioregionalism, enriched through ecofeminism, and critiqued through socially critical analysis" (p. 9).

2.3.2. Studies to measure behavior

Most environmental psychologists and educators believe that environmental education is linked to environmental behavior (Palmer 1996, 1997, 1998, 1999; Tilbury 1994; Wilson 1996, etc.). A major assumption here is that education leads to greater awareness and attitude change that ultimately improves environmental behavior. Thus, these researchers believe that the primary goal of EE should be to encourage people to engage in more pro-environmental behaviors.

The process of the development of a positive attitude towards the environment and environmental behavior is a major focus of both American and European researchers (e.g. Disinger 1982; Eagles and Demare 1999; Kamaneva *et al.* 1991; Lysenko 1993; Marcinkowski 1987; Nikolaeva 1992, 1993; Sia 1984; Tilbury1994; Uzzel 1999; Wilson 1996; Zelezny 1999, etc.). These authors emphasize that the development of EE is a continuing process that takes place during the whole life of an individual. But the starting point for it is the earliest stage of the formation of personality when environmental values and a positive attitude towards environment are built. Wilson (1996) identifies two main reasons for beginning EE during the early years of a child's life. Her premises focus on the conservation of nature and the healthy development of a child. The first reason is that if a child does not develop a sense of responsibility, respect and positive attitude towards nature during his/her childhood, he is liable not to form such attitudes later in life. The idea of existence of critical periods for the development of environmental attitudes and values is supported by Stapp (1978), and Tilbury (1994). They emphasized that if a child develops a negative attitude towards the environment, it is hard to change such an attitude later. A second reason for beginning environmental education in the early years is that a child needs healthy positive

interactions with the natural environment (Carson 1956; Wilson 1996). A child uses the environment as a source of wonder, joy, and knowledge (Nikolaeva 1992, 1993; Sobel 1993, 1998). Sobel (1993, p. 52) believes that childhood is a "critical period in the development of the self and in the individual's relationship to the natural world." Small children tend to construct "special places" and investigate their world starting from their neighborhoods and expanding the area of their interest later. By doing this they explore the world around them and their place in it. Thus, environmental education in the early years should focus primarily on young children exploring and enjoying the world of nature under the guidance of adults (Lysenko 1993; Sobel 1991, 1998; Vygotskiy 1991).

As stated above, many researchers believe that environmental education leads not only to increased awareness but also to improved environmental behavior (Disinger 1982; Marcinkowski 1987; Sia 1984; Zelezny 1999). According to Disinger (1982), environmental education in non-traditional non-formal settings is expected to be more effective than traditional classroom programs in changing environmental behavior. Zelezny (1999), who presents the analysis of 22 studies on educational interventions, also agrees that EE could improve environmental behavior. However, unlike Disinger (1982), the author states that interventions in non-traditional settings (such as outdoor camps, etc.) are less effective because of the short-term nature of most visits, and the fact that many visitors are adults, whose behavior is less easy to influence or change. According to the researcher, programs that target young learners and are longer in duration tend to be more effective in changing environmental behavior of the participants.

Many researchers believe that responsible behavior is connected to personal experiences in the environment and participation in environmental activities outside the classroom (Dresner and Gill, 1994; Jordan *et al*., 1986). Howe and Disinger (1988) state that in order to develop responsible behavior of students, the EE programs should provide investigation and analysis experiences as well as an opportunity to work on real environmental issues. Also, as mentioned by the authors, programs and projects that include long-term activities usually are more successful in developing positive

environmental behavior than short-term activities. Culen and Volk (2000) come to a similar conclusion and suggest using investigation-evaluation and an "action training" model. Ballantyne *et al*. (2001) who studied two EE programs and their impact on students, teachers and parents, concludes that the programs that provided an enjoyable experience for students affected student learning and changed their behavior.

2.3.3. Research to measure attitudes

As stated by many researchers, environmental education programs help to develop positive attitudes toward the environment (Dettman-Easler and Pease 1999; Knapp and Poff 2001, Zimmermann 1996b). Dettman-Easler and Pease (1999) evaluated six residential programs and came to the conclusion that students' positive attitudes toward wildlife increased after their participation in the programs. The authors assume that there are other important factors besides program content that affect students' attitudes. In addition, the article recommends that classroom work be more closely integrated with residential programs and that the number of pre-, during-, and post-visit activities be increased.

On the other hand, Gillett *et al.* (1991) reported that although there were changes in self-concept and environmental knowledge of teenagers who participated in a hiking program, no changes in environmental attitudes of the students took place. Similarly, Eagles and Demare (1999), who observed students who participated in a week-long program in a residential camp, did not find any significant changes in environmental attitudes of the participants. As authors conclude, environmental attitudes are created over a long period of time, so the week–long period is not enough to increase existing environmental attitudes significantly.

Musser and Diamond (1999) developed and described an "age-appropriate scale" for measuring environmental attitudes of pre-school children. According to the authors, although many

kindergartens and pre-school programs provide different types of environmental activities, no instrument for measuring young children's environmental attitudes had been developed. So theirs was the first. They found a correlation between children's attitudes and their participation in different environmental activities. Also children's attitudes seemed to be influenced when children observe their parents' participation in such activities. The authors believe that the family and school are very important environments in which young children learn about behavior patterns and develop attitudes appropriate for the culture and environment they live in.

2.3.4. Research instruments: surveys and questionnaires

Many researchers have used tests and questionnaires in their work in order to measure different components of environmental education (Alekseev 1998; Bunting and Cousins 1983; Eagles and Demare 1999; McKechnie 1971, 1977; Musser and Diamond (1999); Palmer 1996, 1999; Palmer *et al.* 1999; Pustovit and Plechova 1995; Subbotina 2000; Zimmermann 1996). Most of the tests (Bunting and Cousins 1983; McKechnie 1971, 1977; Zimmermann 1996b, etc) have been used for measuring people's attitudes towards the environment and environmental values. For example, McKechnie (1971, 1977) has developed a test named the Environmental Response Inventory (ERI) to study people's interaction with their environment. Bunting and Cousins (1983), using the ERI as a basis, have developed the Children's Environmental Response Inventory to study children's attitudes toward the environment. Both tests were multiple-choice test with the 5-point answer scale ("Likert scale"), ranging from "agree very strongly" to "disagree very strongly". The neutral answer is "don't know, can't say". Later Zimmermann (1996b) developed a short form of the CERI to assess environmental values and attitudes in adults and children. The test measures values related to conservation, pollution, and urban/natural environments. It consists of 31 questions and has the same answer scale (five options). Schindler (1999) created the Survey of Environmental Issue

Attitudes to measure environmental attitudes among college students. In addition, the survey measures ecological knowledge, behavior changes, and demographics.

Besides tests for measuring environmental attitudes and skills, many tests have been developed for assessing knowledge (e.g. Alekseev 1998; Palmer 1996, 1999; Pustovit and Plechova 1995, etc.). The number of questions and the levels of difficulty are highly variable. At the same time, most of them are multiple-choice tests (MCT), i.e. they ask the respondent to choose one answer out of several given. However, such types of tests are unable to capture the complexity and richness of students' thinking, the depth of his/or her knowledge. So it is very unlikely that they present *real,* complex assessment of student understanding and performance. On the other hand, these tests are easier to administer and score and require less time and financial resources.

Overall, it can be stated that although there are many research efforts in which tests or questionnaires have been introduced, environmental researchers and educators traditionally focus on measuring such components as attitudes towards the environment, level of environmental knowledge and environmental behavior that results from environmental programs. Fewer instruments have been developed to measure environmental skills. The reason for this is, probably, the difficulty of measuring practical or physical skills through a survey or a paper test.

In general, most of the research presents statistical analysis of the findings. However, many authors agree that all components of environmental education are very complex in nature and involve the "human" dimension. The development of knowledge, skills, values, responsible behavior and other EE components are affected by many external factors, such social status of the families, parents attitudes, education and knowledge, living environment, reinforcement from friends, family and community, culture and traditions, etc. Thus, there are many interactions and correlations between these various components and not all of them have been studied. In many cases, it is difficult to capture the whole range of complex interactions through statistical functions. I believe that qualitative studies would be more appropriate and effective in EE because they would

provide more in-depth descriptive analysis of the living and learning environments in which EE components are developed. These qualitative descriptions could be combined with statistical results for a more complex and nuanced interpretation of the research findings. Overall, like Firestone (1987), Sogunro (2001) and others, I believe that EE researchers should use a combination of both research methods in order to obtain more diverse information and to allow more in-depth interpretation of the results.

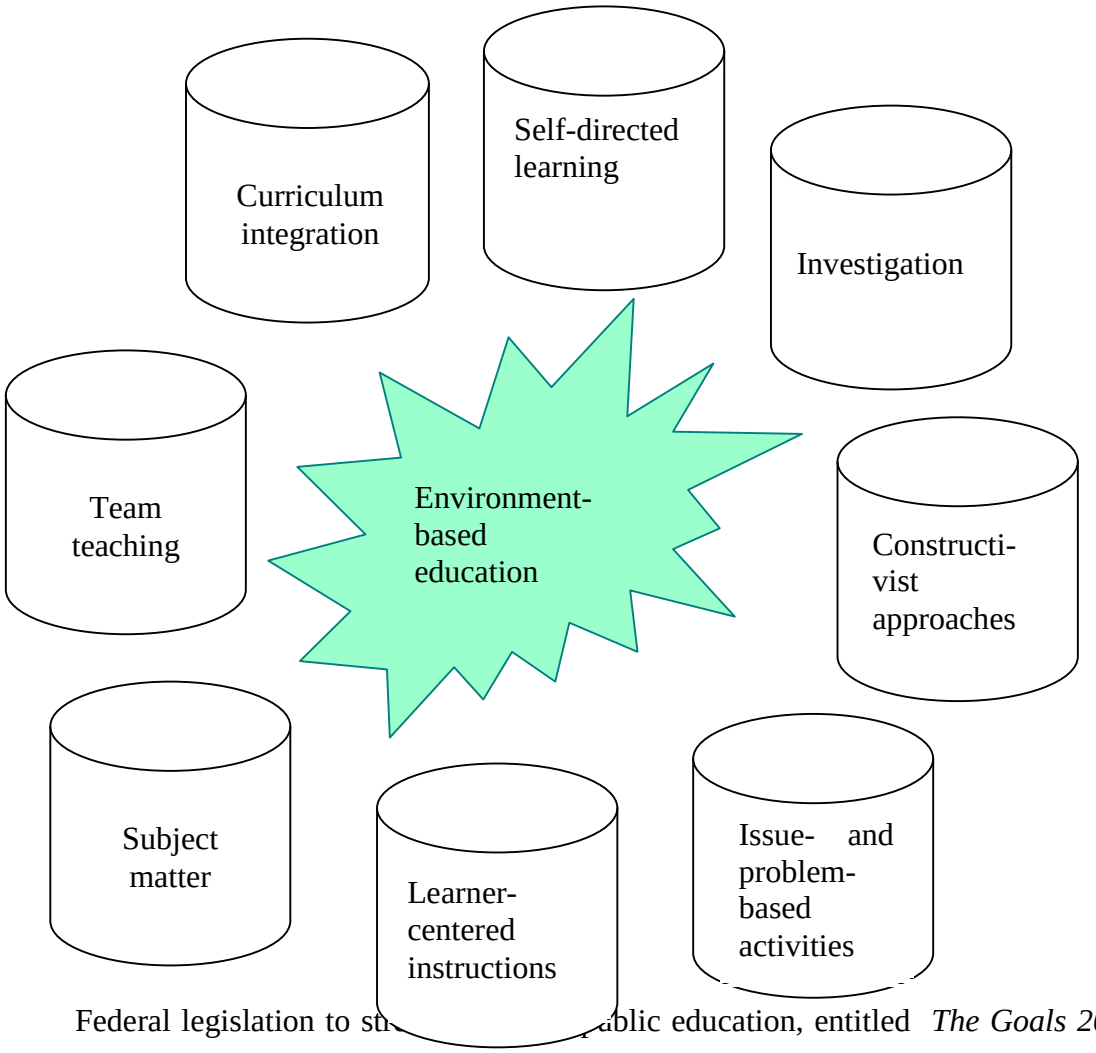
2.4. Rational for environment-based education

In recent decades more and more educators and researchers have started to speak about integrating environmental education into all subjects and grades rather than teaching it as a separate discipline. Moreover, many of them see EE as a *curriculum integrator*, an environment in which deeper learning could take place. Several terms such as "integrated environmental education", "environment-based education", "environment as the integrating context for learning" are widely used in the literature (Angell *et al.* 2001; Lieberman *et al.* 2000; Lieberman and Hoody 1998, NAAEE & NEETF 2001, etc.)

NAAEE & NEETF (2001) explicitly state that there is a difference between *environmental education* and *environment-based education*. While *EE* aims to develop environmental knowledge and skills that an individual could use for solving environmental issues, *environment-based education* "uses a popular subject matter [the environment] to improve students' learning skills and create a wider learning context for students, teachers, and the community." This idea can be found in the philosophy of outdoor education which suggested to "teach in the outdoors what can best be taught in the outdoors" (MacGregor 2003). As seen from Figure 10, environment-based education integrates subject matter, issue-, and problem-based projects and activities, self-directed learning, learner-centered instruction, constructivist approaches and team-teaching, and problem

investigation. Similarly, according to Liberman and Hoody (1998), *environment as the integrating context for learning* is an approach that combines natural, social and cultural environments and aims to develop critical thinking, investigation, analytical and decision-making skills in students and to help them to construct a coherent system of knowledge rather than to develop environmental knowledge and attitudes alone. Its aim is to create a framework within which students can construct their knowledge and integrate and apply information received in the classroom.

Figure 10 Components of environment-based education



Federal legislation to st[illegible]ublic education, entitled *The Goals 2000*, set goals to create a student population that is ready to learn, to develop measurable benchmarks for student achievement and active citizenship, to educate literate adults and lifelong learners, to increase

parents' participation in the school activities, and to create a safe and disciplined school environment (NEETF 2000). As argued by NEETF (2000), Monroe *et al.* (2002), WDFW (1999), environment-based education can provide opportunities to fulfill these goals.

Educators today generally agree that an increase in student achievement and cognitive development takes place when students are motivated and interested in what they are doing, see the connections between subjects, and issues and have an opportunity to work collaboratively on solving real-life problems (NEETF 2000). The proponents of environment-based education believe that it does exactly this. It gives opportunities for integrated learning. It develops decision-making, critical-thinking and problem-solving skills. It uses issue-based projects and activities (Howe and Warren 1989; NEETF 2000, Monroe *et al.* 2002, Lieberman and Hoody 1998). This line of reasoning is largely corroborated by the major report *How People Learn* (Bransford *et al*. 1999), published by the National Research Council in 1999. By developing investigation, teamwork, problem-solving, critical thinking and communication skills, environment-based education also helps to prepare students for professional work (NAAEE & NEETF, 2001).

2.5. Efficacy of environmental education

While analyzing recent articles from the *Journal of Environmental Education* and several online databases, I have found only a few articles and reports that discuss the impact of environmental education on student achievement in traditional school subjects and on standardized school tests. Hoody (1995) reached a similar conclusion, stating, that she could not locate any "compelling research …that measured the effectiveness of interdisciplinary EE methods" (p. 14). According to the literature, there are several explanations for the lack of research on EE efficacy, such as lack of funding for EE programs and research and planning time for evaluation; lack of examples because

of a poor research base; the difficulty of assessing and evaluating students' problem-solving, decision-making, critical thinking and analytical abilities through traditional assessment methods (such as multiple-choice tests) (Hoody 1995). Hoody believes that "until the educational systems are restructured to incorporate learning modeled by EE methods (e.g., critical thinking, problem-solving, hands-on activities and use of relevant subject matter), evaluation of its effectiveness can't take place" (p. 18-19).

One study that has attempted to investigate the efficacy of environmental education in increasing school learning was conducted by the State Education and Environmental Roundtable (Lieberman and Hoody 1998). The report *Closing the achievement gap: using the environment as an integrating context for learning* presents the analysis of student achievement at 40 schools across the United States that adopted environment-based programs, also called EIC ("Environment as Integrating Context") schools. The research conducted by the SEER group claims that the students learn more effectively within an environment-based context than within a traditional educational framework. These students demonstrate better performance on the standardized tests in reading, math, writing, science, and social studies. For example, in Tahoma High School (Maple Valley, WA) 11^{th} grade students who had been in the EIC program averaged 4.8 percent higher scores on Curriculum Frameworks Assessment System (CFAS) in language, 1.7 percent higher scores in writing, and 4.4 percent higher in social studies compared to the students who did not participate in the program. In Bagley Elementary (Seattle, WA) the average reading and language scores on Iowa Test of Basic Skills (ITBS) rose from 46 to 52 and from 43 to 53 respectively. According to 98 percent of teachers who use EIC methodology, the students showed increased engagement, enthusiasm, and interest in math, science and other subjects if they were a part of an integrated EE program (Lieberman and Hoody 1998). The authors argue that removing the boundaries between subjects enabled these students to tie together disciplinary knowledge they received in the classroom. Also students who participated in the EIC programs showed an increased ability to think

critically, stronger communication and collaborative skills, and greater pride and ownership in accomplishments.

According to the report, SEER's researchers used 8 criteria for EIC schools selection. First, the whole school should have implemented the EIC concept or at least have one EIC program in its curriculum with at least 2 classes involved and lasting for a majority of the school year. The length of such a program was to be at least 2 years. Also, teachers should have worked in teams to integrate at least three subjects around the environmental topic or theme. And finally, students should have been involved in problem-solving activities and projects, constructing their own knowledge.

Overall, it should be stated that SEER's methodology used in both studies is superficial at best. Although the report provides comparisons of EIC schools (or classes in some cases) and schools with traditional curricula, there is no information about the comparison schools or groups of students. EIC schools are situated in different states with huge variations in curricula. Furthermore, there is no description of the initial learning and teaching environments of the schools (teachers' background, amount of funding and training the schools received from state organizations or districts *and* from SEER's staff, the overall level of the participating schools compared to other schools in the same location, etc.) In addition, although the SEER's team gathered data through teacher, administrator and student surveys, the report does not provide the items on the surveys. Also it is not clear what methods of analysis the group used to analyze the data.

In some cases the report presents the comparison of EIC and non-EIC schools' test scores. However, there is no information about the statistical analysis of this data or whether the difference between schools was statistically significant (probably, because no statistical analysis of this kind was done. Finally, for some schools/or subjects the report presents a kind of longitudinal analysis, showing that the test scores for EIC schools have improved over the years (usually 2-3 years). However, there is no information about other schools in the same location and changes in their test scores. In my opinion, the changes in the test scores could have been caused not only by EIC

programs but by changes in the state or district policies and regulations or increased or decreased amount of teacher training. So such facts presented alone without supporting information cannot be considered strong evidence of EIC impact on student learning. Overall, I think that this widely circulated report presents anecdotal "success stories" rather than research data based on sound theoretical and statistical foundations and/or qualitative analysis.

Another study conducted by SEER presents the analysis of student achievement in 11 "environmental schools" or "EIC schools" in California. The study compares student achievement between "EE schools" and "control schools" with a traditional curriculum. According to Lieberman *et al.* (2000), EIC students showed higher results in 101 (72%) out of 140 academic assessments in language arts, math, science and social science.

Like the first SEER's report, the methodology of this study has some deficiencies. As stated in the report, the pairs of schools were selected using demographic criteria such as attendance rates, ethnicity percentage, percentage of students who receive free or reduced lunch, etc.). On the other hand, it not clear how the EIC schools were selected in the first place. Also according to the report, students who participated in the EIC program were matched with students in non-EIC courses or program. However, there is no information about how this was done. Finally, although the study seems to compare test scores of EIC and non-EIC students, no information about any statistical analysis is presented. The report claims that the EIC schools scored a certain percentage higher than their comparison schools, however, there is no evidence that this difference is significant.

Another study conducted by Randall (cited in Monroe *et al.* 2002), shows that if environmental education lessons are designed to meet state curriculum goals, they can improve student achievement (test scores in particular). According to Randall (2001), students who participated in a biodiversity program that focused on development of l biology knowledge and writing skills, showed a significant increase in writing test scores. "When teachers perceive environmental education as an "extra", environmental activities will be easily discarded in favor of

increasing student knowledge and performance for state tests. When environmental education lessons are developed for state curriculum standards, they will be acknowledged as supporting student achievement in dimensions that educators recognize, such as performance tests, attendance, and interest", Monroe *et al.* (2002) conclude. However, it is not clear how comprehensive this study was.

The National Environmental Education and Training Foundation's report *Environment-based education: creating high performance schools and students*, supports the idea that environment-based education can improve student learning. According to the case studies presented in the report, student achievement in reading, math, science and social science tend to improve due to the environment-based programs (NEETF 2000). Students in the schools with environment-based curriculum appear to develop the ability to transfer knowledge they receive in class to unfamiliar contexts. And, finally, the teachers reported a decrease in behavioral problems in EE classes. The report recommends conducting further research on the efficacy of environmental education, and the development of environment-based programs that show how EE can become a tool for improving students' skills and achievement.

The Washington Environmental Education Model Schools Program, started in 1993 by OSPI is one of the most cited and studied EE programs in Washington State. Its aim was to create effective K-12 environmental education programs at 18 different schools using an interdisciplinary, community-based approach. Billings *et al.* (1996) report that environmental behaviors of students participated in EE programs increased by 38 percent. Also students became more environmentally interested and engaged. Teachers who participated in the study commented that environmental education programs made learning more interesting and relevant for students. The program decreased behavioral and attendance problems and improved students' environmental knowledge and attitudes.

Another OSPI project, called Model Links, continued the Washington Environmental Education Model Schools Program. It was designed to improve their teaching and learning environment and to continue integration of school curriculum through environmental education. EE was seen as a tool for the implementation of state standards (such as Essential Academic Learning Requirements in math, writing, reading, communications, etc.) Yap (1998) conducted a summative study to investigate impact of the project on student achievement in reading, writing and communication. The study included an analysis of the test results on several state tests such as Comprehensive Test of Basic Skills and the analysis of the surveys given to teachers and administrators of the schools. According to the report, although the number of years schools participated in the Model Links project varied from one year to three years, all participating schools reported a high level of EE implementation through thematic activities correlated with state standards. However, the study did not find any significant differences in student achievement between EE and comparison schools. As stated by Yap (1998), students from both EE and comparison schools had scores near or above the national norms on CTBS. On the other hand, there was a correlation between student achievement and the level of EE implementation. Schools with higher levels of implementation of their environment-based programs had higher results on the standardized tests.

According to another report on Model Links Schools conducted by the Washington Department of Fish and Wildlife (1999), implementing EE improved staff relations in schools; and increased teachers' and students' engagement. Also it increased teachers' professionalism and strengthened schools' relationships with parents and communities. Several schools reported improved test scores due to participation in the Model Links program. As mentioned in the report, students' thinking skills improved as well. Teachers cited attributed these improvements to providing students with "more meaningful and experiential learning opportunities" which helped them "to construct their own meaning in new curriculum frameworks" (WDFW 1999, p. 16-17).

2.6. Limitations of existing research

After analyzing articles and reports from the various sources, it is possible to state that there are several limitations in the existing EE research. The most common are weak methodology, small groups in the studies and lack of theoretical foundations and valid research instruments. For example, most of the research uses schools' test information as an indicator of student achievement. Usually the researchers compare the results on state standardized tests such as ITBS, CTBS, etc. However, I could not find any research that studied the applicability of these multiple choice test results to demonstration of student learning progress in the classrooms. Although, as mentioned by NEETF (2000, p. 47), "test scores are the most universal and quantifiable tool we have to measure learning", different states use different tests aligned with different state standards, so it is difficult to compare the results of the studies from different states. And, finally, many variables such as the amount of teacher professional development, the degree of engagement of teachers in EE work, the extent of reinforcement and support by EE consultants and school and district administrations, etc. are difficult to control. In most cases these variables have complex dynamic nature. They interact with one another as well as with many other external components of the living, teaching and learning environments. Thus, in many cases researchers can only infer that correlations seem to exist between the components of the research and cannot claim the cause-effect relationships between them.

As stated in the NEETF report (2000), "to date, most of the research on the connections between environmental education and academic achievement has been qualitative and/or anecdotal" (p. 45). Many of the existing research cannot be called "scientific" because of the research methodologies, selection of control groups, etc. The authors of the report believe that it is necessary to conduct more "quantitative studies to prove the efficacy of environmental education" (p. 45).

As argued by Hoody (1995) and others, most EE research articles do not conduct follow-up studies to evaluate long-term effects of EE programs. In most cases the studies measure the state of variables immediately after the program (or ”intervention”). Many research studies were conducted on very small sample sizes (a single class or even 5-10 students). Some of them present poorly designed studies and use invalid and/or unreliable instruments and provide inconclusive results. A similar conclusion was reached by Lewis (1981-83, cited in Hoody 1995), who agued that “a majority of the reports had instruments of questionable validity and lacked sufficient methodological detail” (p. 13). Like Lewis, Leeming *et al.* (1993) comment on weak research designs and invalid research instruments. The authors mention that very often it is the designers of the EE programs and materials who create instruments to assess the efficacy of the course/or material. This raises questions about the validity and credibility of these studies, Leeming *et al.* (1993) argue. Also, many of the practitioners who designed instruments for program assessment did not have experience or training in the development of assessment instruments (Hoody 1995; Leeming *et al.* 1993, etc.). This leads us to the conclusion that EE research in general needs to develop a much more sound theoretical and methodological base.

Overall, although there are many research studies in the field of environmental education, most of them focus on the development of environmental knowledge, attitudes and behavior, and the relationships between them. A few studies investigate the impact of environmental education on student achievement in the traditional school subjects and most of them are anecdotal in nature. They do not have a sound theoretical base and, in most cases, present a set of “success” stories rather than a thorough quantitative or qualitative analysis of the findings. All this leads me to the conclusion that there is a need for more in-depth quantitative and qualitative studies to prove the efficacy of environmental education and its positive impact on student achievement.

3. Factors influencing student achievement

Improvement of student achievement has always been one of the main goals of education. In past decades researchers and educators have conducted many studies and experiments to determine the factors that affect (positively or negatively) student achievement. Many factors have been identified and the relationship between them is very complex and dynamic. Some researchers believe that student characteristics, their living and learning environments and instruction activities contribute to student achievement (House 2002, etc.). NEETF (2000) divides factors that influence learning outcomes into five categories:

1. external (such as gender, race, parents' educational background, etc.),
2. internal,
3. social,
4. curricular and
5. administrative.

Table 4 summarizes the findings of Brown (1999), Garton *et al.* (1999), Harris and Mercier (2000), Hitz and Scanlon (2001), House (2002), Howley (1989), Howley *et al.* (2000), Klavas (1994), Klein and Merritt (1994), Kozioff *et al.* (2000/2001), Lieberman and Hoody (1998), Lord (1999), NEETF (2000), NAAEE & NEETF (2001), Papanastasiou (2002), Patrick (1991), Peterson (1989), Rainer and Guyton (1999), Schacter (1999), Thomas *et al.* (2000) and others. The table presents factors listed in NEETF's report as a basis (NEETF 2000), with additional factors mentioned in other research.

Table 4. Summary of factors that influence achievement

	Positively	Negatively
External	• Male gender;	• Female gender;

	• Member of Caucasian race; Asian immigrant; • Average or above-average income; • High expectations of teachers and parents • Parent education • Good, safe neighborhood • Reinforcement • Small school size • Less TV viewing • "maintstreaming" students, i.e. putting students with different abilities together	• Member of minority race; • Under- or uneducated parents; • Poverty; • Tracking/ability group (divide students by their abilities • Unsafe neighborhood • Large school size • More TV viewing
Internal	• Motivation • Self-reflection	• Motivation (lack)
Social	• Ability to connect with teacher and fellow students (smaller learning communities)	• Poor or remote relationship with teacher (larger or "anonymous" learning communities)
Curricular	• Matching teaching style to learning style; • Engaging material; engaged teachers and learners; • Student choice in curriculum; • Collaborative/cooperative learning; • Participation in group discussions at school and home; • Peer interaction; • Demanding subject matter; • Problem-based learning; • Issue-based and/or project based real-world instructional activities; • Teaching for connections • Using environment as an integrated context • Parents and community involvement in educational process • Use of technology and other	• Using same teaching style for all students; • Unengaged teachers • Teacher-centered curriculum; • Irrelevant curriculum • Traditional teaching methods such as lectures • Subject matter that is too easy • Lack of resources • Less time spent on homework

	multiple resources, computer-based instructions • Active learning • Authentic assessment • Student-centered curriculum • Constructivist teaching approach • Integrated curriculum • Much time spent on homework assignment	
Administrative	• Common vision • Implementation of comprehensive reform programs • Teacher empowerment • Access to assistance, in-service training, and resources • Continuous quality improvement of teaching and learning • Good supportive school climate	• Lack of focus; • Lack of administrative support or attention to enhancing teacher quality/competence

Patrick (1991) found that "achievement has been associated with the following factors: high educational attainment of parents, a home environment where reading and discussions of ideas are valued, limited television, significant amounts of time spent on homework assignments, and stable family structure" (p.2). The author believes that student achievement is positively influenced by

- challenging subject matter;
- in-depth investigations of topics;
- discovery of alternative solutions to the problems;
- active learning and thinking;
- multiple resources and media for teaching and learning;
- use of technology;
- high expectation of student performance;

- a safe school climate; and
- authentic on-going assessment.

Many other researchers also believe that students learn best when they have an opportunity to discover and investigate (House 2002; NAAEE & NEETF 2001; WDFD 1999, etc.) as well as to make connections between their studies and real life (Krynock and Robb 1999).

Klavas (1994), Thomas *et al.* (2000) and others found that students show better achievement when teachers take into account students' varied learning styles. When teachers offer varied learning environments, students are more motivated, interested and engaged. Rainer and Guyton (1999) found that students have better attitudes towards learning when they have an opportunity to make their own choices. The opposite results are reported by Garton *et al.* (1999) who analyzed the learning style of 187 science students and 4 instructors and came to conclusion that there was no significant correlation between student achievement and learning style.

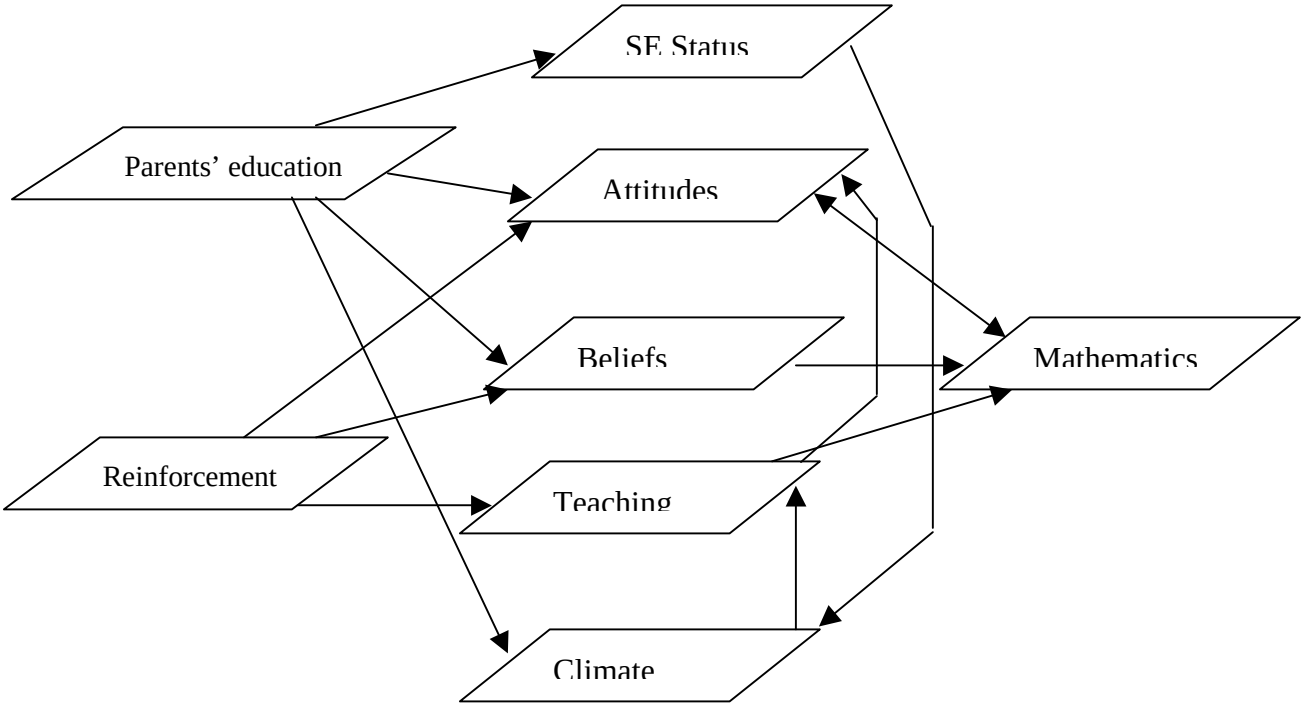
Many authors name technology and media as a promising tool for improving student learning. Schacter (1999) conducted a meta-analysis of the existing literature focused on the relationship between student achievement and technology use in the classroom. According to his findings, students in technology-rich environments have shown increased achievement in all subject areas.

Almost all research names socio-economic status as one of the factors that affects student learning (Howley 1989; Howley *et al.*2000; House 2002). Students learn better if they are from above-average or average income family, with well-educated parents who participate in the schools' education process and encourage children to learn. When parents are involved in their children's education, children have better grades and test scores, better attitudes and behavior (Brown 1999; Peterson 1989, etc.). In addition, as argued by Harris and Mercier (2000), student achievement in school is affected not only by the family environment but also by the neighborhood where the

student lives. Safe neighborhoods that value education and participate in school events and projects can provide additional reinforcement for students.

According to the literature, the method of instruction also affects student learning. Hitz and Scanlon (2001) state that students who attended traditional teacher-centered classes show better results immediately after the program. However, students who were taught using project-based methods had a greater level of retention and an ability to use received knowledge and skills over time. Similar opinions were expressed by Lord (1999) and Klein and Merritt (1994), who believe that constructivist teaching approach leads to improved student achievement because it develops critical thinking, interpretation and analytical skills.

Figure 11. Model of mathematics achievement process (adapted from Papanastasiou 2002).



An interesting model has been developed by Papanastasiou (2002) who has studied achievement in mathematics and factors that affect it. Figure 11 presents the factors influencing learning outcomes in math and the relationships between them. The author found that although attitudes toward the subject, students' beliefs and teaching methods can affect achievement, their impact is not statistically significant. On the other hand, family educational background is a very important factor. It affects school climate, socio-economic status, attitudes toward the subject and learning in general, and students' beliefs. Teachers', friends' and parents' reinforcement has a direct impact on students' beliefs, teaching environment and attitudes towards the subject. As we can see from the model, the relationships between the components are numerous and diverse. It only supports our assumption that there are many factors that can contribute to an increase in student achievement. Although the model initially was developed to study achievement in mathematics, I believe that the same factors affect student achievement in other subjects.

According to many studies, one of the factors influencing student achievement is curriculum integration, which is seen as a promising way for teachers and students to make the "connections between and among the key ideas of the various academic disciplines" (Ellis and Stuen 1998, p. 3). According to the authors, an integrated curriculum creates the "opportunity to explore the relationships necessary to the development of deeper, fuller understanding of content" whereas the traditional curriculum "keeps academic subjects apart from one another" (p. 3). On the other hand, Lake (1994) analyzed the available research and concluded that there were "no detrimental effects on learning when students are involved in an integrated curriculum" (p. 7). However, because of the limited number of research on the topic, the authors did not make a conclusion about regarding the benefits of curriculum integration. As stated by Wineburg and Grossman (2000), there is no evidence that students in interdisciplinary programs achieve higher results compared to students in traditional programs. According to the authors, it is not because of lack of data on student achievement but because "the existing literature on this topic is almost entirely comprised of

idealized descriptions of programs and how to put them in place, and almost entirely devoid of descriptions of what actually happens when theory meets school practice" (Wineburg and Grossman 2000, p. 9). Thus, although it is possible that integrated learning and teaching can positively affect student achievement, it is necessary to take into account that there is not enough supporting evidence in research literature at this point.

Overall, it can be stated that an environment-based approach to teaching and learning described in the previous chapter can provide opportunities for simultaneous development of many factors described above and shown in Table 2 (above). It provides engaging material, problem-, project- and issue-based activities and opportunities for investigation, collaboration and participation. It develops connections between facts, knowledge and subjects and allows taking into account diverse student learning styles, abilities and interests. However, although there are several studies and reports that state that environment-based education improves academic achievement, more comprehensive quantitative and qualitative studies are needed.