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; • 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	• Female gender; • 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	• 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

	context • Parents and community involvement in educational process • Use of technology and other 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.

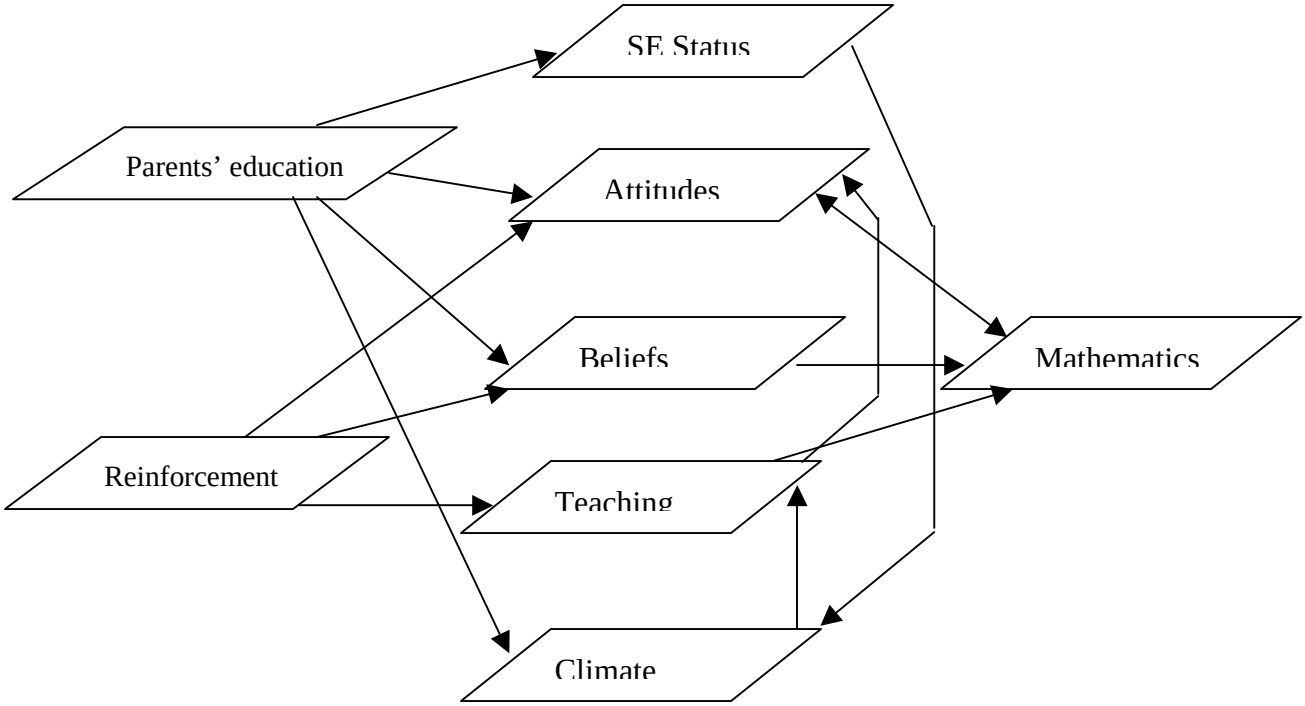
Many authors name technology and media as a promising tool for improving student learning. Schacter (1999) conducted a meta-analysis of the existing literature focused on the relationship between student achievement and technology use in the

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.

5. Results of the research

This chapter will present the results of several statistical tests which were used to analyze the research data. It gives the comparison of descriptive statistics for two groups of the study, the results of the paired sample t-tests, and the results of discriminant and longitudinal analyses. The second part of the chapter presents the analysis of the data received through the electronic survey.

5.1. Descriptive statistics: results

As mentioned above, in the research I compared two groups of schools: a group of EE schools and a group of comparison (non-EE) schools. For each EE school a comparison school with similar demographic and geographic parameters was identified. Six variables were used in the analysis:

- WASL_M – mean percentage of students who meet standards in math on the WASL;
- WALS_R - mean percentage of students who meet standards in reading on the WASL;
- WASL_W - mean percentage of students who meet standards in writing on the WASL;
- WASL_L - mean percentage of students who meet standards in listening on the WASL;
- IT_R - mean percentage of students who were above the 50^{th} percentile in reading on the ITBS; and

- IT_M - mean percentage of students who were above the 50th percentile in math on the ITBS.

According to the descriptive statistics presented in Table 7, EE schools had higher means for all six variables. The variances for EE schools were consistently larger than the variances for comparison schools. Using a 95% confidence interval around the proportions, the overlapping confidence bands ranged from 0.47 to 2.01 percent.

Table 7. Descriptive statistics for six variables (WASL_M, WASL_R, WASL_W, and WASL_L, IT_R and IT_M) for two populations (EE and comparison schools)

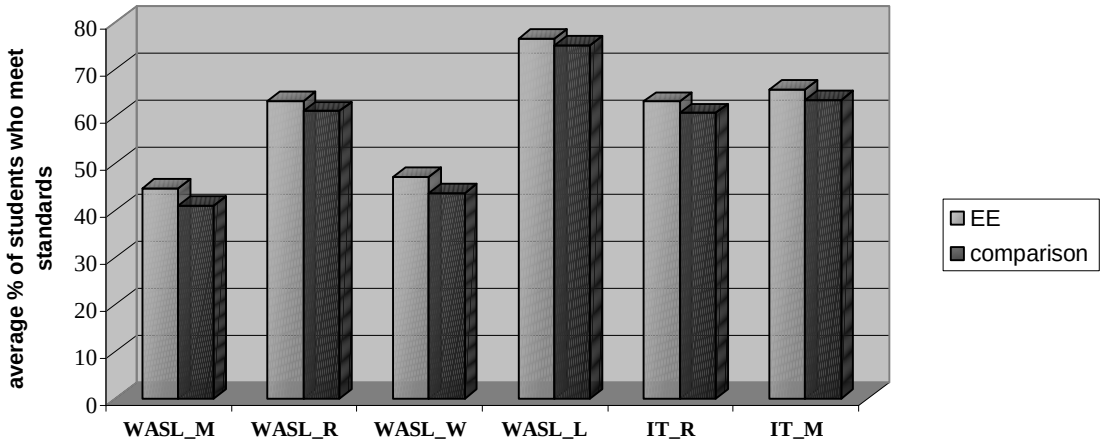
	STATUS			Statistic	Std. Error
WASL_M	comparison	Mean		41.070	1.0360
		95% Confidence Interval for Mean	Lower Bound	39.030	
			Upper Bound	43.110	
		Variance		288.705	
		Std. Deviation		16.9913	
		Minimum		5.9	
		Maximum		82.8	
		Interquartile Range		26.450	
		Skewness		-.045	.149
	EE	Mean		44.636	1.2237
		95% Confidence Interval for Mean	Lower Bound	42.227	
			Upper Bound	47.046	
		Variance		410.304	
		Std. Deviation		20.2560	
		Minimum		1.7	
		Maximum		92.8	
		Interquartile Range		27.950	
		Skewness		.099	.147
WASL_R	comparison	Mean		61.151	1.0139
		95% Confidence Interval for Mean	Lower Bound	59.155	
			Upper Bound	63.147	
		Variance		276.521	
		Std. Deviation		16.6289	
		Minimum		14.3	
		Maximum		90.9	
		Interquartile Range		24.300	
		Skewness		-.500	.149
	EE	Mean		63.301	1.0984
		95% Confidence Interval for Mean	Lower Bound	61.139	
			Upper Bound	65.464	
		Variance		330.577	
		Std. Deviation		18.1818	
		Minimum		10.3	

		Maximum		97.9	
		Interquartile Range		26.225	
		Skewness		-.477	.147
WASL_W	comparison	Mean		43.704	.9496
		95% Confidence Interval for Mean	Lower Bound	41.834	
			Upper Bound	45.574	
		Variance		242.590	
		Std. Deviation		15.5753	
		Minimum		8.8	
		Maximum		81.7	
		Interquartile Range		24.200	
		Skewness		.026	.149
	EE	Mean		47.133	1.0306
		95% Confidence Interval for Mean	Lower Bound	45.104	
			Upper Bound	49.162	
		Variance		291.023	
		Std. Deviation		17.0594	
		Minimum		6.2	
		Maximum		80.7	
		Interquartile Range		23.800	
		Skewness		-.287	.147
WASL_L	comparison	Mean		75.158	.7855
		95% Confidence Interval for Mean	Lower Bound	73.611	
			Upper Bound	76.705	
		Variance		165.985	
		Std. Deviation		12.8835	
		Minimum		25.0	
		Maximum		97.7	
		Interquartile Range		15.900	
		Skewness		-.904	.149
	EE	Mean		76.497	.8198
		95% Confidence Interval for Mean	Lower Bound	74.883	
			Upper Bound	78.111	
		Variance		184.141	
		Std. Deviation		13.5699	
		Minimum		20.7	
		Maximum		100.0	
		Interquartile Range		15.950	
		Skewness		-1.158	.147
IT_R	comparison	Mean		60.72	.941
		95% Confidence Interval for Mean	Lower Bound	58.87	
			Upper Bound	62.58	
		Variance		238.237	
		Std. Deviation		15.435	
		Minimum		14	
		Maximum		95	
		Interquartile Range		21.00	
		Skewness		-.633	.149
	EE	Mean		63.16	.894
		95% Confidence Interval for Mean	Lower Bound	61.40	
			Upper Bound	64.93	
		Variance		219.215	
		Std. Deviation		14.806	
		Minimum		18	
		Maximum		95	
		Interquartile Range		18.25	

		Skewness		-.557	.147
IT_M	comparison	Mean		63.49	.878
		95% Confidence Interval for Mean	Lower Bound	61.76	
			Upper Bound	65.22	
		Variance		207.415	
		Std. Deviation		14.402	
		Minimum		19	
		Maximum		94	
		Interquartile Range		21.00	
		Skewness		-.349	.149
	EE	Mean		65.75	.950
		95% Confidence Interval for Mean	Lower Bound	63.88	
			Upper Bound	67.62	
		Variance		247.090	
		Std. Deviation		15.719	
		Minimum		21	
		Maximum		97	
		Interquartile Range		23.00	
		Skewness		-.425	.147

Figure 18 below presents the comparison of average percentages of students who meet or exceed standards on WASL and ITBS tests for EE and comparison groups. As indicated on the chart, the average percentages of students who meet standards on the standardized test are higher for EE schools on all six variables.

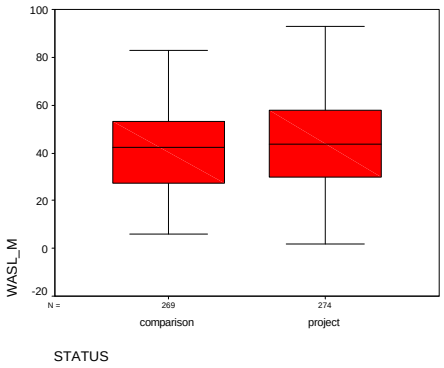
Figure 18. Comparison of average percentages of students who meet standards on WASL and ITBS for EE and comparison schools



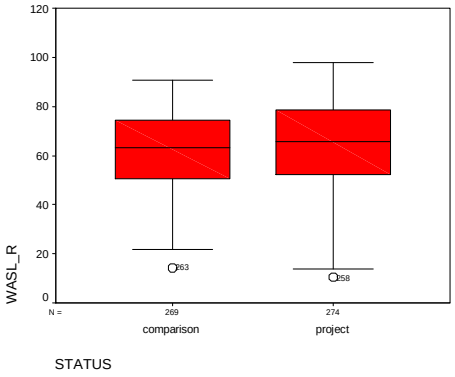
After analyzing boxplots for six variables (Fig. 19) we can state that the range, median, and quartiles are higher for the EE schools group for most pairs. However, the interquartile range, which shows the spread of 50% of the observations, is higher for EE schools in WASL_M(ath)and WASL_R(eading), WASL_L(istening) and IT_M(ath), whereas for the rest of variables it is higher for comparison schools.

Figure 19 (a-f). Boxplots of six variables (six pairs) for two populations: EE schools and comparison schools.

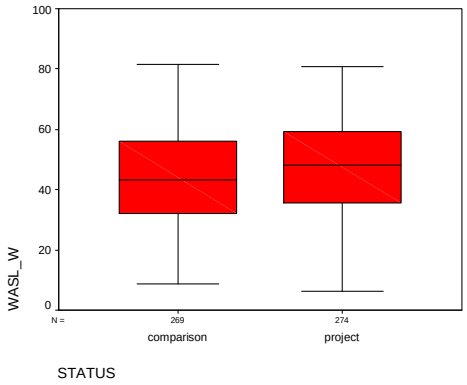
a. WASL math



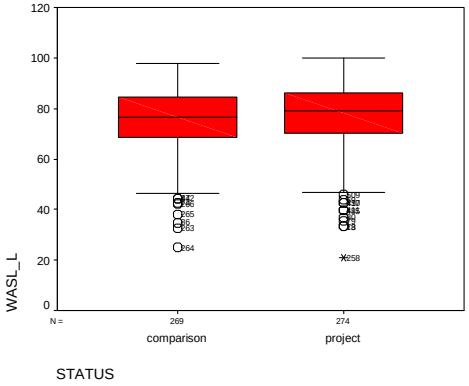
b. WASL reading



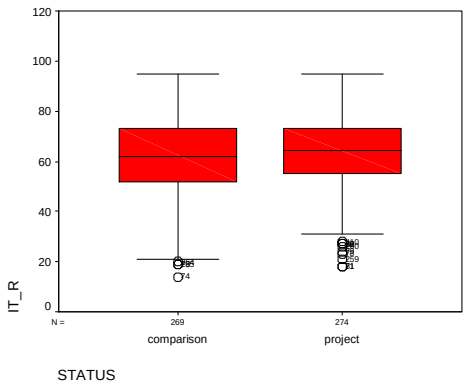
c. WASL writing



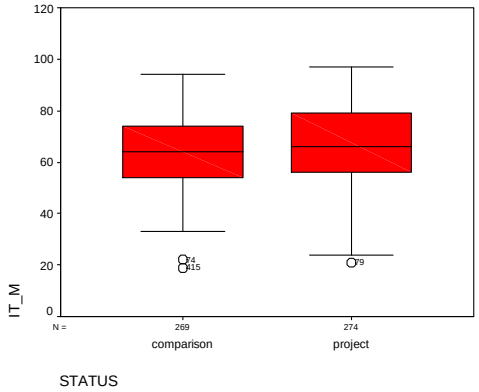
d. WASL listening



e. ITBS reading



f. ITBS math



Overall, on the WASL tests 50 EE schools did *better* in math, 51- in reading, 56 – in writing, and 46 EE schools did better in listening. On the ITBS tests 45 and 44 schools did better in math and reading respectively. In general, in 73 pairs out of 77 EE schools had higher scores in ***at least*** one subject.

5.2. Paired sample t-test results

According to a Paired Samples T-Test (alpha equal to 0.01, 0.05 or 0.1), the difference between the means of the percentages is significant for all six variables. Table 8 presents the results of the paired sample t-test. The last column in the table shows significance or p-value. Because I was interested in whether EE schools have ***higher*** results compared to comparison schools, I used a one-tailed p-value, (which is equal to two-tailed p-value divided by 2). To conclude, the descriptive statistics and t-test allow me to state that there is ***a significant difference*** in math, reading, writing, and listening on the WASL tests and

in math and reading on ITBS tests, ***with EE schools performing better than non-EE comparison schools in all tests.***

Table 8. Results of Paired Samples Test for six pairs of two populations

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EE_WM - NE_WM (math)	4.289	14.8325	.7974	2.721	5.858	5.379	345	.000
Pair 2	EE_WR - NE_WR (reading)	2.844	12.6229	.6786	1.509	4.179	4.191	345	.000
Pair 3	EE_WW - NE_WW (writing)	4.224	14.3627	.7721	2.705	5.742	5.470	345	.000
Pair 4	EE_WL - NE_WL (listening)	1.791	11.0472	.5939	.623	2.959	3.016	345	.003
Pair 5	EE_ITR - NE_ITR (reading)	2.23	11.358	.691	.87	3.59	3.220	269	.001
Pair 6	EE_ITM - NE_ITM (math)	2.04	12.863	.783	.50	3.58	2.607	269	.010

5.3. Discriminant analysis results

As mentioned above, discriminant analysis is a statistical technique that determines which variables discriminate between two or more groups (Klecka 1980). Table 9 presents structural coefficients which show correlations between discriminant variables and standardized canonical discriminant function.

Table 9. Structure Matrix

Variable	Function (1)
WASL_writing	0.870
WASL_math	0.791
ITBS_reading	0.669
ITBS_math[a]	0.612
WASL_reading	0.512
WASL_listening[a]	0.444

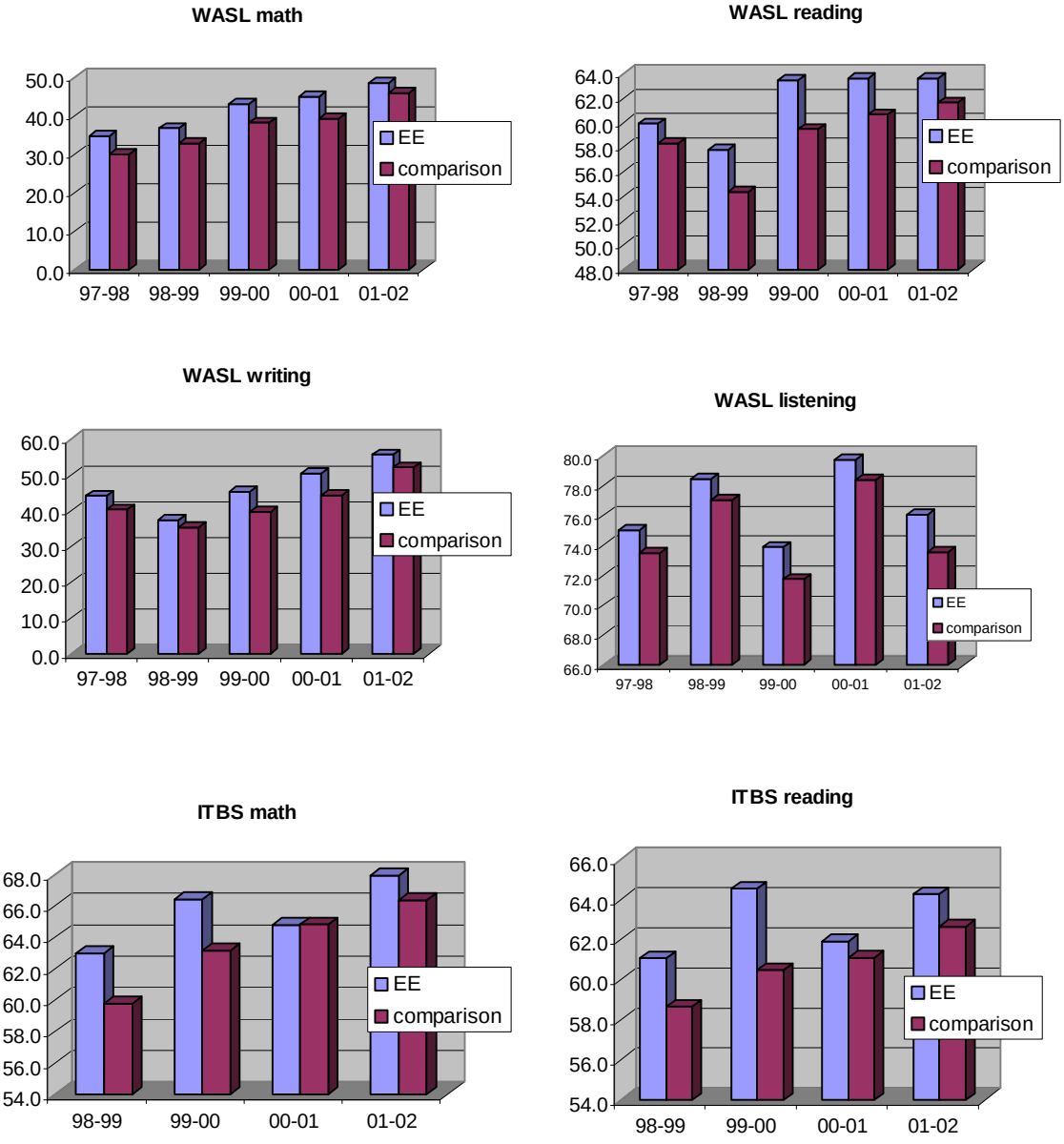
a. this variable not used in the analysis

According to the test, the highest coefficient was WASL_writing, followed by WASL_math, ITBS_reading and WASL_reading. WASL_listening and ITBS_math did not have significant correlation with discriminant function. Thus, the variables that were most useful in discriminating between EE and comparison schools were WASL-math and WASL_writing.

5.4. Results of longitudinal analysis

Longitudinal analysis showed that EE schools had higher mean percentages of students who met standards on the WASL and who were above average on the ITBS for the period of 1997-2002. Figure 20 (a-f) presents the results of the longitudinal analysis. Although EE schools had higher mean percentages of students who meet standards of both tests, the overall patterns of changes in the performances over time are similar for both groups of schools. This result indicates that there are likely to be other factors that affect both EE and comparison schools. According to the survey results, one such factor is the changes in the test itself, which over recent years has become less stressful and more age-appropriate. Another factor is the change in state educational policies and regulations, which affect all schools in the state. And finally, increasing teacher skills in preparing students to take these tests could also affect test results.

Figure 20 (a-f). Comparison of the mean percentages of students who meet standards in math, reading, listening and writing on the WASL and in math and reading on the ITBS for two groups of schools



5.5. Survey results

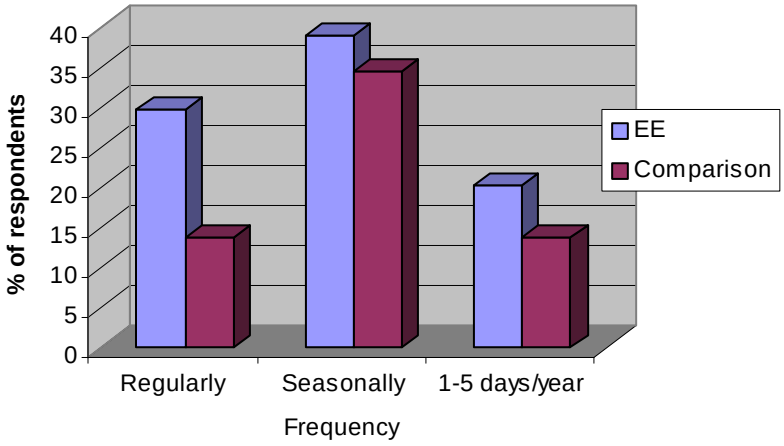
As described above, in order to discover more about the teaching and learning environments (which form the "environment" component of the Austin's model) of the EE and comparison schools, an electronic survey was developed. It was published on the Internet and the invitations were sent to teachers and administrators of the participating schools. Overall, 113 responses were received, out of which 71 respondents were from 53 EE schools and 42 respondents from 31 comparison schools. As seen from these figures, 69% of the 77 EE schools contacted completed the survey compared to only 40% of non-EE schools. Overall, 84 respondents were teachers, 19 responses were received from school administrators and 10 – from other school staff such as educational assistants, etc.

5.5.1. Usage of natural areas and links to outdoors and community

One of the survey questions asked respondents to evaluate how often natural areas were used in the learning process. The respondents were asked to select all options that can describe their schools' links to outdoors. Figure 21 presents the comparison of usage of natural areas in EE and comparison schools. As reported by the respondents, 29.7 % of EE schools used natural areas in their curriculum on a regular basis throughout the year. Only 13.8% of comparison schools used natural areas in their learning process regularly. About 40% of EE schools and about 35% of comparison schools use natural areas seasonally (at least 3-4 times a year). And finally, 20.3% respondents from EE schools

and 13.8% respondents from comparison schools reported that their schools use outdoors for a few concentrated days.

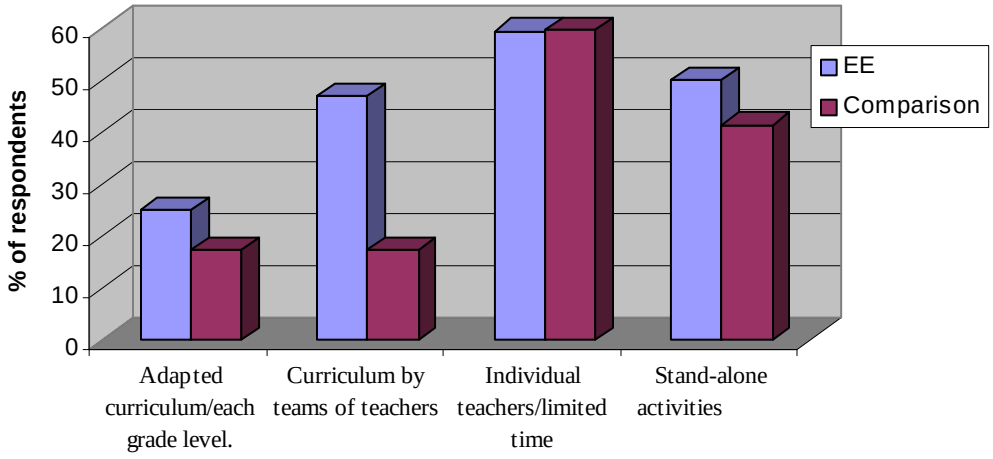
Figure 21. Reported frequency of usage of natural areas in the learning process



Question 2 asked respondents to evaluate the curriculum links to outdoors and community. Respondents chose all answers that applied to their school building (Figure 22). About 30% of EE participants claimed that teachers in their schools adapted curriculum based on students' interests and involved contributions from the outdoors/community, which included the natural environment/community at each grade level. The same option was selected only by 13.8% of respondents from comparison schools. About 50% and 17% of respondents from EE and comparison school respectively believed that in their schools, teams of teachers designed the curriculum to link students to outdoors/community. At the same time about 60% of respondents from both groups thought that individual teachers in their school buildings designed the curriculum which focused on specific natural areas or the community for limited time.

And finally, 50% of EE respondents and 41.4% of respondents from comparison schools claimed that teachers provided stand-alone activities using natural areas.

Figure 22. Reported curriculum links to outdoors and community for EE and comparison schools

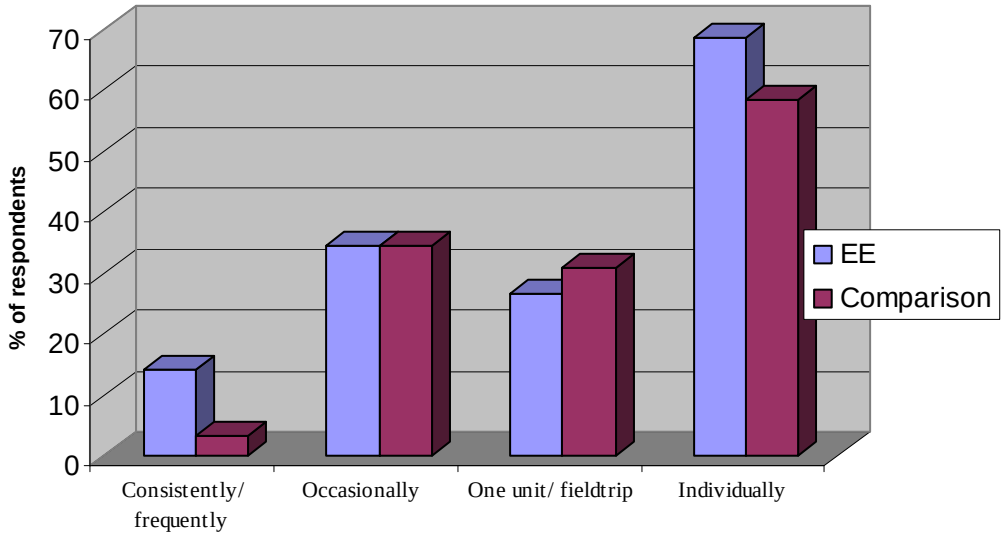


5.5.2. Teaching, assessment and learning practices

Describing teaching practices related to EE, 14.4% respondents from EE schools and 3.4% respondents from comparison schools claimed that teachers in their schools worked together *consistently and frequently* to design and facilitate EE workshops and projects. In addition, 34.4% and 34.5% of participants from EE and comparison schools respectively stated that teachers *occasionally* worked together in EE workshops and projects. Twenty six percent of EE respondents and 31% of respondents from comparison schools reported that in their school buildings teachers worked together just for one integrated EE unit or field trip each year. Sixty nine percent and 58.6% of respondents

from EE and comparison schools respectively claimed that teachers worked *individually* to provide activities using natural areas on the school site or in the nearby community. Figure 23 presents the comparison of different teaching practices related to environmental education existing in EE and comparison schools.

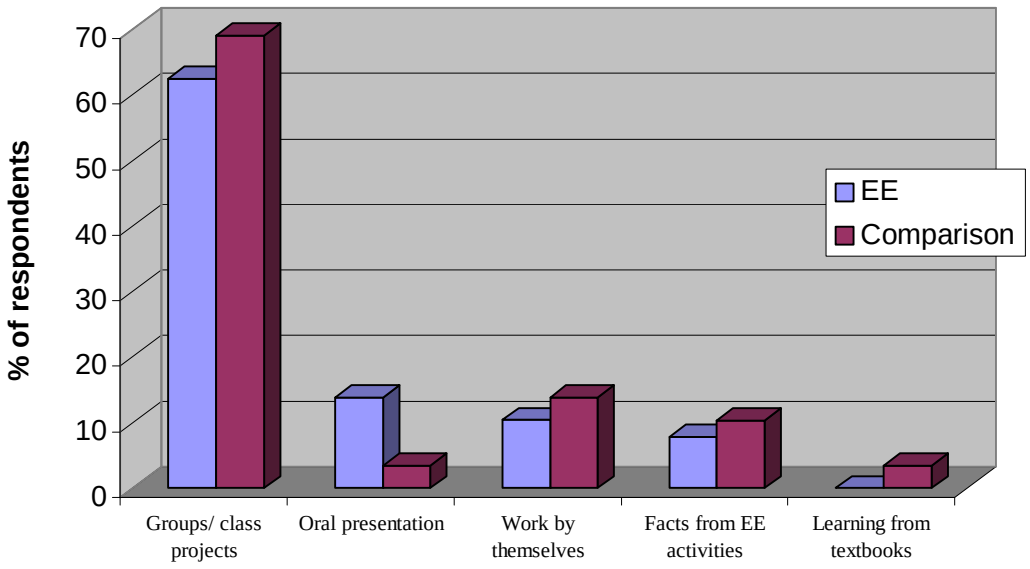
Figure 23. Reported teaching practices related to EE



Describing the style of student learning that is most widely used by teachers in the classrooms, 62.5% respondents and 69% of respondents from EE and comparison schools respectively claimed that in their schools students usually worked in groups on class projects that looked at different ways to solve problems. However, 18.8% of EE participants compared to only 3.4% of respondents from comparison schools stated that students had an opportunity to make oral presentations on what they have learned. Ten percent (EE) and 13.8% (comparison) of respondents believed that in their school buildings students generally worked by themselves on projects. In 7.8% of EE schools

students focused on learning facts from EE-based activities compared to 10.3% of comparison schools. None of the EE schools used textbooks as the only source of information compared to 3.4% of comparison schools in which students learned using textbooks provided.

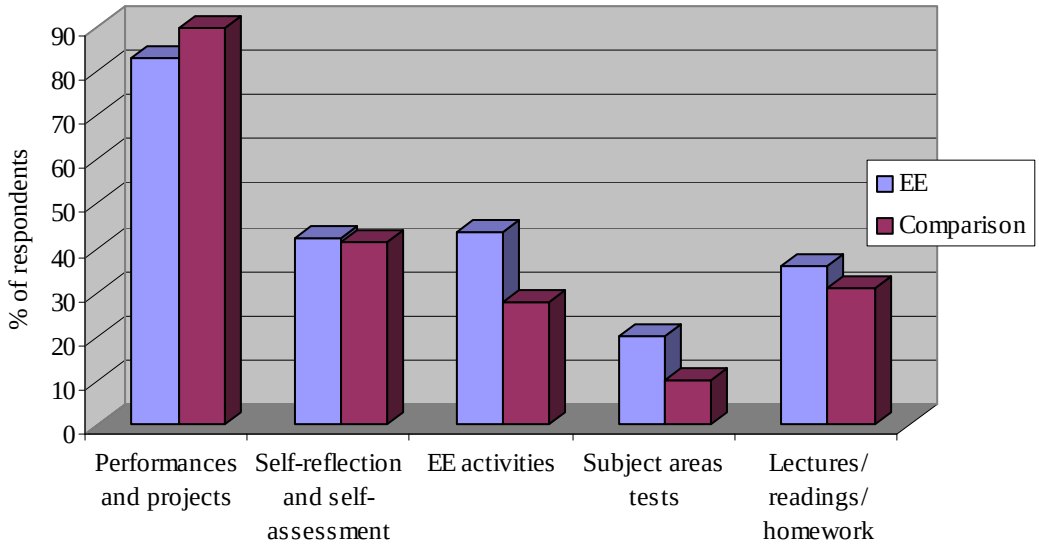
Figure 24. Reported approaches for student learning that are most widely used by teachers in the classrooms of EE and comparison schools



In question 5 respondents were asked to select all types of assessment, which teachers used in their classrooms. Figure 25 compares the types of assessment used by teachers in EE and comparison schools. Eighty three percent of respondents from EE schools and 89.97% of respondents from comparison schools reported that in their schools students frequently were assessed through performances, projects, discussions and presentations. Also 42.2% of EE participants and 41.4% of respondents from comparison schools claimed that students assessed their own work, and self-reflected on their learning. According to the survey, in EE schools students were assessed on what

they learn in integrated Environmental Education activities more often than in non-EE schools (43.8% and 27.6% respectively). Twenty percent of EE respondents and 10.3% respondents from comparison schools believed that in their school buildings in many cases students were assessed through subject area tests only. And finally, 35.9% respondents from EE schools and 31% of respondents from comparison schools reported that in their schools students were also tested on material covered in classroom lecture/discussion and assigned reading and homework.

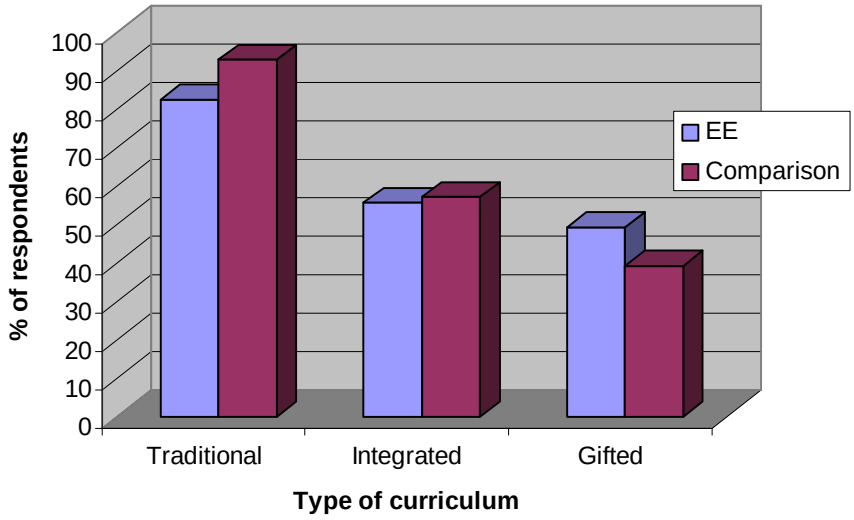
Figure 25. Reported types of assessment used by teachers in EE and comparison schools



In question 6 participants were asked to identify all types of curricula that were used in their schools. The results are presented in Figure 26 below. Eighty three percent of EE respondents and 92.9% respondents from comparison schools stated that their schools implement traditional curricula. Also along with traditional programs, 55.6% and 57.1% of respondents from both EE and comparison schools respectively claimed that there were integrated curricula in their schools. In addition, 49.2% of participants from

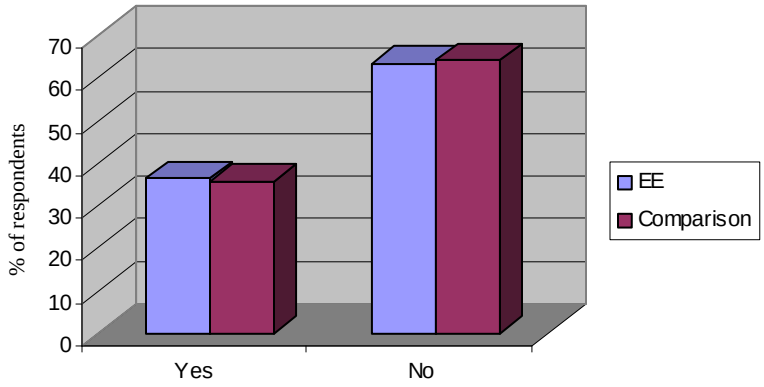
EE schools and 39.3% from comparison schools reported the usage of gifted programs in their schools. Although both EE and comparison schools reported the existence of integrated programs in their schools buildings, the number and subjects integrated are different. Comparison schools mostly integrate two or more traditional subjects together (such as math, science, history or language arts). On the contrary, EE schools reported integrating environmental units and themes into other subjects.

Figure 26. Reported types of the curriculum in EE and comparison schools



As seen from Figure 27, the patterns of participation in regional events and festivals are very similar for both EE and comparison schools. Overall, 36.5% and 35.7% of respondents from EE and comparison schools respectively reported that their schools participated in regional events, festivals and competitions.

Figure 27. Reported participation in regional events and festivals for EE and comparison schools



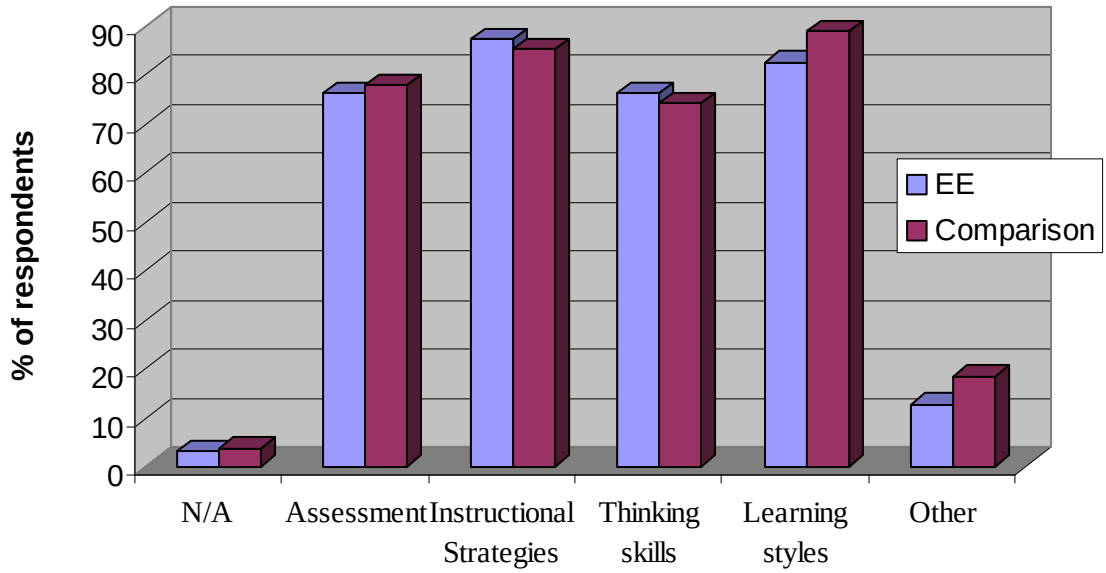
5.5.3. Staff educational background and professional training

According to survey, the average percentages of teaching and administrative staff who have Master's degree are 53% and 50.8% for EE and comparison schools respectively, ranging from 10% to 90% for EE schools and from 33% and to 75% for comparison schools. The percentage of school staff with PhD degrees varies from 0 to 10 for both EE and comparison schools. The average percentage of staff who have teaching certificates is 93% for EE and 100% for comparison schools. However, not every respondent answered these questions. Some of the respondents did not have enough information about amount and types of degrees the staff in their schools have.

Overall, the number of years of teaching experience of the respondents varies from 1 to 36 years with an average of 15 years for EE schools, and from 2 to 33 years with an average of 14 years for comparison schools.

Figure 28 presents the comparison of responses about the types of assessment-reform training or professional development courses the respondents attended. Besides the courses mentioned in the figure, some respondents attended such training as *Technology, Curriculum and Development, Multiple Intelligences, WASL scoring, Integrating Technology into Curriculum,* and so on.

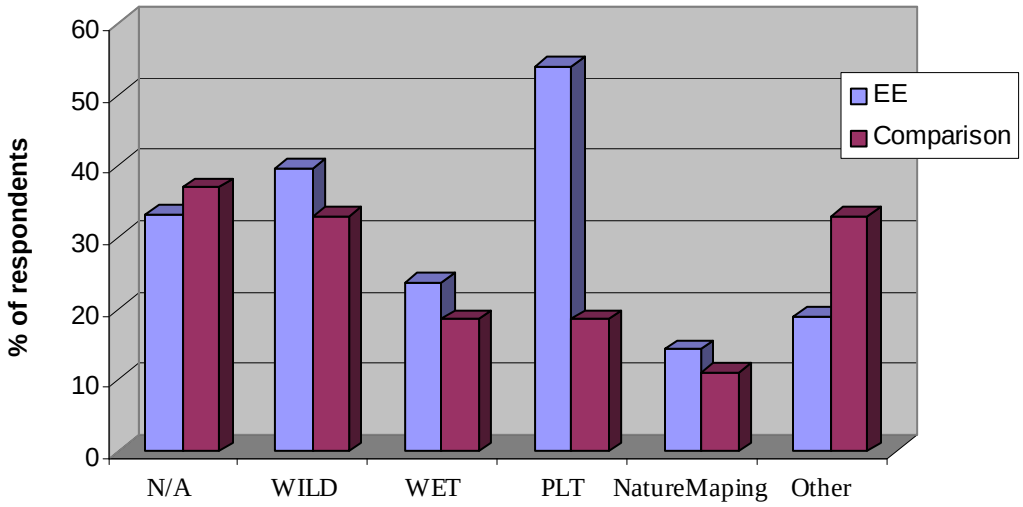
Figure 28. Reported types of assessment reform training or professional development courses the respondents attended



Although the number of respondents who participated in assessment-reform training or professional development courses is higher for comparison schools, the pattern of participation in environmental educational courses and training varies significantly (Fig.29). The most attended course is Project Learning Tree, followed by Project WILD and Project WET. Among other EE courses and training respondents

named *Forest of WA, Globe, Washington Science Teachers Association's Pathways, Woodland Park Zoo workshops, Nooksack Salmon Project, Kitsap Water Watchers,* etc.

Figure 29. Reported types of environmental educational courses and trainings attended by the participants



As for the school buildings in general, the average percentage of teaching staff who participated in environmental education courses and training is higher for EE schools (28% and 11% for EE and comparison schools respectively). On the other hand, the percentage of teaching staff who attend assessment-reform trainings or professional development courses are relatively similar for both groups of schools (65% and 70% for EE and comparison schools respectively).

5.5.4. Attitudes toward environmental education

Question 23 asked participants to rate the value of environmental education based on their experience. The suggested answers were “no value”, “little value”, “valuable” or “extremely valuable” (on the “Likert scale”). Table 10 and Figure 30 (a-d) compare the ratings EE and non-EE respondents assigned to EE. As seen from the table, the percentage of respondents who believe that EE can improve student achievement on standardized tests such as WASL is quite low for both EE and comparison schools. Only 16 percent of respondents from both groups thought that EE can be extremely valuable. Forty-six percent and 44% of participants from EE and comparison schools respectively claimed that EE could be valuable for this purpose. One of the reasons for such ratings could be the lack of information and published research on the impact of environmental education on student achievement in different traditional subjects.

Figure 30 (a-d) present the comparison of respondents who believe that environmental education could be valuable or extremely valuable for the development of factors described in Table 10. Overall, 95% of EE participants (compared to 88% of representatives from comparison schools) thought that EE could increase student motivation to learn. Ninety one percent of teachers from environmental schools strongly believed that environmental education was extremely valuable or valuable for increasing teachers’ motivation. Teachers and administrators from comparison schools saw less value of EE in increasing teacher motivation: 88% of respondents from comparison schools claimed that EE could be extremely valuable or valuable for increasing teachers’ motivation.

In addition, participants from EE schools stated that environmental education could be extremely valuable or valuable in

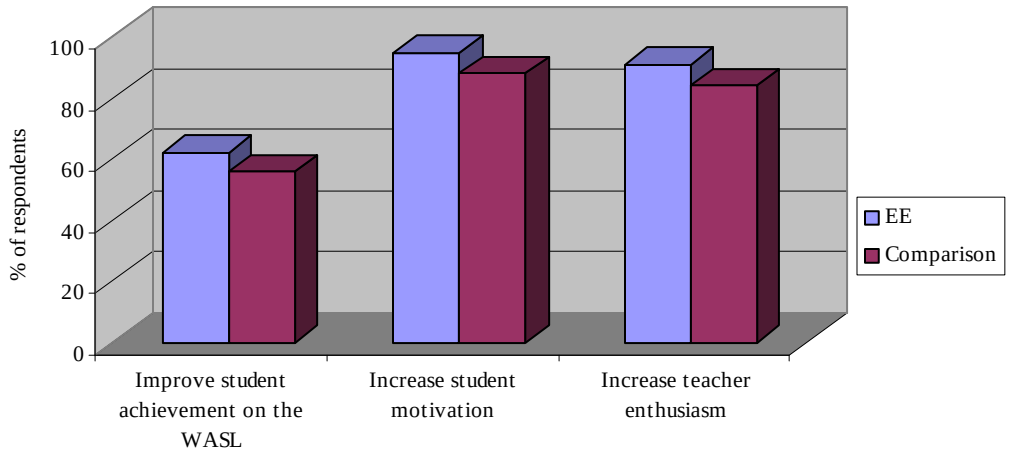
- strengthening student involvement in helping to resolve community issues (88%);
- improving student critical thinking and problem solving skills (100%);
- improving awareness of environmental issues (98%);
- developing a sense of citizenship (86%); and
- increasing student attendance and lowering rates of truancy (58%).

Ninety six percent of respondents from EE schools (compared to 84% participants from comparison schools) believed that EE could be valuable or extremely valuable for strengthening student cooperation and communication skills. Sixty-one percent of EE participants believed that environmental education could reduce behavioral problems, compared to 52% of respondents from non-EE schools who agreed with the statement. And, finally, 79% of EE participants and 68% of respondents from comparison schools thought that EE could be valuable or extremely valuable for increasing community involvement.

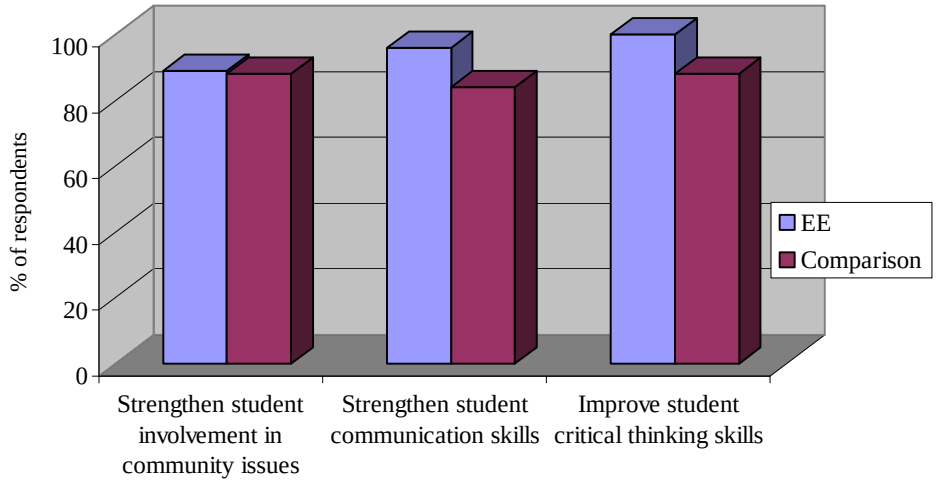
Overall, as seen from Table 9 and Figure 30 (a-d), more teachers and administrators who work in schools with strong environmental education programs believed that EE could be a very valuable tool for improving school environmental student learning, thinking and other skills and increasing links to community and natural areas. The percentage of EE respondents who thought EE was valuable or extremely valuable was ***higher in every category***.

Figure 30 (a-d). Reported attitudes toward environmental education for EE and comparison schools

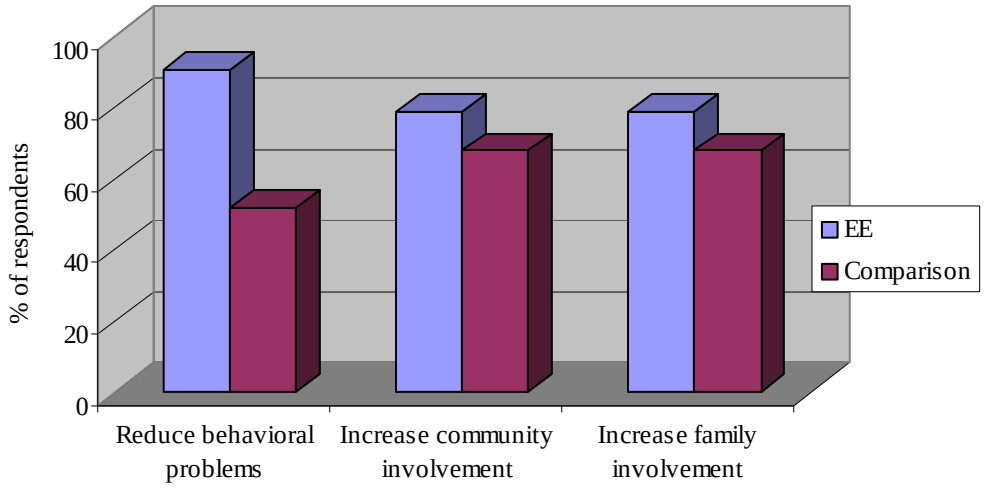
a) Role EE in increasing student achievement and teachers' and students' motivation



b) Role EE in strengthening student involvement in solving community issues and improvement of critical thinking and communication skills



c) Role of EE in increasing community and family involvement in the learning process and decreasing behavioral problems



d) Role EE in increasing student attendance and improvement of environmental awareness and development of a sense of citizenship

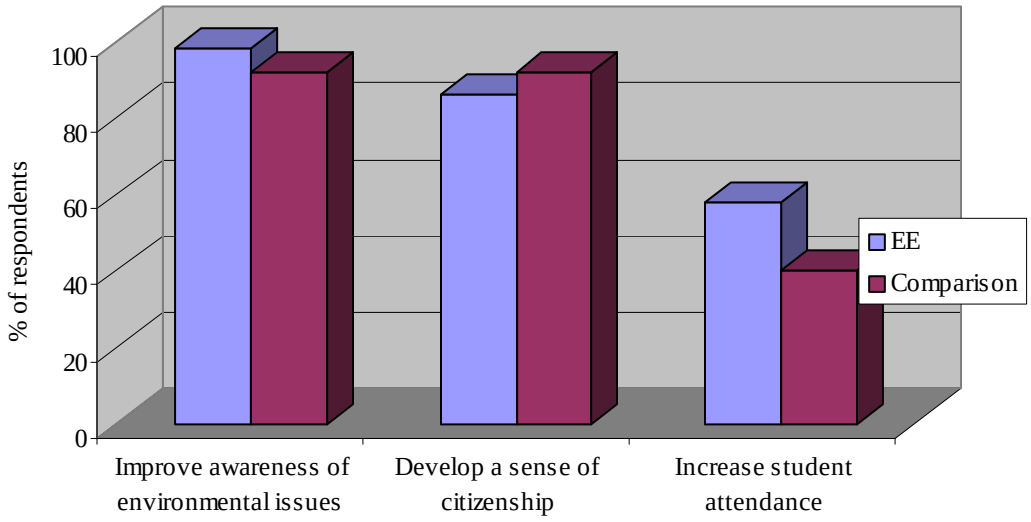


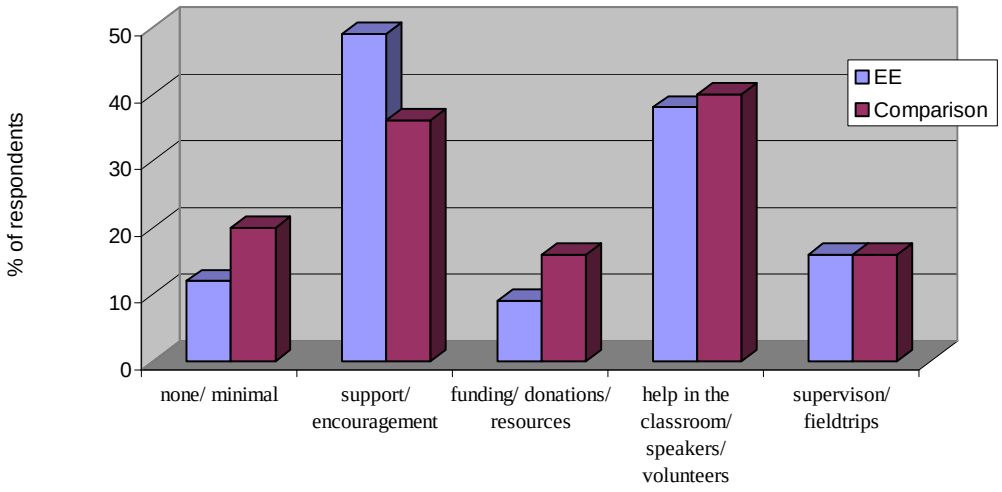
Table 10. Rating of the value of environmental education by respondents from EE and comparison schools

	EE (%)					Comparison (%)				
	No value	Little value	Valuable	Extremely valuable	Total (valuable/ extremely valuable)	No value	Little value	Valuable	Extremely valuable	Total (valuable/ extremely valuable)
Improve student achievement on standardized tests, like the WASL	4	35	**46**	16	62	0	44	40	16	56
Increase student motivation to learn	2	4	44	**51**	95	0	12	44	44	88
Increase teacher enthusiasm	2	7	**54**	**37**	91	0	16	48	36	84
Strengthen student involvement in solving community issues	2	10	43	**46**	89	0	12	52	36	88
Strengthen student cooperation and communication skills	0	4	**56**	**40**	96	0	16	48	36	84
Improve student critical thinking and problem solving skills	0	0	53	**47**	100	0	12	60	28	88
Reduce behavioral problems	4	35	**42**	**19**	61	0	48	36	16	52
Increase community involvement	2	19	**51**	**28**	79	4	28	44	24	68
Increase opportunities for family involvement	4	18	**56**	23	79	0	32	40	28	68
Improve awareness of environmental issues	0	2	35	**63**	98	0	8	40	52	92
Increase student attendance, lowers rates of truancy	11	42	23	**25**	58	8	52	24	16	40

5. 5. 5. Parents, administration and community involvement in the learning process and environmental education

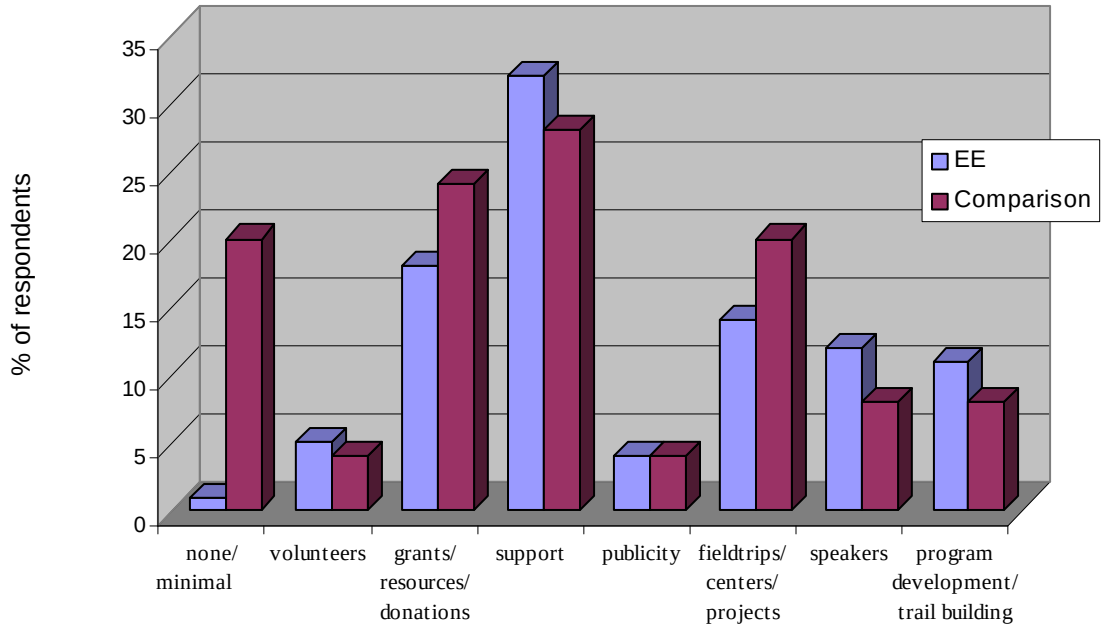
Several questions in the survey asked respondents to evaluate support from the administration, parents and community in the learning and teaching activities including implementation of environmental education. According to the survey, 12% of EE respondents and 20% of respondents from comparison schools received none or minimal support from parents (Figure 31). Forty-nine percent of participants from EE schools (compared to 36% of non-EE respondents) claimed that the parents of their students are very supportive and participate in school activities as well as express positive attitudes and encouragement at home. On the other hand, a higher percentage of respondents from comparison schools stated that parents in their schools provided funding, resources and help in the classrooms as volunteers and guest speakers.

Figure 31. Reported parental involvement in the school learning and environmental education for EE and comparison schools



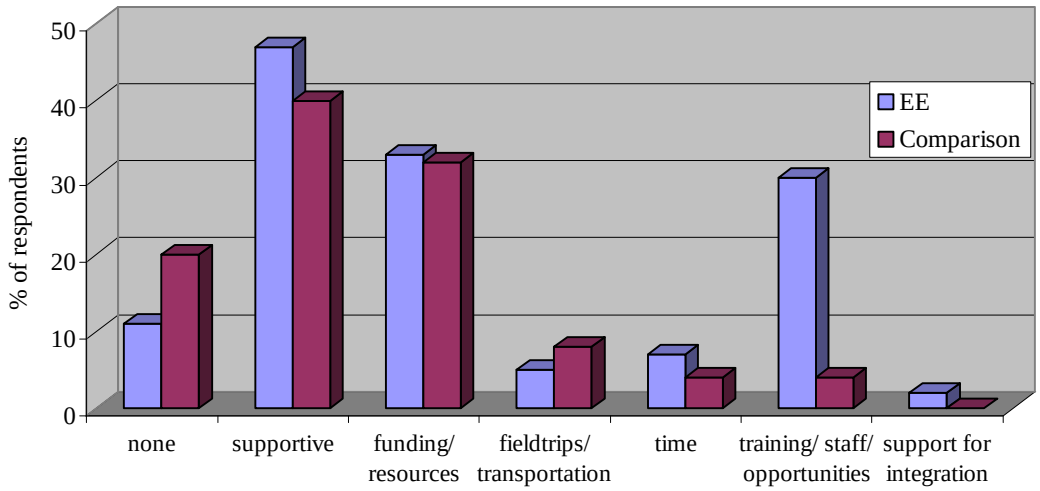
As seen from Figure 32, 32% of EE respondents (compared to 28% of participants from comparison schools) believed that their schools received strong support from their communities: in EE schools, the community seems to be more involved in program development and trail building (11%), plus participate in the learning process as guest speakers (12%) and volunteers (5%). However, a higher percentage of participants from comparison schools reported that they received support for fieldtrips, funding, and resources. On the other hand, 20% of participants from comparison schools (compared to only 1 % of EE respondents) stated that they did not receive any (or minimal) community support.

Figure 32. Reported community involvement in the learning process and environmental education for EE and comparison schools



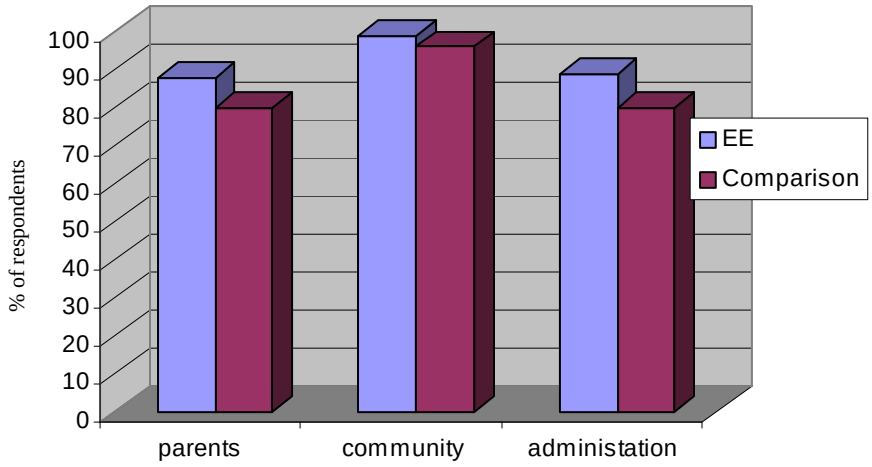
As seen from Figure 33, EE schools seem to have more support from their schools and district administration compared to non-EE schools in almost all categories. They have more support from administration for doing EE, more resources, more time and training. Forty-seven percent of EE participants (compared to 40% of respondents from comparison schools) claimed that their administration is (very) supportive. Seven percent of EE respondents (compared to 4% of respondents from comparison schools) reported having more time for planning and curriculum development. **Thirty percent** of EE respondents (compared to **only 4%** of respondents from non-EE schools) claimed that they have training and other opportunities and special staff in their schools who help to implement EE activities.

Figure 33. Reported administrative involvement in the learning process and environmental education for EE and comparison schools



Overall, as seen from Figure 34, more respondents from EE schools claimed that they receive any support from their students' parents, administration and community.

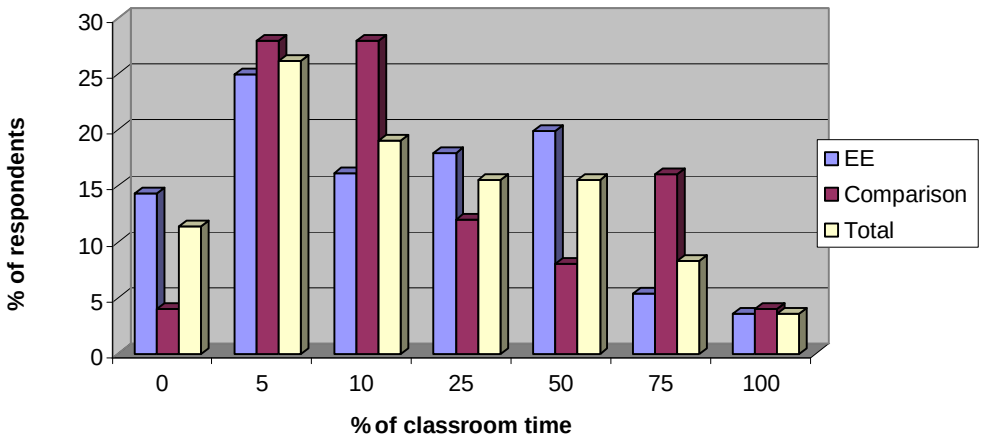
Figure 34. Reported support from parents, community and administration



5. 5. 6. WASL: time for preparation and possible factors affecting WASL scores

Because this research used the WASL scores as a measure of student achievement, several questions in the survey were devoted to this topic. The respondents were asked to reflect on the amount of time they spent in classrooms on WASL preparation. Also they were asked about changes in the test scores and test policies and procedures. Figure 35 below shows the percentage of classroom time the schools spend on WASL preparation. As seen from the figure, the amount of time spent on preparing students to the WASL varies from 0 to 100 percent. For the model preparation time, 27% of respondents said they spent on average about 5% of their classroom time on WASL preparation. About 4 percent give all their classroom time to preparing for the test.

Figure 35. Reported amount of time spent on WASL preparation

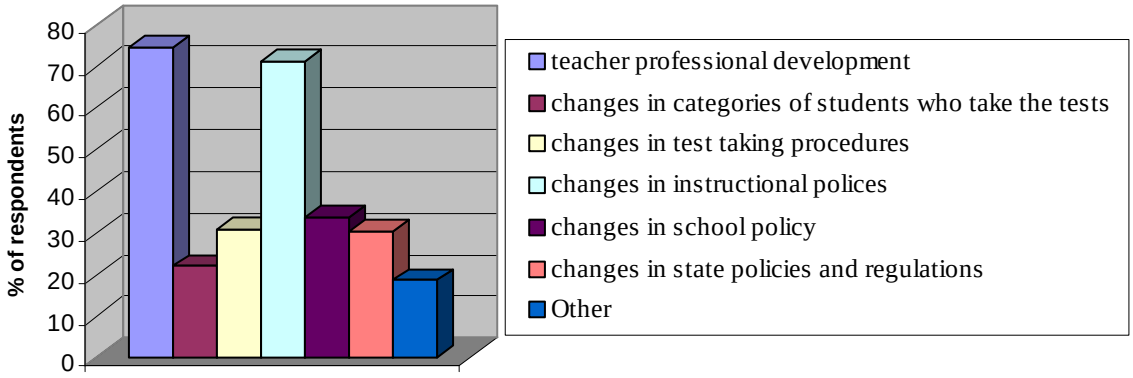


Overall, about 14 percent of respondents from EE schools claimed that they did not spend time on the WASL compared to 4 percent of participants from comparison schools. About 20% of respondents from EE schools spent 50% of their classroom time on WASL preparation compared to 8% of respondents from comparison schools. On the other hand, the percentage of teachers who stated that they spent 75% or 100% of their classroom time to prepare their students for the WASL is higher for comparison schools.

When asked about changes in the test scores, teachers and administrators from both comparison and EE schools named several similar reasons such as:

- professional development on test preparation,
- changes in state and school policies that encourage teachers to prepare students for the WASL , and
- “increased focus on learning target and constant push from school administration to improve test scores” .

Figure 36. Factors that influence changes in test scores on the WASL



According to respondents to the survey results (presented in Figure 36), teachers are encouraged to teach to the test by focusing on developing thinking skills and essential learning outcomes described in the state standards. Respondents indicated that professional development and teacher training has increased over the past several years. Some respondents mentioned changes in teaching style, and changes in school and district policies.

5.5.7. Needs and barriers for doing environmental education in the classrooms

Several questions of the survey focused on needs for improving EE in the classrooms and the barriers they experience. According to the survey, there were several main needs for improving EE in the classrooms. Teachers indicated that they needed

- more funding (40%),
- more time for planning and instruction (47%),
- more materials (18%),

- curricula and activities (19%),
- more opportunities for professional development and teacher training (29%), and
- support from administration and districts to develop and maintain EE program (18%).

About 8% of respondents stated that less WASL preparation would give more time for environmental education. Ten percent of respondents wanted more information about the impact of environmental education on student achievement and sought an opportunity to communicate with state environmental organizations and institutions. Other needs mentioned by the respondents were more flexibility in the curriculum, more motivation and leadership, more knowledge about the environment and more confidence in teaching EE.

Accordingly, the main barriers identified for implementing environmental education in schools were

- lack of time (58.8%);
- money (48%);
- lack of support and understanding from school administration (8.9%);
- lack of training (15.8%);
- and necessity to devote time to preparing for the WASL (11.7%).

According to the survey, other barriers to emphasizing EE are curriculum expectations and administrative pressure that do not allow teaching EE, lack of commitment from other teachers, lack of teacher's own environmental knowledge and skills, and parental attitudes.

6. Discussion

As I have already mentioned, I used the I-E-O[1] model developed by Austin (1991) as the basis for my research design. Like Austin, I believe that in order to more fully interpret the outcome (or outputs) of the program/ or model, it is necessary not only to compare similar groups (or understand and take into account the differences between them) but also to understand and analyze the educational environments in which these groups operate. Tables 12 and 13 below present the summaries of my findings and the questions still to be answered.

Input component

As described earlier, for the present research, 77 pairs of EE and comparison schools were selected. Each school was rated by different EE and other experts according to the Environmental Education Rubrics for school buildings. Table 11 below presents the characteristics of EE and comparison schools on the EE Rubrics. All EE schools have environmental programs which have been implemented for more than three years and 20% of teachers (or more) as well as 33% of students (or more) participated in EE programs.

Table 11. Characteristics of EE and comparison schools on the EE Rubrics developed the EE Consortium

	EE	Comparison
School Building Rubric		
• # of years in EE • % of teachers /classrooms	• At least 3 years	• less than 3 years • less than 20% (or none

[1] The Input - Environment - Output model

involved • % of students involved	• 20% or more • 33% or more	at all) • less than 33% (or none at all)
Curriculum	• Integration • Links to natural areas	• No integration around EE • Stand-alone EE activities or none at all
Instruction	• Teams of teachers who help students to develop their own knowledge	• Teams are only forming OR only individual teaching OR no teaming
Assessment	• Best practices	• Traditional practices
Student learning	• Construct their own learning	• Traditional approaches
Community	• Participates in learning process and provides EE opportunities	• Few community partners OR no participation OR do not provide EE opportunities

Table 12 below presents the summary of my research. The findings from the survey, statistical analyses, external rating, etc. are organized using the elements of the I-E-O model.

As mentioned above, the pairs of EE and comparison schools were selected in such a way that they were similar in their socio-economic, demographic and geographic parameters. This allowed me to assume that the schools in each pair are fairly comparable. Also, according to the survey, teachers in both groups of schools have similar educational background, and similar professional and assessment training. In most schools 90-100% of the staff have teaching certificates. The percent of the staff who has a PhD degree varies from 0 to 10 percent for both EE and comparison schools. The average percentage of Master's degrees is also quite similar: 53% for EE and 50.8% for comparison schools. Similarly, the average percentage of staff who participated in professional development courses is 65% and 70% for EE and comparison schools respectively.

However, I acknowledge that there could be other variables which I did not have an opportunity to investigate. For example, I did not study teachers' motivation to teach EE in their classrooms, their skills and knowledge in this area as well as teachers' level of confidence in teaching environmental education. Also, focusing on the schools in general, I did not take into account individual students' backgrounds, and their individual skills. Although I compared schools using socio-economic parameters, I did not study parents' background and education. I think that all these factors can affect student achievement. However, at this point I could not include them in my research.

Environment component

The rating of schools conducted by external experts to a degree describes an environment where integrated environmental education is being introduced, supported and valued, or conversely where little EE has been developed to date, or is just being introduced. Building on that second hand knowledge about these schools, I used my survey results to evaluate and compare teaching and learning environments of the EE and comparison schools. Using the survey responses I analyzed teaching practices, instructional and assessment strategies reportedly used in schools, amount of time spent on preparation for the state WASL test, types of school curriculum and school staff educational background. Although I planned to evaluate the amount of funding the schools receive from different sources, most respondents could not provide enough information about it. Most of them (especially teachers) stated that they did not have such information.

Table 12. Summary of the research organized by components of the I-E-O model

<table>
<tr><td colspan="3">Inputs</td></tr>
<tr><td colspan="2">Similar</td><td>What I do not know</td></tr>
<tr><td colspan="2">• Demography
• Socio-economic status
• Ethnicity
• Location
• Teachers' professional training
• # of teaching certificates</td><td>• Individual students' background
• Individual students skills, strengths and weakness
• Parents' background and education
• Amount of reinforcement from parents
• Teachers' motivation, skills, knowledge and area of expertise</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Environment</td></tr>
<tr><td>Similar</td><td>Different</td><td>What I do not know</td></tr>
<tr><td>• Pedagogy
• Assessment practices
• Time spent for the WASL preparation
• Needs and barriers for doing EE in the classrooms
• State/district educational policies and regulations</td><td>• Rating on EE Rubrics by EE experts
• Degree of usage of natural areas
• Level of integration around EE
• EE training
• Support from parents, community and administration for doing EE
• Valuing EE</td><td>• Level of teachers' confidence teaching EE
• Amount of funding schools receive from various sources
• Teachers, parents' and student attitude toward the WASL
• Nature of the WASL preparation</td></tr>
<tr><td></td><td></td><td>What I did not do</td></tr>
<tr><td></td><td></td><td>• I did not observe the schools/classes directly
• I did not survey each teacher in each school
• I did not interview teachers, parents, students and community partners</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">Outputs</td></tr>
<tr><td colspan="2">Different</td><td>What I do not know</td></tr>
<tr><td colspan="2">• Test Scores (higher for EE schools)</td><td>• How correct standardized tests results reflect school learning and changes in student skills and knowledge.
• Reasons for changes in the individual student's scores on the WASL/ITBS</td></tr>
</table>

Table 13. Summary of the similar, different and unknown parameters of the research

EE and comparison schools are SIMILAR in		
• Demography • Socio-economic status • Ethnicity • Location • Amount of professional educational training • Time spent on the WASL preparation • Proportion of faculty with teaching certificates, and Masters and PhD's • Subject to the same state/district policies • Needs/barriers for doing EE • Pedagogy • Assessment methods		
EE and comparison schools are DIFFERENT in		
• EE Rubrics		
	EE	***Comparison***
% of years of engagement with EE	*3 years or more*	*less than 3 years*
% of teachers involved	20% or more	less than 20%
% of students involved	*33% or more*	*less than 33%*
• WASL/ITBS scores	*higher scores*	*lower scores*
• Usage of natural areas	*on a regular basis*	*occasionally or not at all*
• EE training	*more teachers attended EE training*	*Less EE training*
• Integration around EE	*integrated curriculum*	*no integration around EE/ stand-alone EE activities*
• Support from parents	*more*	*less*
• Support from community	*more*	*less*
• Support from administration	*more*	*less*
• Attitudes towards EE	*teachers value EE more (higher in every category)*	*less*
What is UNKNOWN		
• Students' background and skills • Parents' education • Parents' and community reinforcement • Teachers' motivation for doing EE • Teachers' skills and knowledge for teaching EE and the level of confidence in teaching this discipline • Nature of preparation for the WASL test • Parents', students' and teachers' attitude toward the WASL test • School funding for EE or other reform or improvement efforts		

EE and comparison schools use similar types of assessment. In most schools, teachers assess through performances and projects and allow students to assess their own work. In addition, both types of schools use "traditional" forms of assessment such as subject area tests, assessment through lectures, readings and homework, etc. However, the percentage of teachers who assess students through EE activities is higher for EE schools.

Along with traditional curricula both groups of schools tend to implement integrated and gifted programs. However, many EE schools use environmental topics and themes for integration (by merging several subject areas using this context) whereas comparison schools appear to interpret integration by the merging traditional subjects such as math, history, language arts, or social studies.

Because the pairs of schools were selected from the same state and, when possible, in the same district, they were subject to the same state (and district) educational policies. However, school policies vary from school to school. In some cases, respondents described their school's policy regarding WASL. However, this information was not available for each school.

Teachers in EE schools attended more EE training and workshops compared to their colleagues from comparison schools. The average percentage of teaching staff who participated in environmental educational courses and training is higher for EE schools. About 30% of EE participants (compared to 13.8% of non-EE respondents) claimed that teachers in their schools adapted curriculum based on students' interests and involved contributions from the outdoors and community, which included the natural environment and/or community at each grade level.

According to the results, EE schools use natural areas more regularly. The teachers in these schools try to link their curriculum to the environment and community. On the contrary, comparison schools reported that their teachers use natural areas occasionally, for a short period of time or do not use them at all.

The amount of time spent on the WASL preparation varies greatly for both EE and comparison schools. According to the survey, it is not possible to make a conclusion that any of the group schools devoted more time for WASL preparation than the other group. However, what I did not investigate in my research is the nature of the WASL preparation schools undertake. Also I did not have an opportunity to study the attitudes toward the WASL test of parents, students and teachers. I believe that these attitudes could be a factor that affects students' performance on the test. Positive attitudes of parents and teachers could reinforce students' positive attitude to the test and their willingness to do their best on the WASL whereas negative attitudes of parents and teachers and lack of reinforcement for them would probably result in a worse performance.

According to the survey results, teachers in EE schools receive more support from parents, administration and community. A really dramatic difference was found in the amount of support from administration. Teachers in EE schools seemed to receive more training, time, etc. Thus, ***30%*** of EE respondents (compared to ***only 4%*** of respondents from non-EE schools) claimed that they have training and other opportunities and special staff in their schools who help them to implement EE activities. However, in order to develop a clearer picture about types and amount of support provided by community and parents, it is necessary to conduct interviews of parents and community members who are

involved in the learning process. Unfortunately, I did not have an opportunity to survey these two groups. On the other hand, the results received through the teacher survey are similar to the school evaluations conducted by external experts who stated that most of the EE schools have a high level of community and parental support.

And finally, a difference between EE and comparison schools was found in how teachers rated the value of EE in developing critical thinking and communication skills, improving student achievement, increasing family and community involvement, improving student attendance and engagement, reducing behavior problems, and some other components. Ratings of EE school teachers were ***higher in every category***.

Overall, the survey data provided valuable information about EE and comparison schools. However, the results would be more complete if every school responded to the survey. Obviously, if I were able to survey each school (and each teacher in the school), I would have more complete understanding of their school environment.

Outputs

I used the WASL and ITBS test scores as measures of student achievement in math, reading, writing and listening. The descriptive statistics and t-tests showed that there is a ***significant difference*** in math, reading, writing, and listening on the WASL tests and in math and reading on ITBS tests with EE schools performing ***better*** than non-EE comparison schools in all tests.

According to the longitudinal analysis, although EE schools had higher mean percentages of students who meet standards on both tests, the overall patterns of change in performance over time are similar for both groups of schools. This result indicates that there are likely to be other factors that affect both EE and comparison schools. According

to the survey results, one such factor is the change in the test itself which over recent years has become less stressful and more age-appropriate. These changes affected all schools in the state and could explain the similar patterns of change in the test scores for EE and comparison schools.

Overall, I believe that environmental education can be one of the causes for EE schools' success on the WASL. Investigating environmental topics requires students to apply knowledge and skills from different subjects. Used as a basis for integration, environmental education can allow for integration of math, science, language arts, social sciences and other subjects. In addition, it asks students to become investigators and to search for the solutions to very multidimensional questions. By doing this, students can develop their analytical, problem solving and critical thinking skills valuable in any traditional subject.

Also it is necessary to emphasize that the study indicates ***a correlation*** rather than a cause-effect relationship between student achievement and the role of environmental education in the school. It is necessary to point out that environmental education is only one of many possible factors that affect student achievement and test results. There are many other internal and external factors such as school funding, teaching and learning practices, administrative school policies, students' individual characteristics, etc. that affect student achievement. The test results are also affected by the extent of teacher professional development in specific subject areas, especially math, reading and writing. The present research does not take these factors into account. Finally, according to the research not every EE school is higher on the WASL and ITBS compared to its non-EE

pair. This also does not allow me to claim that there is a cause-effect relationship between EE and student achievement.

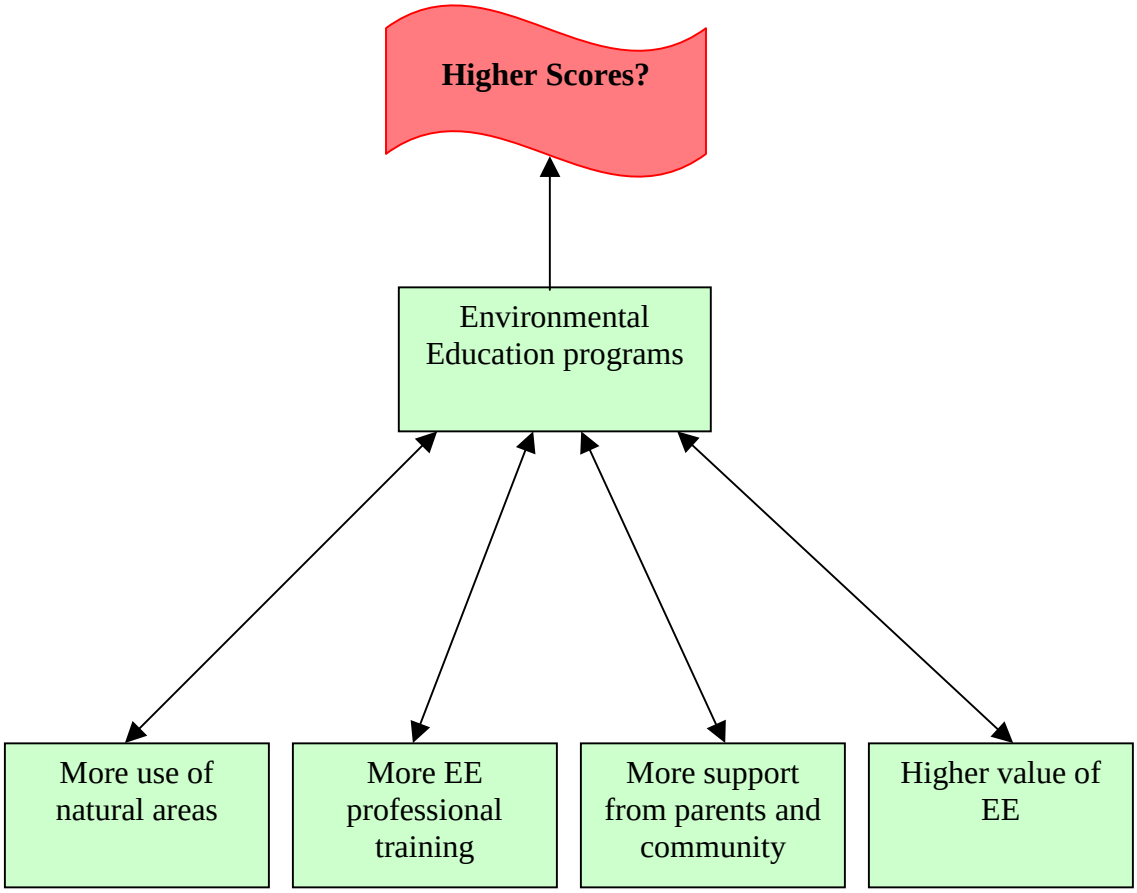
However, the research shows a pattern (Figure 37) indicating that in schools with environmental educational programs teachers

- 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.

In addition, most schools for which these parameters were true, had higher scores on the WASL/ITBS compared to their comparison schools. However, the research did not make it possible to determine how this translates to student learning, plus what particular skills have been improved, and what scientific concepts have been mastered.

These results ***validate the EE Rubrics*** developed by the EE Consortium and used as a basis for school selection for this study. Initially, EE schools and their pairs were rated by EE providers and other EE and educational experts. The data from the survey support the external ratings. According to the results, the schools which were rated high on the EE Rubrics, were reported as having higher level of community, administration and parents involvement, using well developed practices in assessment and instruction more, and more consistently and regularly using natural areas, etc. Thus, I think that the present research also proves that the EE Rubrics can be used for assessing school building's EE implementation.

Figure 37. Patterns found by the research



Next steps in the EE Assessment Project

The Environmental Educational Consortium continues to investigate student learning performance and differences through EE Assessment Project research. For this next phase of the research, WASL-like performance tests were administered to 15 pairs of EE and their comparison schools. These 15 pairs were chosen out of the 77 pairs studied in the present research. The WASL-like tests are aligned with EALR's (state standards) and the EE standards (or Integrated Benchmarks). They assess how students mastered EE

concepts and skills as well as the main concepts in math, science, social studies, language arts, history and arts. Comparing the results on the EE WASL-like tests for each student with his or her WASL and ITBS scores as well as the analysis of the student's responses on the WASL-like test, will reveal more precise data about the development of environmental and other knowledge and skills, as well as the possible impact of EE on the student learning.

Overall, the results of my research suggest the need for further study of the impact of environmental education on student achievement. Although my research shows that the scores are higher for the schools with environmental educational programs, we still need to learn more fully why this is occurring, what factors affect tests scores and what practices are making the difference. I think that the next step for this research is a more in-depth qualitative study of the selected pairs of schools. In order to receive a more complete picture of the teaching and learning environment, it is also necessary to analyze funding the schools receive from different sources. Also the interviews of teachers, principals, students as well as students' parents and community partners involved into the learning process would provide very valuable information. Finally, we also need to know the complete professional development received by the faculty for the past several years, for this may have contributed to their school's WASL scores. Such research would not only give evidence of the positive impact of environmental education but also would add to the theory of educational research.