Exploring the Impact of Outdoor Environmental Activities on Children Using a Qualitative Text Data Analysis System

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SUMMARY. The main objective of this study was to investigate the impact of an outdoor environmental program, Math and Science in the Outdoor Classroom, on elementary grade students' creative and critical thinking, and attitudes toward math and science. Math and Science in the Outdoor Classroom is an on-campus nature program in Santa Fe, N.M. Students participated in half-day programs focusing on topics such as water, insects, soil, and weather. Twenty-one teachers from five schools volunteered 175 second through sixth graders to participate in the program and research study. Surveys were administered to students, teachers, and volunteers after completion of the program. Interview data was analyzed using QSR NUD*IST (Nonnumerical Unstructured Data Indexing Searching and Theory-building) computer-assisted qualitative data analysis system to examine respondents' perceptions of the program using Bloom's taxonomy as a theoretical framework. Results indicated that students not only learned math and science at the lower levels of Bloom's taxonomy, but were also thinking at the higher levels of synthesis and evaluation within the framework.

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Outdoor programs have been used historically in conjunction with the general school curriculum to promote learning and plant knowledge, agricultural methods, and nature, among other lessons (Bachert, 1976; Montessori, 1912; Skelly and Bradley, 2000). These types of programs have educational benefits because of the hands-on, experiential learning, as well as their real-world application (Barron, 1993; Kutsunai, 1994). Some educators report that these outdoor learning experiences result in greater scores in science, or greater academic achievement overall (Braun et al., 1989; Stetson, 1991).

Outdoor nature programs provide a positive, fun environment for children to learn about the world (Alexander et al., 1995; Barker, 1992; Konoshima, 1995), as well as teaching them responsibility (Kaiser, 1976; Konoshima, 1995; Montessori, 1912), improving their attitudes towards school and reducing dropout rates (Baum et al., 1985). Educators admit that there is a correlation between childrens' attitudes toward school and academic achievement.

Studies have shown that it is important to instill positive attitudes toward science in children at an early age (Catsambis, 1995; Farenga and Joyce, 1998; Simpson and Oliver, 1990; Yager and McCormack, 1989; Yager and Yager, 1985). These positive attitudes in the elementary school years tend to encourage exploration of science and science-related careers in the future (Tanner, 1980). Out-of-school science activities and hands-on learning experiences are viable mechanisms to promote science to students (Farenga and Joyce, 1998), yet many traditional science programs do not take advantage of these opportunities (Yager and McCormack, 1989).

Most studies that examine the effectiveness of hands-on experiences in learning use traditional quantitative research methodology. These methodologies generally provide controlled isolation of specific variables and allow for ease in developing statistical analysis comparisons of prediction, hypothesis testing, correlations and mean comparisons in an objective manner (Bogdan and Biklen, 1992). Qualitative data analysis procedures, however, collect data in the natural settings in which they occur focusing on a holistic, big picture perspective. Supporters of qualitative methodologies argue that those who use quantitative methods are losing validity in the effort to maintain a controlled condition within the experiment. They also argue that data is not meaningful when it occurs outside of the natural environment. Supporters of quantitative designs argue that those who utilize qualitative methodologies have difficulty replicating the experiment in the general population due to small sample sizes; the data is subjective and will be difficult to analyze because of the verbal context of the data and the way in which it is collected (e.g., documents, case studies, interviews and observations) (Babbie, 1990; Low, 1987).

Some researchers support the notion of integrating both types of methodologies into research designs, thereby gaining the advantages of each while minimizing their disadvantages (Bogdan and Biklen, 1992). While some related anthropological research areas have incorporated qualitative data into research (e.g., ethnobotany, ethnopharmacology), most researchers in the horticulture realm still shy away from qualitative research design (Barker, 1992; Merton, 1995).

Computer-aided qualitative data analysis systems (CAQDAS) were first developed in the early 1980s. While this technology allowed greater ease in the analysis of qualitative data, there was some controversy over the implications of using computers for qualitative research analysis. Concerns tended to be that the computer program would not guide, but control the outcome of the experiment, with the researcher becoming too distanced from the data. Supporters of computer use reasoned that the software would allow the researcher more time for analysis, rather than spending larger amounts of time with tedious organizational tasks that are so much a part of the qualitative technique (e.g., searching for key words, filing note cards, color-coding responses) (Burgess, 1995; Buston, 1997; Coffey et al., 1996; Lee and Fielding, 1996).

Nevertheless, the ease for computer-based analysis of qualitative data may make the methodology more appealing to quantitative approach researchers.

The objectives of this study were to investigate the impact of outdoor environmental activities on children's critical and creative thinking, as well as their attitudes toward science and math. An additional objective was to illustrate the capabilities of one computer qualitative data analysis software, NUD*IST (QSR International, Melbourne, Australia), by analyzing the answers to open-ended survey questions.

Materials and methods

EDUCATIONAL PROGRAM. An on-campus environmental education program for elementary schools in Santa Fe, N.M., called Math and Science in the Outdoor Classroom, was evaluated for this study. This program is a 3- to 4-h hands-on laboratory program in which students have the opportunity to study topics including insects, weather, soil, and water. Examples of activities include a soil texture exercise, an insect scavenger hunt, an exercise labeling insect anatomy and an exercise on the force of water. Teachers participating in the program are trained by one leader who heads the Math and Science in the Outdoor Classroom program and the teachers administer all laboratory exercises.

SAMPLE POPULATION AND INSTRUMENTATION. Second through fourth grade teachers from five schools in New Mexico volunteered their classes for participation in the study during the 1998–99 school year. The survey tool was unique to the outdoor program and included fifteen open-ended interview questions relating to the effectiveness of the program, students' enjoyment of the program, and students' perceptions of science and math. One hundred seventy-five children were interviewed after they participated in the program, and were allowed to answer questions in their own words. Twenty-one teachers and 75 volunteers were also interviewed regarding the impact of the program.

Once survey instruments were completed and returned, they were transcribed using Microsoft Word (Microsoft, Redmond, Wash.). For this study, all text data, including responses from students, teachers and volunteers, were then imported and organized within the QSR NUD*IST, Revision 4 database. Data were analyzed for response trends using Bloom's taxonomy (Bloom et al., 1956) as the theoretical framework. Bloom's taxonomy states that children progress through the stages of *knowledge, comprehension, application, analysis, synthesis,* and *evaluation*. Words and ideas relating to these categories were organized during the analysis.

SOFTWARE. The NUD*IST software was chosen for several reasons, including recommendations from other social science researchers and the reported ease of use. However, other computer programs [e.g., Info Select (Micro Logic, Midland Park, N.J.), The Ethnograph (Qualis Research, Salt Lake City), askSam (askSam Systems, Perry, Fla.)] have been evaluated by researchers (Stanley and Temple, 1995) who believe that the suitability of the computer package depends on the particular data set.

The NUD*IST software allows the researcher to work with textual documents and the organization of components within the documents. The software supports theory building in qualitative analysis by searching for key words and phrases quickly for the researcher. The researcher then has the ability to organize data hierarchically in structured trees that index categories based on the analysis and their own thoughts related to the analysis.

DATA ORGANIZATION. Within a project being evaluated using NUD*IST software, the size of the text unit is an important consideration during the course of the research project. Imported data needs to be broken into units for analysis and the software allows the researcher to manipulate the size of the text units that will be analyzed. In order to differentiate the size of a text unit, a hard carriage return is keyed at the end of each text unit. For this study, each text unit was made up of one respondent's answer to a survey question. Much smaller text unit segments could have been used, including individual sentences or words, but smaller text units may result in the loss of context of respondents' comments (Buston, 1997).

Headers and subheaders within the program help the researcher to organize files and address text units with information useful for its identification. Using headers, a researcher can code documents with respondents' demographic information, the date the information was gathered, or any other useful comments. For this project, headers were used to code text units with the school and teacher that responded to the survey. It was decided that the question asked would be used as the subheader, though many of the responses could be clearly understood on their own.

INDEXING PROCESS. NUD*IST uses nodes to help organize data in a tree-like structure where main categories make up a trunk status and subcategories make up a branch status. NUD*IST allows for free nodes, as well, when the data does not break down easily into main and subcategories. Nodes can be moved and removed from the tree-like structures, and developed as the project progresses.

Researchers and educators have believed for many years that one method for instruction and testing is not sufficient for critical thinking development (Carr, 1990). In 1956, Bloom developed a classification system for intellectual behavior as a way of organizing educational goals and objectives. It is still commonly used today when organizing testing instruments (Bloom et al., 1956). Six levels of competence are arranged as a hierarchy from least to most complex (Table 1). Generally, educational research has agreed that students progress through the first four levels from knowledge through analysis, yet the top two levels of synthesis and evaluation are at similar levels of difficulty and use different cognitive processes (Huitt, 1992). The level of evaluation is thought to be involved in left-brain, as in problem-solving and decision-making critical thinking, while synthesis is thought to be right brain, as in emotional, intuitive creative thinking (Springer and Deutsch, 1993). Educators and researchers believe that productive learning requires cognition at all levels of Bloom's taxonomy, and that students that are effective at creative and critical thinking are better problem-solvers (Duemler and Mayer, 1988).

ANALYZING. Key words and ideas that were mentally recalled from the initial data input were investigated using NUD*IST software and retrieved, as were those terms that related to ideas corresponding to the theoretical framework of Bloom's taxonomy (Bloom et al., 1956). During this retrieval, to gain insight into the intended idea, it was important to consider the context in which terms were being used. The data were then considered on a relational basis with respect to how the terms corresponded to the theoretical framework and to each other.

Results and discussion

Responses indicated strong support of learning occurring at the Math

Table 1. Levels included in Bloom's taxonomy[z] of educational objectives, the definition of each level and a sampling of behaviors associated with each level.

Level included in Bloom's taxonomy	Definition of level	Sample behaviors associated with level
Knowledge	Observes, recalls or recognizes information, ideas and principles.	Write, list, label, name, define, identify, quote
Comprehension	Translates, interprets or understands information, ideas and principles.	Explain, describe, construct, discuss, differentiate
Application	Uses methods, concepts or theories to solve problems in new situations.	Apply, show, examine, demonstrate, solve
Analysis	Observes patterns or organization of parts, and classifies and relates this information to a question.	Categorize, compare, analyze, arrange, classify
Synthesis	Creation of original ideas from the combination of old information.	Combine, integrate, plan, substitute, generalize
Evaluation	Ability to compare ideas and reason based on the values.	Support, test, rank, measure, justify, critique

[z]Bloom et al., 1956.

and Science in the Outdoor Classroom program. The term learn occurred in the data set in nearly 20% of the overall responses. When exploring the data set using Bloom's taxonomy as a theoretical framework, there was evidence that respondents felt that participating students were using both creative and critical thinking skills. The data set included terms that were associated with each level of Bloom's taxonomy (Table 2). Terms such as look, listen, explore, and count were associated with Bloom's *knowledge* level and occurred in about 50% of responses. Research in many disciplines has shown that levels of knowledge of a particular subject matter affects attitudes which, in turn, affects behavior (Kooler and Bruvold, 1992; Marietta et al., 1999; Sears et al., 1988). Therefore, it was encouraging to find that Math and Science in the Outdoor Classroom appeared to be effectively teaching the subject matter.

Bloom's application level was where most responses were found to support the students' engagement in the activities. Students applied knowledge and concepts through graphing, plotting, planting, estimating and measuring. These types of terms occurred in nearly 87% of responses (Table 2). This finding supports past research (Braun et al., 1989) that showed that an outdoor school garden helped students apply school lessons to other educational concepts.

About 19% of responses indicated that students were experiencing learning at Bloom's analysis level. Terms such as experiment and investigate occurred in the data set and indicated that the outdoor program stimulated higher-level learning (Table 2). Educational benefits have been known to occur in various types of outdoor programs because of the experiential learning derived from the real-world application (Barron, 1993; Kutsunai, 1994).

Table 2. The percentage of occurrences[z] of terms relating to each level of Bloom's taxonomy (Bloom et al., 1956) including knowledge, comprehension, application, analysis, synthesis and evaluation as a result of a text search of interview data using QSR NUD*IST (Nonnumerical Unstructured Data Indexing Searching and Theory-building) software.

Level of Bloom's taxonomy	Term[z]	Occurrence (%)
Knowledge	Look/see	12
	Listen	2.5
	Observe	12
	Participate	5.1
	Explore	4.7
	Identify	0.85
	Label	0.42
	Count	12
Total		49.57
Comprehension	Discuss	3.4
	Understand	5.1
	Describe	0.42
	Express	0.85
Total		9.77
Application	Make/create	13.9
	Apply	3.8
	Discover	4.2
	Demonstrate	0.42
	Solve	1.3
	Add, subtract, multiply, divide	26
	Write	1.7
	Graph	11
	Estimate	1.3
	Plant	11.8
	Measure	9.3
	Plot	0.85
	Show	1.3
Total		86.87
Analysis	Experiment	17.4
	Investigate	1.7
Total		19.1
Evaluation and synthesis	Problem-solving	9.7
	Integrate	1.7
	Plan	1.3
	Test	3.4
	Support	0.42
Total		26.22

[z]Terms reported by survey respondents. Those terms that resulted in an occurrence percentage of 0 were not recorded in this Table.

Bloom's highest levels of learning are those of evaluation and synthesis. Terms relating to these levels occurred in about 26% of responses, and included ideas relating to problem-solving (9.7%), and testing (3.4%) (Table 2). This was an exciting finding since educators believe that students are rarely challenged in academic settings at the uppermost levels of synthesis and evaluation. Furthermore, students remember more about subject matter when they have worked with that topic at a higher taxonomic level (Bloom et al., 1956). Past studies in the similar area of school gardens found that outdoor experiences aid in problem-solving and predicting skills (Stetson, 1991), as well as in understanding abstract concepts (Kutsunai, 1994).

Themes that arose in the data supported the idea of positive attitudes towards learning math and science in the Math and Science in the Outdoor Classroom program. Responses indicated that the outdoor program was enjoyable for the participating children with terms such as enthusiasm (6.4%), fun (19%), exciting (3%), new (5.9%), interesting (12%), and enjoyable (12%) for a total of 58.3%. Positive attitudes of youth toward science have been known to increase student interest in science and lead those students to additional science course enrollment, as well as to consider science-related occupations (Tanner, 1980; Simpson and Oliver, 1990; Farenga and Joyce, 1998). Research has shown that elementary-aged children generally have positive attitudes toward science and think science is fun, similar to results in the Math and Science in the Outdoor Classroom study. Junior-high and high school-aged children tend to consider science as boring (Yager and Yager, 1985). However, children with positive attitudes toward science in elementary school may eventually translate into positive attitudes in secondary school-aged students (Farenga and Joyce, 1998).

Additional analysis produced other intriguing ideas within this study. The notion of experiential learning was a main theme that respondents reported. Terms that occurred that supported this theme included hands-on (17%), practical (2.1%), and real world/real life (5.9%). While adults typically see nature and the landscape as a backdrop for their activities, children directly experience and manipulate a natural environment. Children use the natural environment as a sensory experience and interact with it (Sebba, 1991). Natural elements of plants, animals, soil, water and rocks provide opportunities for the exploration of diverse materials (Moore, 1993).

Negative responses were also noted. About 10% of respondents reported that students became distracted and lacked attentiveness. The lives of children today are very structured and supervised and with few opportunities to explore. When children do have free time, it is often spent in scheduled sports or lessons, or in front of the television or computer (Frost and Jacobs, 1995). However, while children may have appeared inattentive, early experiences exploring nature through play have been linked with the development of the imagination and a sense of wonder (Cobb, 1977). Development in these areas is thought to be an important motivator for a life long interest in learning (Wilson, 1997).

Most social science researchers generally accept one research perspective, either quantitative or qualitative, to the exclusion of the other. NUD*IST and other similar qualitative data analysis systems are tools that simplify data analysis and therefore, provide a means to use both techniques with ease. This study aims to promote the use of qualitative data techniques within studies relating to human issues in horticulture, leading to more valid research in the future.

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