Chapter 5
Conclusion and discussion

Introduction

This chapter presents a summary of the study followed by a discussion of the conclusions, implications and recommendations based upon the findings of the investigation. Initially, the purposes of the study are summarized as follows:

1. To develop the CTSPZ for middle school students. The program development was based on a constructivism theory and thematic science.
2. To explore the use of the CTSPZ on students' science process skills, scientific attitude, attitudes towards science, and attitudes towards the environment by converging both quantitative (broad numeric trends) and qualitative (detailed views) data.
3. To evaluate the CTSPZ with emphasis on a constructivist learning environment.

This research was a study on the effects of the CTSPZ implementation on level three students' science process skills, scientific attitude, attitude towards science, attitude towards the environment, and the constructivist learning environment. Specifically, the research was designed to answer the questions as follows:

1. Does the use of the CTSPZ program designed by the investigator and offered at Chiangmai zoo, significantly influence student's science process skills?
2. Does the use of the CTSPZ program significantly influence students' scientific attitude?
3. Does the use of the CTSPZ program significantly influence students' attitude toward science?
4. Does the use of the CTSPZ program significantly influence students' attitude towards the environment?
5. Does the incorporation of the CTSPZ provide a constructivist learning environment?

The hypotheses of the research were:

1. The designed CTSPZ program significantly influences student's ability to use

science process skills.

2. The use of the designed CTSPZ program significantly influences students' scientific attitude.

3. The designed CTSPZ program significantly influences students' attitude toward science.

4. The designed CTSPZ program significantly influences students' attitude toward the environment.

5. The incorporation of the CTSPZ provides a constructivist learning environment.

Research methodology

The research procedures are presented under the three major phases; a) program design; b) program implementation; c) program evaluation.

1. Phase one: program designing

During the first phase, the constructivist thematic science program at Chiangmai zoo (CTSPZ) was developed to customize to the needs of particular teachers and students by integrating it with formal national science standards.

The details for program designing are summarized as follows:

1.1 Identifying learner needs

The program design was begun by identifying the learner needs. Therefore a needs assessments procedure; opinion survey; and task analysis were used to gather the information.

1.2 Articulation program intentions

The researcher wrote the program rationale, goals and selected contents of science standards based on a process of clarification and articulation.

1.3 Planning instruction

The CTSPZ was developed as program- based activities. Six elements of the constructivist learning design (CLD) were used as a teaching strategies in this research. Instructional contents that best support the national science standards and are suitable for the Chiangmai zoo environment, including 6 units; 1) biodiversity; 2) food web; 3) soil horizontal; 4) water conservation; 5) Bernoulli force; 6) velocity were used.

1.4 Consulting with curriculum experts to examine and verify the draft CTSPZ

In this step, five experts about the programs validity and reliability were consulted. In addition, the curriculum evaluation form was used to gather information regarding the suitability and consistency of the curriculum. The result of the curriculum suitability evaluation showed that the ranges of the mean score were between 3.40 – 4.20 and with a standard deviation of 0-0.89. This means the curriculum was very suitable. In addition, the results from consistency evaluation of each component of the curriculum showed the content validity index is 0.80. This indicated that the curriculum had consistency among its components.

1.5 Pilot study

Small scale pilot testing was conducted on part of the curriculum to explore the students' experience when they attended the CTSPZ. Then the information was used to evaluate the drafted CTSPZ program. Finally, all feedback was used to revise the program based on a program revising guide.

2. Phase two: program implementation

The research design was a mixed method, control group interrupted time series design. The experimental group for the study included students from two schools, Satit CMU and NMP. The control groups were comprised of students from the same school system who study science in a regular class at the schools.

Quantitative and qualitative studies were used in this research. The instruments used in this study are classified as follows:

Quantitative instruments

1. Science process assessment for middle school students (SPAMSS)
2. The scientific attitude inventory: a revision (SAI II)
3. Science attitude scale for middle school students
4. The children's attitude towards the environment scale (CATES)
5. The constructivist learning environment survey (CLES)

Qualitative instruments

1. Semi-structure interview questionnaires

2. Observation

3. Phase three: program evaluation.

By evaluating the CTSPZ, the researcher measured how effective the CTSPZ was for measuring the students' science process skills; scientific attitude; attitude towards science; attitude towards the environment; and constructivist learning environment. In order to arrange the data for analysis, each dependent variable was addressed as follows:

Quantitative data analysis

Upon completion of all instruments; science process assessment for middle school students (SAMSS), the scientific attitude inventory: a revision (SAI II), science attitude scale for middle school students(SASMSS) , the children's attitude towards the environment scale (CATES), and a constructivist learning environment survey (CLES), the collected quantitative data were analyzed using the following procedures:

1. Descriptive statistic, mean, standard deviation, and variance were calculated for all instruments.
2. The t-test of significance were performed using the results data from SAMSS , SAI II, SASMSS, CATES, and CLES before and after using the science program.

Qualitative data analysis

The specific approach to phenomenological analysis as advanced by Moustakas (1994) was used to analyze qualitative data.

Conclusion

The research findings were concluded as follows:

1. Phase one: program design

According to the needs assessment procedure (opinion survey and task analysis), the CTSPZ was developed based on the CTSPZ for level 3 students as an instructional resource for educator who want to introduce students to hands-on and minds-on activities. The program organization composes of program rationale, program goal, and content science standard, planning instruction, and planning for assessment.

The program documents were examined by five experts in different field (2 zoo educators, 2 teachers who had experience in science teaching for more than 10 years, and

1 science education professor). Then the program was then revised and implemented in one classroom as a pilot study. All information from the pilot study was used to revise the CTSPZ based on program a revising guide.

After all revising, the CTSPZ composed of six thematic units that are biodiversity, velocity, water conservation, Bernoulli force, soil component and soil horizontal, and food webs. Each unit is integrated within a different field of science such as biology, chemistry, physics, and earth science. It takes 3 hours for all activities in each unit to be accomplished.

The teaching strategy would follow the constructivist learning design (CLD) to present the constructivist perspective. CLD is composed of six basic parts; 1) situation; 2) grouping; 3) bridge; 4) question; 5) exhibition; and 6) reflection.

2. Phase two: program implementation

Program implementation was conducted based on a mixed method, control group interrupted time series research design. During which the CTSPZ was studied as an independent variable and with the dependent variables being the students' science process skills, scientific attitude, attitude towards science, attitude towards the environment, and constructivist learning environment. The participants in this study were a volunteer students from Satit CMU and NMP who study in level 3.

Firstly, both quantitative and qualitative instruments were used to explore students' science process skills, scientific attitude, attitude towards science, attitude towards the environment, and constructivist learning environment as a pretest. All participants were equally divvied into an experimental and a control group. Control group students were those who studied science in a regular science class in school. While the experimental group students attend the CTSPZ at the Chiangmai zoo for all 6 units. Secondly, the posttest was conducted using the same quantitative and qualitative instruments as in pretest. The purpose was to explore whether there were a changes on the dependent variables. Finally, one month after the CTSPZ implementation, the a retention study was conducted using the same quantitative and qualitative instruments. The purpose was to explore whether students' science process skills, scientific attitude, attitude towards science, attitude towards the environment were retained.

3. Phase three: program evaluation.

To thoroughly and accurately evaluate the CTSPZ, the researcher developed a full understanding of this program. The method of achieving this understanding was through developing a theory of the program that expresses the hypothesis. The evaluation was designed primarily to determine the degree to which the CTSPZ is effective in reaching the various research related hypothesis as follows:

Hypothesis one: the designed CTSPZ program significantly influences on student's ability to use science process skills.

According to the research hypothesis one it was expected that students who participated in The CTSPZ (experimental group) would gain a higher posttest score than a student who studied science in a formal regular class in school (control group). Before conducting the CTSPZ, the results from this study showed that the mean scores of pretest between experimental and control group from Satit CMU, NMP and all participants were not significantly different at the 0.05 level. It could be assumed that students' science process skills were not different.

Since the experimental group received a treatment (the CTSPZ), it was found that the *p*-value (0.035) of the students who had low scores in science process skills (NMP) was lower than 0.05. This means that the mean score of the posttest between experimental and control groups were significantly different at the level of 0.05. This showed that students who attended the CTSPZ had a higher mean score (34.23) than the students' who attended a formal regular science class in school (29.50). Moreover, in the experimental group, the *p*-value (0.080) between posttest and retention scores were higher than 0.05. It meant that the mean score of the science process skills between posttest (34.23) and retention (37.97) were not significantly different at a level of 0.05. This showed that there was retention on student science process skills in the experimental group. This supported hypothesis I.

In addition, for a low score in science process skills students (NMP), it was found that the *p*-value of defining operationally (0.001) and interpreting data skill (0.006) were lower than 0.01 indicating the mean posttest scores between the experimental (1.63, 3.43) and control groups (2.30, 4.37) were significantly different at the 0.01 level respectively. Moreover, it was found that the *p*-value of formulating models skills (0.013) were lower than 0.05 indicating the mean posttest scores between the experimental (2.10) and control groups (2.87) were significantly different at the 0.05 level. This shows that the CTSPZ had an influence on the integrated science process skills.

Meanwhile, the *p*-value of the students who had a high score in science process skills (Satit CMU) and all participants were 1.072 and 1.953 respectively. These mean that the posttest mean scores between experimental and control group were not significantly different at the level of 0.05. It showes that although a high score in science process skills for students attending the CTSPZ, their posttest mean score (42.80) was not much different than a student who attended a formal regular science class in school (41.23). This was not in support of hypothesis 1.

However, for a high score in science process skills students (Satit CMU), it was found that the *p*-value of formulating hypothesis skills (0.035) was lower than the 0.05 level indicating the mean posttest scores between the experimental (1.47) and control groups (1.77) were significantly different at the 0.05 level. This shows that the CTSPZ has influence on integrated science process skills.

The qualitative study revealed that students use different senses in science by touching, feeling, moving, observing, listening, smelling and sometimes testing materials in a controlled manner while they attendeing the CTSPZ. Subsequently, students showed that they developed more in basic science process skills such as observing, classifying, measuring, and prediction. However, students showed a few developments on the integrated skills such as identify and pose research questions, identify and formulate hypothesis, identify variables, define variables operationally, design investigations, implement investigations, collect analyze and interpret data, draw conclusions from data, report findings orally and/or in writing.

Hypothesis two: the use of the designed CTSPZ program significantly influence students' scientific attitude.

According to the research hypothesis two, it was expected that students who participated in the CTSPZ (experimental group) would gain a higher posttest score in scientific attitude than a students who studied science in a formal regular class in school (control group). Before conducting the CTSPZ, for all participants, the results from this study showed that the *p*-value of all participants, Satit CMU, and NMP are 0.407, 0.965, and 0.248 respectively. These *p*-values were higher than 0.05. That means the mean scores of pretest between experimental (135.10, 136.97, 126.43) and control group (133.15, 137.10, 124.47) were not significantly different at the 0.05 level. It could be assumed that the students' scientific attitudes between experimental and control group were almost at the same level.

Since the experimental group received the treatment (the CTSPZ), it was found that the *p*-value (0.018) was lower than 0.05 for all participants. This means that the mean score of the posttests between experimental and control groups were significantly different at the 0.05 level. This showed that the students who attended the CTSPZ had higher mean score (134.53) than the students' who attended a formal regular science class in school (129.83). Moreover, in the experimental group, the *p*-value (0.332) between posttest and retention scores were higher than 0.05. This means that the mean score of the scientific attitude between posttest (134.53) and retention (136.55) were not significantly different at a level of 0.05. This showed that there was the retention on student scientific attitudes in the experimental group. This was on support of hypothesis 2.

According to the findings of the qualitative collected data, the second research hypothesis has shown that when students attended the CTSPZ, it enables the development of positive scientific attitudes in level three students. The CTSPZ students' view of science information and methods as it is changeable. They also had a strongly belief that science is important and relevant to everybody's life. In addition, students prefer a science related career when they are grown up.

Hypothesis three: the use of the designed CTSPZ program significantly influence students' s attitude towards science.

According to research hypothesis three, it was expected that students who participated in The CTSPZ (experimental group) would gain a higher posttest score in attitude towards science than a student who studied science in a formal regular class in school (control group). Before conducteding the CTSPZ, the results from this study showed that the *p*-value (0.491) was higher than 0.05. This means the mean scores of pretest between experimental (79.43) and control groups (78.08) were not significantly different at the 0.05 value of significance. It could be assumed that the students' attitude towards science between experimental and control group were almost at the same level.

Since the experimental group received a treatment (the CTSPZ), it was found that the *p*-value (0.000) is lower than 0.01. This means that the mean score of the posttest between experimental and control groups were significantly different at the 0.05 level of significance. This showes that students who attend the CTSPZ had a higher mean score (87.65) than the students' who attended a formal regular science class in school (77.93). Moreover, in experimental group, the *p*-value (0.000) between posttest and retention scores were lower than 0.01 (TABLE 17). The mean score of the students' attitude towards science between posttest (87.65) and retention (99.13) were significantly different at a level of 0.01. The retention means score is higher than the posttest mean score. This showed that there was the retention on students' attitude towards science in the experimental group. This supports hypothesis 3.

The qualitative results showed that the CTSPZ activities based constructivism theory were more effective in improving students' attitudes towards science. The interview results suggested that positive attitudes toward science are formed by interactions of both student's perception and the CTSPZ activities. While they attended the CTSPZ, students viewed the use of science outside of school as an extension of their science knowledge. Students also discussed issues about science more with their family and peers.

Hypothesis four: The use of the designed CTSPZ program significantly influence students' s attitude towards the environment.

According to research hypothesis four, it was expected that studentswho participated in The CTSPZ (experimental group) would gain a higher posttest score in attitude towards the environment than a student who studied science in a formal regular class in school (control group). Before conducted the CTSPZ, TABLE 22, the results from this study showed that the *p*-value (0.668) was higher than 0.05. That means the mean scores of pretest between experimental (129.77) and control groups (129.17) were not significantly different at the 0.05 level. It could be assumed that the students' attitude towards the environment between experimental and control group were almost at the same level.

Since the experimental group received the treatment (the CTSPZ), it was found that the *p*-value (0.000) is lower than 0.01. This means that the mean score of the posttests between experimental and control groups were significantly different at the level 0.01 of significance. These data showed that students who attend the CTSPZ had higher mean score (135.32) than the students' who attended a formal regular science class in school (129.48). Moreover, in experimental group, the *p*-value (0.883) between posttest and retention scores were higher than 0.05. It means that the mean score of the students' attitude towards the environment between posttest (135.32) and retention (135.52) were not significantly different at level 0.05 of significance. This showed that there was retention on student scientific attitudes in the experimental group. This was in support of hypothesis 4.

Accordingly, to determine the change in attitudes toward the environment, the researcher looked at the change in how the students responded on interview questionnaires from pretest to the posttest. The qualitative results indicated that the CTSPZ students accepted that environmental conservation is a serious issue as they responded and answer about cause and effect relationships between human activity (brush their teeth) and the water conservation. Also they are aware of individual responsibilities for environmental conservationas their view of animals is equally important with humans.

Hypothesis five: the incorporation of the CTSPZ provides a constructivist learning environment.

According to the research hypothesis five, it wasexpected that students who participated in The CTSPZ (experimental group) would gain a higher posttest score in constructivist learning environment than a pretest score. The study presented that the *p*-value (0.000) is lower than 0.01. Meaning that the mean scores of the pretest (95.23) and the posttest (104.07) were significantly different at the 0.01 level. This supported the hypothesis 5 that the CTSPZ provided a constructivist learning environment.

In addition, the response to a semi-instructional interview students responses revealed that students showed positive perception of their preferred learning style and experiences while they attended the CTSPZ. Students discussed their own ideas and the ideas of their peers to help them to achieve their goal of understanding.

Discussions

1. Phase one: program design

One of the primary challenges facing curriculum developers today is how to design curricular innovations that are appealing and useful to teachers and at the same time bring about transformative practices (Kurt; Squire; & et.al. 2003: 468).

By purpose, the CTSPZ designing started by identifying the learner needs using task analysis (a master plan of Thai zoo education, 2005) and gathering data from opinion surveys (specialist and clients). Tyler (1994) indicated that curriculum planners should identify the general curriculum objectives by gathering data from three sources: the subject matter, the learners, and the society (Ornstein; & Hunkins. 1993: 267). The uniqueness of the CTSPZ is that the actual curriculum design was drawn on many types of input such as: decision on content, information about students' prior ideas, teacher's practical knowledge of students, schools and classrooms, and perspectives on the learning process. Specifically, a constructivist view of learning and thematic science also has implications for a view of the CTSPZ designing as described by Driver and Oldham (1986) indicated that the science program is seen as the program of activities from which knowledge or skills can possibly be acquired or constructed and acknowledging that what is constructed by any learner depends to some extent on what they bring to the situation (Driver; & Oldham. 1986: 112). Constructivism is undoubtedly a major theoretical influence in contemporary science education. Constructivist influence has extended beyond just the research and scholarly community. It has an impact on a number of national curricular documents and national education statements for example, the National Council for Teacher Mathematics in the U.S., the National Science Teachers Association, and the U.S. National Science Teachers Association standards. (Matthews. 2002: 122). In Thailand, Thailand national education act and IPST visions also suggested the main ideas about constructivism as a psychological influence on curriculum thinking in science.

In addition, the CTSPZ was designed to link informal science with formal science studied in the classroom. The CTSPZ program was introduced to the national science education standards as a mechanism for bridging formal and informal science education. Based on previous reports on student learning and educational effectiveness of science museums, specific science content from the standards is outlined as potentially useful in informal settings for increasing student learning (Hofstein; Bybee; & Legro. 1997: 31). Moreover, there is already evidence to suggest that factors outside schools have a strong influence on students' education outcome, perhaps strong enough to swamp the effects of variations in education practices (Schibeci. 1989: 3). One of the most common findings of casual visiting to the zoo is that the students are often framed as social experiences that encourage group learning. Informal settings such as science museums and zoos are popularly largely because many of the activities are socially mediated and involve social-group (Hofstein; & Rosenfeld. 1996: 102). These findings support the constructivist learning design as a teaching strategy in the CTSPZ.

2. Phase two: program implementation

Successful implementation of program was resulted from careful planning. The planning process address the needs and resources prerequisites for carrying out intended actions. Implementation requires planning, and planning focuses on three factors including participants, programs, and processes (Hofstein; Bybee; & Legro. 1997: 299). Therefore, a modified mix-method control group interrupted time series design was utilized in this study. The purpose of experimental research was to test cause and effect relationships among the variables. The researcher manipulated one variable to measure the effect of this manipulation upon three dependent variables. In order to have a true experiment, three things must be evident: (1) there must be at least two groups; (2) the researcher must manipulate the dependent variable; and (3) experimental units must be randomly assigned to the groups (Merrill. 2000: 42).

The CTSPZ research design; however, lacks at least one of the three items listed above. In this study, there were two different groups (control group and experimental group). The researcher manipulated the dependent variable; but could not randomly sample the subjects; therefore, subjects were the voluntary students. The modification of this design stemmed form the fact that the researcher used comparison groups rather than “true” control groups. Campbell and Stanley stated that this design is “one of the most wide spread experimental designs in educational research“(Campbell; & Stanley. 1963: 47).

In addition, an important variant of the basic quasi-experimental design is time design. A common research problem, especially in studies of the development and growth of children, involve the study of individuals and groups using time as a variable (Kerlinger; & Lee. 2000: 544). The use of this design allowed the researcher to make it possible to separate reactive effects form the effects of the treatment. It enabled the researcher to determine, if the measurements had a reactive effect, and whether the treatment was strong enough to overcome that effect.

One difficulty with time studies, especially with children, is the growth or learning that occurs naturally over time. Therefore, the qualitative instruments that were used incorporated the quantitative instruments. In quantitative instruments, the outcome is best addressed by understanding what factors or variables influence an outcome. In qualitative instruments, the researcher could describe a research outcome that can best be understood by exploring a concept or phenomena (Creswell. 2003: 74).

3. Phase three: program evaluation

Five main instruments were used to evaluate the CTSPZ with different prospective. All five instruments are research instruments validated to evaluate the CTSPZ and have been widely used. The details for each perspective are discussed as follows:

3.1 Science process skills

According to the findings, it was found that the CTSPZ influenced the student's ability to use science process skills differently. Considering the pretest score, the participants in this study were categorized into a high score in science process skills students and a low score in science process skill students.

For low score in science process skill students, the posttest mean score of the posttest between experimental (34.23) and control groups (29.50) were significantly different at the *p*-value of 0.05. This would support the hypothesis that the students who attend the CTSPZ gained higher mean scores than that of the control group students. This result supports the findings that when hands-on learning activities are undertaken along with student-centered teaching approaches, the science process skills of students develop better (Hofstein; & Lunetta. 2004: 50). In addition, through hands-on activities in the CTSPZ, students used different senses in science classes by touching, feeling, moving, observing, listening, smelling and sometimes testing materials in a controlled manner. This helps students to progress from concrete thinking levels to more complex thinking levels (Bilgin. 2006: 28).

On the other hand, the *p*-value (1.072) of the students with a high score in science process skills students was higher than 0.05. It means that the posttest means score between experimental (42.80) and control groups (41.23) were not scientifically different at level 0.05 of significance. For quantitative approach, this did not support the hypothesis that students who attended the CTSPZ should gain higher score on posttest than control group students. In addition, the qualitative approach, this finding could be discussed in different ways. Firstly, it could be assume from the pretest results that a high score in science process skills students scored high on pretest (almost 50); therefore, they could not score much further in posttest. This would suggest that, more than one instrument should be used to explore student science process skills. There are several evaluation approaches that science educators can use to evaluate student's science process skills. Harlen focused on an approach for process skills assessment in three purposes; formative, summative, and national and international monitoring. In all cases, the assessment of skills is influenced not only by the ability to use the skills but also by knowledge of and the familiarity with the subject matter with which the skills are used. Thus what is being assessed in any particular situation is a combination of skills and knowledge and various steps have to be taken if they are to be separated (Harlen. 1999: 129).

Similarly, in this research, formative assessment was gathered by researcher and by students assessing their own work. Information was gathered by; observing, using open ended questions, phrased to invite students to explore their ideas and reasoning; setting tasks in a way that it requires the students to use certain skills; and asking students to communicate their thinking through drawings, artifacts, actions, as well as writing.

3.2 Scientific attitudes

In this study, it can be seen that scientific attitudes have been the focus in the program evaluation Koballa. 1988: 119) described scientific attitude as the separation of individuals between the problems, events, situations, and feelings that they experience and comment on them based on logical data. In this study, scientific attitude refers to a particular approach a person assumes for solving problems, for assessing ideas and information, and for making decisions. It includes such scientific methods and predispositions as objectivity, suspended judgment, critical evaluation and skepticism (Gauld. 1982: 115).

According to the findings of the collected data, it has been determined that when students attended the CTSPZ, their scientific attitudes developed in a positive manner. This result agreed with the previous study indicating that educational activities based on social learning theory were more effective in improving students' scientific attitudes (Murat; & Rahmi. 2006: 363). Supportably, briefly giving life histories about famous scientists, museum or zoo visits, and activities on natural life will help students appreciate scientific education. Therefore, in the primary school period, the teaching activities might increase the effectiveness of general education by taking the scientific and affective aspects into consideration in order to develop scientific attitudes and planning.

Moreover, the CTSPZ as an informal learning program makes positive contributions to the development of students and provides permanency of their interest and desire to learn. At the first level the students were faced with the CTSPZ through basic activities during their zoo visit. During this period, the students were helped to become acquainted with science in a field setting, notice the basic principles of scientific methods, develop permanency of interest and a desire to learn, acquire the scientific process skills, and were provided with facilities to decide an appropriate field of study related to science. The evaluation of success in scientific teaching and learning is made through positive changes in behaviors.

3.3 Attitude toward science

The investigation of students' attitudes toward studying science has been a substantive feature of the work of the science educational research community for the past 30 to40 years. Consequently, the promotion of favorable attitudes towards science is increasingly a matter of concern. However, the concept of an attitude towards science is somewhat nebulous, often poorly articulated and not well understood (Osborne. 2003: 1049). This research offers; therefore, a review of current knowledge about attitudes towards science which was developed in an informal setting.

The collected data demonstrated that when hands-on learning activities at an informal setting were used with a constructivist learning approach in the CTSPZ, it enables the development of positive attitudes toward science in level three students compared to a formal science approach in science classrooms. There was also a rise and high retention in attitudes toward science in a social context after the visit. Although these students had clearly been influenced by the CTSPZ, some also talked about how they liked experiments in school. This result agreed with previous studies in that when hands-on learning activities are used in groups, the students' attitudes toward science develop positively (Hofstein;& Lunetta. 2004: 43).

In addition, the CTSPZ can address aspects of science educationthat might be missing in more formal, class-based science learning, to provide an awareness of the relevance of science to society. It can also generate a sense of wonder, interest, enthusiasm, motivation, and eagerness to learn, which are much neglected in traditional formal school science (Pedretti. 2002: 35; Ramey; & Walberg. 1994: 11). Attitudes not only influence views of science and aspirations for future careers, they can also influence attainment. Children with more positive attitudes toward science show increased attention to classroom instruction and participate more in science activities (Germann. 1988: 689). Learning science in an informal setting not only promotes positive attitudes, which may influence achievement in school, but some cognitive learning can occur as well (Hofstein; & Rosenfeld. 1996: 90)

3.4 Attitude toward the environment

Holahan described attitude toward the environment as “people’s favorable feelings toward some features of the physical environment or towards an issues that pertains to the physical environment.” In this study the researcher viewed and measured attitude towards the environment as attitude towards taking environmental actions, positive or negative reactions to activities related to the natural environment (Hines; & et al., 1987: 6).

The results of this study provide a strong support for the hypothesis that students who attended the CTSPZ in an informal setting scientifically improve in the positive attitude towards the environment more than the students who study in a formal science classroom. These findings are consistent with Milton, Cleveland, and Bennett-Gates who reported that outdoor activities requiring direct involvement with the natural environment help students improve more in positive attitude towards the environmental then indirect or noninteractive experience such as videotape, reading, or discussion (Milton; &Cleveland; & Bennett. 1995: 37). The findings of this study add to this body of knowledge by providing evidence that informal learning at the zoo can function as an easily accessible, familiar, natural setting for outdoor science inquiry and learning. It generally has been assumed that participation in outdoor recreation promotes environmental awareness simply by exposing people to environmental issues and concerns.

In addition, Baterson and Xin found the strong relationship between general positive attitude toward science and general positive attitude towards the environment. That is, the general positive attitude underlying the structure of attitude toward the environment correlated substantially with the general positive attitude underlying the structure of attitude towards science. Students who had a favorable attitude toward the environment also showed a favorable attitude towards science. This finding implies that environmental educators can predict attitude toward the environment from the attitude towards science if information is not available about students' attitude toward the environment. This relationship also indicates that attitude towards the environment and attitude towards science do influence each other (Ma; & Baterson. 1999: 30)

3.5 Constructivist learning environment

There is increasing evidence that to prepare students who will be better, more effective learners of science, different methods of preparing prospective learners are necessary. This study presents that theoretical and practical rationale for developing a constructivist-based informal science programs and reports on the findings for the program implementation.

The results of this investigation have shown that the CTSPZ activities provide a constructivist learning environment. In traditional teaching approaches, students are passive recipients, but in the CTSPZ learning approach students are in an active position. This approach allows students to work in groups and enables them to develop social interactions. According to Johnson and Johnson (1986), students who talk through course materials with peers will learn more effectively. The tasks requiring social interactions will stimulate learning and will enable students to recognize that an action should be taken with reference to others. In cooperative learning, students are provided with concrete experiences first hand.

According to the constructivist theory, learning is the interpretation of what is happening in the world from the point of view of the individual in planned experiences (Jaworsky. 1994: 18). Within the CTSPZ, students took part in the learning-based activities, felt the activity by using all possible senses, and reached a conclusion after thinking in terms of cause-effect relations. Therefore, students are not passive recipients of knowledge but they construct knowledge by participating actively in learning activities and by using cognitive processes (Wheatley. 1991: 11).

Recommendation

After interpretation of the results CTSPZ based on constructivist learning theory, the following concerns need to be considered when developing and implementing an informal science program:

For science teacher

The results of this investigation showed that the CTSPZ, positively influenced student's science process skills and attitudes toward science. It appears that science instruction that includes an informal experience is a viable and effective instructional method for science teachers. Based on the findings presented in this study, a hands-on activites, thematic units, and constructivist learning environment, as parts of the CTSPZ, offered a prescriptive method for raising science process skills levels and promoting positive attitudes toward science among science students, particularly for those who enrolled in CTSPZ. The model of CTSPZ proposed here appears to be effective with students of diverse backgrounds including both high scores and low scores in the science process skills. Therefore, teachers who are the operators of the science curriculum must be informed about this effective learning.

In addition, most of the research studies in theliterature showed that there were positive relationships between the students' science process skills and their achievements in science and also between the students' positive attitudes toward science and their achievements in science (Schibeci; & Riley, 1986). Therefore, science teachers should be aware of the importance of improving the students' science process skills and positive attitudes toward science, because they are strong predictors of the students' achievement in science.

According to Newman (1990), social conditions in a class are constructed actively by the teacher and students. The learning environment constructed in the CTSPZ are support interactive dialogue, discussion, and cooperation in activities. Hands-on activities and constructivist learning environment are the most important learning environments that provide the development of attitudes and cognitive levels in a positive manner that lead students to discover scientific facts and concepts in small groups as well as providing development of social relations through these activities. Due to these reasons, hands-on activities should be given more consideration in science teaching (Hofstein; &etta. 2004:95)

For school administrators

The emphasis in this research was on learning in informal settings in that the researchers examined the learning in a zoo, focused on using the school system to maximize the effectiveness of the educational interventions that took place outside of the school. In the light of the results of this study, the positive attitude towards science and the attitude towards the environment disposed students to engage in learning about science and the environment. Therefore, one would look to the richness of experiences in informal settings to develop understanding. Considering the amount of time that students spend in formal vs. informal settings, it would seem more appropriate to focus on how informal settings can enhance or improve school-based instruction. However, more work has to be done to illuminate, develop, and support the relationship between formal and informal settings, so as to maximize the strengths of each institution.

The primary goal of this study was to develop a model that can be easily applied to various diverse situations in which an informal education program could effectively enhance and expand formal education. This model would form sustainable relationships and links between informal and formal education. Sustainability is created by integrating the informal education program into the formal education program. The components of the model, setting, teachers, and classroom may change, but the linkages remain. The content could be easily be changed so that the CTSPZ could serve as a blueprint for other informal education programs.

For zoo administrators

With the shift in the zoo paradigm extending the goals of the zoo to include not only recreation but also education, conservation, and research, zoos need to take advantage of every opportunity to educate visitors. Based on the results of the present study, zoos can use the CTSPZ with interpretation to increase educational and recreational benefits and visitor perceptions of the zoo.

Future study

1. Replication of this study should be conducted with a larger sample of subjects through the full range of middle grade levels. In addition, the students should be tested several times over a period of at least one year. This would allow time for the habits of mind discussed, by Aldridge (1989), to develop and for difference between experimental and control groups to become more pronounced.

2. A qualitative study should be conducted to examine which of the science process skills are most often used and in what order students tend to use them. Moreover, the examination of pairs of skills which are closely related to one another, for example measuring and recording data, should be conducted.

3. A longitudinal study could be conducted to determine what the effect of the CTSPZ has on students. A study could be conducted school-wide to determine the effect of the CTSPZ, thematic teaching, or the naturalist have on the teachers.

4. A comparative study of other informal educational programs could also be conducted. Some of the questions might include;

- How was the CTSPZ developed and maintained?
- How is the CTSPZ being used?
- How does the model of the themes, constructivism, and values compare with other informal educational program?