Abstract

This investigation focused on science methods within fifth- through eighth-grade classrooms of a selected Seventh-day Adventist conference. Teachers reported they primarily used the methods of discussion, student projects, and tests or quizzes. Although they felt prepared to use these methods, most said they did not feel prepared or had “never heard of” methods such as inquiry, learning cycle, or constructivism. Over half the respondents felt the methods of discussion, student-projects, and hands-on laboratory work were effective. Learning cycle and constructivism were described as “not at all” effective; these were the same two methodologies many respondents had “never heard of.”

Introduction

Science plays an important role in every student’s education. That it is a component of every elementary and middle school curriculum within the United States demonstrates its acceptance as a core subject, along with reading, English, social studies, and mathematics (Tanner & Tanner, 1989). Science education gives students opportunities to exercise their natural curiosity and explore the world they live in. According to the goals established by the National Science Education Standards (National Research Council, 1996), Project 2061 (American Association for the Advancement of Science (AAAS), 1992), and Benchmarks for Science Literacy (AAAS, 1993), students should engage in exploration of ideas and broad concepts in order for them to make connections between scientific principles and their daily lives. Students should develop ways to solve problems, make decisions, and think critically. This is the vision for science education in American society today.

Through science education, all students should have the opportunity to experience what science has to offer for their developing minds. Therefore, both public and private schools are
expected to meet national science goals. The Seventh-day Adventist education system, along with other church-related schools, is attempting to meet these standards. Having these goals as a critical component of their curriculum development process, helps ensure inclusion of essential science learnings for students. Integration of national standards, guided by the philosophical foundations of Adventist education, enables the system in achieving its goal for quality science curriculum.

**Science Education**

“Science was created by humans to predict and explain event and phenomena” (Krajcik, 1999, p. 12). In order to fulfill this purpose, teachers and students should be continually involved in a day-to-day learning process. The years in the elementary and middle school will allow them to construct a foundation for understanding the world in which they live. Students’ interests in science will grow and lead to a pursuit of science studies in their education. Science as a component of every elementary and middle school curriculum,

helps [students] acquire knowledge and skills that will be useful throughout their lives; it teaches them to think critically, solve problems, and make decisions that can improve the quality of their lives; it develops attitudes, as curiosity or sensitivity to environmental concerns, that foster students’ taking responsibility for their acquisitions; and it guides students in understanding real life issues and participating in a global society (p. 15).

Within a science education program, use of the three-Rs (reading, writing, and arithmetic) arise naturally (Gega & Peters, 1998). For example, programs, where manipulative materials are used, help students to build their reading and language readiness at the primary level. When students are using firsthand experiences in science, their vocabulary and reading comprehension expands. The necessity for good science teaching, where children are taught to develop “the kinds of attitudes, ways of thinking, and solid knowledge base that promote success in the real
“world,” depends on what methods teachers are using in their classroom (Gega & Peters, 1998, p. 23). “Good science teaching” facilitates students’ expanding beyond the thee ‘Rs’; they will not be “trapped into a narrow and superficial outlook that reduces their capacity to learn further and solve real problems” (Gega & Peters, 1998, p. 23).

**National Science Education Standards**

The National Science Education Standards developed by the National Research Council with assistance of the National Academy of Science in 1996, set forth goals that teachers should meet in their classrooms in relation to the methods being used to teach science. These include: (1) to educate students about the natural world, (2) to develop skills in using scientific processes and principles in making personal decisions, (3) to engage in public discourse and debate, and (4) to increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers (National Research Council, 1996).

Standards prompt teachers to use methodologies that develop communities of science learners, support the use of inquiry through the use of outside resources, promote collaboration and discourse among students, help students become responsible for their own learning, and work with other teachers within and outside of science. In addition to goals and standards for K-12 student learning, standards were created to guide professional development of science teachers, assessment practices in science, and science-education programs at the school, district, state, and national levels (Burton, 1998). Science methodologies supported by the literature include: constructivism, inquiry-based science, learning cycle, and hands-on/laboratory work.
Constructivism

Constructivism is defined as, “a view of learning in which learners use their own experiences to construct understandings that make sense to them, rather than having understanding delivered to them in already organized form” (Kauchak & Eggen, 1998, p. 184). Science educators consider the constructivist approach essential to achieving the goals and standards set at the national level (Stainback & Stainback, 1996).

In a constructivist classroom, students build on their prior knowledge in order to develop a deeper understanding of the new material they encounter through various learning activities. Some teaching/learning activities are built on the constructivist philosophy. Four examples of these activities are hands-on, minds-on, guided discovery, and open inquiry. In Teaching Science Through Discovery (Carin, 1997), these four teaching/learning activities are described as follows:

<table>
<thead>
<tr>
<th>Teaching/Learning Activity</th>
<th>Constructivist Philosophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on</td>
<td>Learners explore materials and events through their senses and learn by doing</td>
</tr>
<tr>
<td>Minds-on</td>
<td>Learners construct knowledge and relationships by thinking about what they are doing and learning from the manipulated materials and events</td>
</tr>
<tr>
<td>Guided Discovery</td>
<td>Teacher plans and organizes learning environment and provides experiences to facilitate and guide students’ meaningful knowledge building and learning</td>
</tr>
<tr>
<td>Open Inquiry</td>
<td>Students explore questions of their own construction using a scientific way of knowing</td>
</tr>
</tbody>
</table>

Science for all Children, (Martin, Sexton, & Gerlovich, 1998) describes constructivism as the dominant perspective on learning in science education. The teacher who accepts this method of teaching “supports a different view of science, regards the roles of teacher and learner very differently, and selects and organizes teaching materials with particular care” (p. 45). Two key roles are played in a constructivist classroom: the learner and the teacher. The learner plays an
active role, physically, mentally and socially. The teacher plays a supporting role through encouragement of students’ active participation in the development of their own understanding. It is the teacher who sparks the interest connects to previous knowledge, and stimulates student active and meaningful construction (Stainback and Stainback, 1996).

“Constructivism is a theory that assumes knowledge cannot exist outside the minds of thinking persons . . . Constructivism emphasizes the importance of each pupil’s active construction of knowledge through the interplay of prior learning and newer learning” (Martin, Sexton, & Gerlovich, 1998, p. 49). The use of constructivism as a method of teaching allows for any student to gain knowledge in a dynamic and productive manner. Students are placed in control of their learning.

Kauchak and Eggen (1998) list the following essential characteristics of constructivism: “learners construct their own knowledge, new learning depends on current understanding, learning is facilitated by social interaction, and meaningful learning occurs within authentic learning tasks” (p. 185). These four characteristics provide the foundation for this method of teaching and learning. At the core of the instructional lessons are the solutions and answers to questions and inquiry, which the students develop; however, it is essential the students cultivate solutions and answers. Solutions may be created from the various examples that the teacher has shown in class in the form of illustrations or demonstrations, or they may be derived from the social interactions taking place in the classroom. Interactions are vital because they not only require students to develop their own thoughts, but they also require students to evaluate their thinking and that of their classmates through comparison (Kauchak & Eggen, 1998).

Marvin Tolman and Garry Hardy believe that “occasionally, we acquire new information that we can’t connect to previously acquired information, and a new seed of knowledge and
experience germinates, neither clarified nor cluttered by previous knowledge. The cognitive foundation by which we can build in future learning experiences is then expanded by the new knowledge” (1999, p. 23). Constructivism, as an instructional method, in areas as biology and chemistry, has been proven to be an avenue by which students can connect new information to previous knowledge and/or embrace new learning upon which to enlarge. Students are able to take concepts they have learned from previous schooling and experiences and enrich them. Thus, under a constructivist-oriented instructional model, students “invite, explore, discover, create, propose explanations, and take action” (Carin, 1997, p. 74). The learner regulates learning in constructivistic model (Stainback and Stainback, 1996).

**Figure 1**: Constructivist-Oriented Instructional Model (Carin, 1997, p. 74)

<table>
<thead>
<tr>
<th><strong>Science</strong></th>
<th><strong>Technology</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Originate in questions about the natural world</td>
<td>Originate in problems of human adaptation in the environment</td>
</tr>
<tr>
<td>Methods of inquiry</td>
<td>Problem-solving strategies</td>
</tr>
<tr>
<td>Explanations for phenomena in the natural world</td>
<td>Solutions to human adaptation</td>
</tr>
<tr>
<td>Personal actions and social applications</td>
<td>Personal actions and social applications</td>
</tr>
</tbody>
</table>

| | Invite |
| | Explore, discover, create |
| | Propose explanations and |
| | Take action |

**Inquiry-based Science**

Another method that may be used in the science classroom is inquiry-based science. “According to the National Research Council, inquiry is the ‘shifting (of) emphasis from teachers presenting information . . . to students learning science through active involvement’” (Friedl, 2001, p. 3). Inquiry-based teaching should be the foundation of every elementary science classroom because children are always filled with questions. Taking advantage of natural curiosity will allow the class as a whole to be productive in their learning. “Children are filled
with curiosity. They come to school with a natural love of learning. They ask questions and seek answers to build on their prior knowledge” (Sherman, 2000, p. 15).

Sherman (2000) goes on to say the only way for science “to come to life” is by the teacher facilitating environments that are meaningful for students to learn. These experiences may include using authentic teaching materials such as: rocks and minerals, plants, animals, and other objects that students may use to explore. According to the National Science Education Standards, through inquiry,

students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understandings of science by combining scientific knowledge with reason and thinking skills (National Research Council, 1996).

Sherman says the above statement vastly important “because it describes science as scientists know it, and it applies to the classroom as well” (2000, p. 16). Students should develop the skills that are involved in inquiry training because it allows them to question knowledgably, propose and develop investigations, collect data appropriately, develop thought-provoking explanations to their inquiries, and effectively communicate their results to others (Rakow, Texle, Reynold, & Lowery, 2000).

Inquiry-based science is derived from the scientific process and consists of five phases (Green, Green, & Burton, in press; Suchman, 1966). Phase one begins by facing the students with a discrepant event. Such an event is “an experience, usually in-class, which creates cognitive dissonance in students’ minds and makes them ask, ‘Why?’” (Green, Green, & Burton, in press, p. 3). Cognitive dissonance occurs when the observed event does not ‘fit’ the understandings students have already developed about the world around them. “The more
powerful the dissonance created, the stronger the sense of wonder created, the greater the potential for learning” (Green, Green, & Burton, in press, p. 3).

In the second phase, the students are given the opportunity to gather data, which is then verified and examined. During this phase, there are two primary tasks students complete. The first is “to analyze the discrepant event, and to isolate and test relevant variables” (Green, Green, & Burton, in press, p. 4). At the core of these two tasks are four types of questions that they may ask: verification (seek factual information), experimentation (manipulate variables), necessity (discovery of value of variables), and synthesis (student expression of causation) (Green, Green, & Burton, in press; Suchman, 1966).

In addition, students may develop four different types of data, including objects, conditions, events, and properties. Data can be used to guide student development of questions or in category expansion. In this phase, students should be encouraged to exhaust, or thoroughly investigate, specific variables in order to reach their final analysis and hypothesis concerning the discrepant event (Green, Green, & Burton, in press; Suchman, 1966).

The third phase is inducing cause-effect relationships. In this phase, students begin to automatically develop theories based on their questions and their thought processes. It is important that these theories are also based on facts, which have resulted from answers to their questions. If no factual basis exists for proposed theories, the students must uncover additional facts, and then develop their theories. “It is through the experimental testing of hypotheses that students test cause-effect relationships. As hypotheses about cause-effect relationships are tested through a series of experiments, these hypotheses are found to be credible or implausible” (Green, Green, & Burton, in press, p. 6).
Formulating and communicating an explanation for the discrepant event is the fourth phase (Suchman, 1966). Once students have asked questions, gathered data, exhausted specific variables, and developed theories, they are prepared to give their explanation. “During phase four each student formulates an explanation for the discrepant event and constructs support for that explanation from the data gathered during Phases 2 and 3…It is important that each student be able to explain the reasons why the discrepant event occurred, as this is the demonstration of their concept construction during Inquiry Training” (Green, Green, & Burton, in press, p. 6).

In the final phase of this method, analysis of the inquiry process, students are asked to explain their thinking processes as they moved from one phase to the next. The overt culminating metacognition allows students to “focus on their own thinking processes and make them public. Students also have the opportunity to hear from their peers and see how their thinking processes are similar or different from them. This phase of the lesson provides opportunities for students to increase their repertoire of problem-solving thinking processes by making their personal processes explicit and by hearing alternative approaches that work for others. There are several questions that teachers can use in order to get the students thinking: How did you begin your inquiry training? What made you exhaust certain variables? What got you thinking in a new direction? What could you do better to improve your approach next time? Were you able to explain your reasoning after you tested your hypothesis?” (Green, Green, & Burton, in press, p. 7).

As a teacher, one is able to recognize whether or not one is implementing inquiry into a science education program by using the following acronym: TEACHER
You know you are teaching science as inquiry when you guide students to:

Think about the order of the natural world;
Explore systems of objects and organisms for themselves;
Ask simple questions about natural phenomena that can lead to investigations;
Collect data and gather information that are relevant to the questions;
Hear how others make sense of the data and information;
Explain and defend their own understanding of natural phenomena;
Reflect on their understanding and that of others, clarifying, elaborating, and justifying ideas;
connecting evidence, knowledge, and conclusions; dealing with misunderstandings; and linking what they have discovered to other domains and other subjects.

Learning Cycle

“The learning cycle was first introduced in the early 1960s as the methodology used in the Science Curriculum Improvement Study, a complete program that focuses on giving students a hands-on approach to life and physical science concepts” (Cain, 2002, p.98). The learning cycle is composed of three phases: (1) exploration, (2) explanation (concept introduction), and (3) expansion (concept application). During the first phase the students interact with materials and with each other. The role of the teacher is that of a guide to a learner’s curiosity. Thus, the teacher is also actively involved in the process by asking the students questions and giving hints and cues to keep the phase of exploration flowing until it has reached its climax (Martin, Sexton, & Franklin, 2002, p. 5).

During the explanation phase, the students and the teacher interact in order to invent the concept from the exploring that had occurred in the first phase, where students collected data and/or made observations (Martin, Sexton, & Franklin, 2002). “At this point, the teacher can begin direct instruction by eliciting the information students discovered during their
exploration…. [The teacher can do so] in the form of explanations, print materials, guest speakers, use of technology, and other resources” (Cain, 2002, p. 99).

In the last phase, expansion, the teacher guides student interactions. This phase requires the student to apply the concepts they have built during the first two phases. Consequently, they are expanding on ideas and uses of science. “This phase allows the learner the opportunity to integrate and evaluate his or her new ideas with old ideas to form additional new ideas” (Cain, 2002, p. 100).

Evaluation of the students’ progress may take place throughout the entire learning cycle, informally and formally (Martin, Sexton, & Franklin, 2002). It is important that the teacher is documenting anecdotal observations as the students progress through each phase. In this fashion, the teacher is able to determine whether the learner understands concepts explored. Measurement of understanding can be enhanced through the use of questions during the cycle. The following figure provides an explanation of the type of questions that may be used.

**Figure 3:** Learning Cycle Questions (Martin, Sexton & Gerlovich, 1998, p. 4)

**Using Questions During a Learning Cycle**

<table>
<thead>
<tr>
<th>Step 1 Exploration:</th>
<th>Step 2 Explanation</th>
<th>Step 3 Expansion:</th>
<th>Step 4 Evaluation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-centered cooperative inquiry</td>
<td>Concept is formed; meaning is constructed</td>
<td>Student apply [the] learned and expand understanding of the concept</td>
<td>Formal or informal evaluation occurs throughout the learning cycle universe</td>
</tr>
<tr>
<td>Divergent questions</td>
<td>Divergent, convergent and evaluative questions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convergent questions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Convergent questions

Divergent questions

Evaluative questions
Hands-on/Laboratory Work

Hands-on elementary science is not a method new to science education. Based on research developed in the 1960s and 70s, Bredderman investigated the effects of such a curriculum that was activity-oriented, which involved the experiences of 13,000 students in over 1,000 classrooms in sixty studies over 15 years. His findings state: “‘with the use of activity-based science programs, teachers can expect substantially improved performance in science process and creativity; modestly increased performance on tests of perception, logic, language development, science content, and math; modestly improved attitudes toward science and science class; and pronounced benefits for disadvantaged students” (Bredderman, cited in Ukens, 1992, p. 160).

However, the term “hands-on/minds-on” has become popular more recently. “Scientific knowledge does not reside in the materials, ready to ‘be mysteriously released during hands-on activities.’ On the contrary, scientific knowledge needs to be constructed in interactions in which students and the teachers interact verbally using a shared language” (Tobin, 1998, p. 29). The manipulation of materials increases the opportunities for conversation; however teacher mediation between the language and the student is essential. Although, it should be clearly noted, this method “does not imply a return to the days when teachers transmitted facts in lectures or the principal learning resource was a textbook. But it does require students to talk science—in ways that connect to their experiences in other subjects and to their lives outside of school” (Tobin, 1998).

There are three essential factors for the success of a hands-on/minds-on experience: (1) materials, (2) tools, and (3) emerging artifacts. Materials and design artifacts are tools for students to think with. They are also resources for mediating students’ design talk. Lastly, these
can serve as a ground for students’ emergent discourse of their physical experiences and in their material world (Roth, Tobin, & Ritchie, 2001, p. 36).

**Figure 4:** Reasons for a Hands-On Approach (Ukens, 1992, p. 161)

<table>
<thead>
<tr>
<th>Six Important Reasons for Teaching Science from a Hands-On Approach:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students in an activity-based science program outperform students in non-activity programs.</td>
</tr>
<tr>
<td>2. Students are able to develop thinking skills.</td>
</tr>
<tr>
<td>3. Students are able to develop responsibility for their own learning.</td>
</tr>
<tr>
<td>4. Students learn best by manipulating concrete objects based on Piagetian perspective.</td>
</tr>
<tr>
<td>5. This approach reinforces learning in other curricular areas.</td>
</tr>
<tr>
<td>6. This approach avoids the “mindless” curriculum that forces children to memorize a lot of factual information.</td>
</tr>
</tbody>
</table>

**Research Questions**

Although an exploratory national, cross-denominational study of science education in Christian K-12 schools has been reported (Burton, 1998, p. 37), an investigation of science methodologies in fifth- through eighth-grade science classrooms within the Seventh-day Adventist system of education has not been reported in the research literature. This study sought to investigate the following research questions:

1. What methods are being used by fifth- through eighth-grade science teachers in a selected Conference of Seventh-day Adventists?

2. Do these teachers tend to regularly use a few methods or a variety of methods?

3. What are the teachers’ perceptions regarding their preparation to use current science teaching methods?

4. What are the teachers’ perceptions regarding the effectiveness of current science teaching methods?

This investigation of Seventh-day Adventist schools allowed the researchers to develop a general descriptor of middle grades science education within the system. Descriptors included
teachers’ reported use of selected methods in the science classroom, teachers’ perceptions of their own preparation to use selected methods, and their perceptions of the methods in science education effectiveness.

Methodology

Sampling and Procedure

Participants were selected from a list of teachers employed by a selected conference (state-level division) within the North American Seventh-day Adventist educational system. This conference was selected because it employed a multiple number of elementary teachers and it had a history of collaboration with the researchers. Using the addresses listed for the conference teachers, the survey instrument was sent to all fifth- through eighth-grade science teachers within the selected conference. These 72 teachers included those who taught in multi-grade classrooms, single-grade classrooms, and those who worked as subject-area specialists.

The study utilized standard mail-survey techniques for the data collection procedure during fall semester 2002. Procedures included an initial mailing, follow-up phone call reminders, and a second mailing of the survey instrument. Thirty-nine teachers returned survey instruments with usable data, resulting in a net return rate of 54.2%.

Instrumentation

The survey instrument for this study was adapted from an instrument used in a previous national study (Anderson, 1996; Burton, 1998). It consisted of four sections: Context Variables (demographics), Science Methods, Perceived Preparation, and Perceived Effectiveness. Methods listed on the instrument included the following specific instructional techniques: lecture, discussion, student reports, student projects, hands-on/laboratory work, cooperative learning, inductive thinking activities, tests or quizzes, simulations, role-play, teacher demonstrations,
field trips, inquiry, discovery, problem-solving, learning cycle approach, constructivism, and project-based science (see Table 2). The instrument did not include definitions or descriptions of these methods; therefore a limitation of the investigation is the possibility respondents could differ in their interpretations of these labels.

Science and mathematics consultants reviewed the preliminary drafts of the instrument. These reviews and discussions with research advisors served as the basis for further revision. After obtaining approval from the Institutional Review Board and officials from the selected conference, the survey was distributed during the months of October and November 2002.

The fifth- through eighth-grade science teachers were asked to rate their use of, perceived preparation for teaching, and perceived effectiveness of the instructional variables (methods) listed on the survey instrument (Table 2).

<table>
<thead>
<tr>
<th>Methods</th>
<th>Inducting Thinking Activities</th>
<th>Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Tests or Quizzes</td>
<td>Discovery</td>
</tr>
<tr>
<td>Student Reports</td>
<td>Simulations</td>
<td>Problem-Solving</td>
</tr>
<tr>
<td>Student Projects</td>
<td>Role Play</td>
<td>Learning-Cycle Approach</td>
</tr>
<tr>
<td>Hands-on/Laboratory Work</td>
<td>Teacher Demonstrations</td>
<td>Constructivism</td>
</tr>
<tr>
<td>Cooperative Learning</td>
<td>Field Trips, Excursions</td>
<td>Project-based Science</td>
</tr>
</tbody>
</table>

Results

Use of Science Methods

The first research question asked, “What methods are being used by fifth- through eighth-grade science teachers in a selected Conference of Seventh-day Adventists?” The Science Methods section of the instrument was designed to answer this question. It contains 18 methods identified as being related to science education or having emerged from science education. For analysis purposes, methods that were reported as “frequent” and “to a great extent” were
combined to form a new category known as “regular.” Likewise, methods reported as “to some extent” and “very little” were categorized as “occasional.” The “not at all” category remained unchanged.

The most commonly used science method was “discussion,” with 71.8% of survey respondents reporting regular use. Another method, “tests or quizzes,” was reported as a regularly used method by 61.5%. Forty-six percent of the fifth- through eighth-grade science teachers reported using “student projects” regularly as well. “Hands-on/laboratory work” was reported as being used regularly by 41% of the respondents, while 33.3% of the respondents reported the use of “cooperative learning” as regular (see Table 3).

It is also informative to note the science methods that were rarely used by science teachers in fifth- through eighth-grade science classrooms. The least used was “role-play.” None of the respondents reported the use of “role-play” (0%). Only 5.1% of respondents reported regular use of “field trips” and “constructivism.” Similarly, only 7.7% of the respondents reported regular use of the methods of “simulations” and “learning cycle” (see Table 3).

**Use of a Few or a Variety of Science Methods**

The second research question asked, “Do these teachers tend to regularly use a few methods or a variety of methods?” Data from the “regular” category described above was used to answer this question. A frequency count was generated to represent the number of methods reported as “regular” use by each respondent (see Figure 5). “Use of a few methods,” for the purpose of this study, was defined as teachers who reported “regular” use of one to four methods. “Use of a variety of methods” was defined as “regular” use of five or more methods. By using at least five different methods regularly, the teacher, hypothetically, is able to use a different method each
<table>
<thead>
<tr>
<th>Method</th>
<th>regular</th>
<th>occasional</th>
<th>not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>23.1*</td>
<td>69.2</td>
<td>7.7</td>
</tr>
<tr>
<td>Discussion</td>
<td>71.8</td>
<td>28.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Student Reports</td>
<td>20.5</td>
<td>74.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Student Projects</td>
<td>46.2</td>
<td>53.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Hands-on/Laboratory Work</td>
<td>41.0</td>
<td>56.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Cooperative Learning</td>
<td>33.3</td>
<td>64.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Inductive Thinking Activities</td>
<td>12.9</td>
<td>81.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Tests or Quizzes</td>
<td>61.5</td>
<td>38.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Simulations</td>
<td>7.7</td>
<td>66.7</td>
<td>25.6</td>
</tr>
<tr>
<td>Role Play</td>
<td>0.0</td>
<td>51.3</td>
<td>48.7</td>
</tr>
<tr>
<td>Teacher Demonstrations</td>
<td>12.8</td>
<td>84.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Field Trips, Excursions</td>
<td>5.1</td>
<td>84.6</td>
<td>10.3</td>
</tr>
<tr>
<td>Inquiry</td>
<td>24.3</td>
<td>62.1</td>
<td>13.5</td>
</tr>
<tr>
<td>Discovery</td>
<td>24.3</td>
<td>67.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>26.3</td>
<td>71.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Learning Cycle Approach</td>
<td>7.7</td>
<td>35.9</td>
<td>38.5</td>
</tr>
<tr>
<td>Constructivism</td>
<td>5.1</td>
<td>43.6</td>
<td>38.5</td>
</tr>
<tr>
<td>Project-based Science</td>
<td>20.5</td>
<td>64.1</td>
<td>12.8</td>
</tr>
</tbody>
</table>

(*Numbers represent percentage selecting each category.)
day of the school week. This sample of teachers was divided almost evenly among those who used a few methods (n=17) and those who used a variety of methods (n=19).

**Perceived Preparation to Use Methods**

Research question three asked, “What are the teachers’ perceptions regarding their preparation to use current science teaching methods?” The Perceived Preparation section of the instrument gathered data to answer this question. This section of the instrument contained the same 18 methods as the Science Methods section. The data were grouped into three categories. If the respondents reported they were proficient in use and have had training and use, these responses were categorized as “prepared.” If the respondents had “tried to use” or were “aware of” these methods, the responses were categorized as “not prepared.” Lastly, those that responded as never heard of the method were maintained as a single group.

The science method respondents felt most “prepared” to use was “discussion,” with 87.2% reporting as proficient in use and have had training and use. Respondents (79.5%) also
felt “prepared” to use “tests or quizzes.” Sixty-nine percent reported that “student projects” was a method they were “prepared” to use. The majority of teachers in this study, 66%, felt “prepared” to use “field trips.” Lastly, “student reports” was a method that 64% of the respondents felt “prepared” to use (see Figure 6).

Teachers also reported methods they were “not prepared” to use. Over 69% of teachers reported they were “not prepared” to use “simulations.” Almost as many teachers (66%) were “not prepared” to use “role-play” and “project-based science.” “Inductive thinking” was a method that 63% percent of respondents felt they were “not prepared” to use in their classroom, while 59% percent reported they were “not prepared” to use “problem solving” (see Figure 7).

It is also informative to note which science methods were reported as “never heard of” by science teachers. The most common method teachers reported they had “never heard of” was “learning cycle” (53%). Forty-three percent reported they had “never heard of” “constructivism.” Both “inquiry” and “discovery” were reported by 7% of teachers as “never heard of” (see Figure 8).

**Figure 6: Perceived Preparation – Prepared**

![Graph showing perceived preparation for various science methodologies.](image-url)
Figure 7: Perceived Preparation - Not Prepared

Figure 8: Perceived Preparation - Never Heard Of
**Perceived Effectiveness of Method Use**

The fourth research question asked, “What are the teachers’ perceptions regarding the effectiveness of current science teaching methods?” The Perceived Effectiveness section of the instrument was used to collect data to answer this question. This section of the instrument included the same 18 methods as the other sections of the instrument and asked respondents to indicate how important these methods were for an effective science education program. Figures 9, 10, and 11 present a summary of the perceived effectiveness of these methods as used by the respondents. The data were recoded into three categories as described in the previous section on perceived preparation. If the respondents reported a method as being “essential” or “to a great extent,” these responses were categorized as “effective.” If the respondents felt these methods were “essential to some extent” or “very little,” they were categorized as being “somewhat effective.” Lastly, the “not effective” responses were categorized as their own group.

The science method reported by the largest group of teachers as being “effective” was “discussion” (87.2%). The science method of “hands-on/laboratory work” was perceived as being “effective” by 82% of the respondents. Sixty-six percent of the respondents felt that “student projects” were “effective” in their science education program, while 64% felt that “cooperative learning” was also “effective.” “Field trips” were reported by 61% percent of the respondents as “effective” (see Figure 9).

As in perceived preparation, there were also methods reported as “somewhat effective.” The method reported by most respondents as “somewhat effective” was “lecture” (69.3%). Both methods of “simulations” and “role-play” were reported by 61% of teachers as “somewhat effective.” Sixty percent felt that “inductive thinking” was “somewhat effective.” “Tests or quizzes” were indicated as “somewhat effective” by 56% of the respondents (see Figure 10).
Figure 9: Perceived Effectiveness – Effective

![Bar chart showing perceived effectiveness of various methods (Lecture, Discussion, Student Reports, Student Projects, Hands-on/Laboratory Work, Cooperative Learning, Inductive Thinking, Tests or Quizzes, Simulations, Role Play, Teacher Demonstrations, Field Trips, Inquiry, Discovery, Problem Solving, Learning Cycle, Constructivism, Project-Based).]

Figure 10: Perceived Effectiveness – Somewhat Effective

![Bar chart showing perceived effectiveness of various methods (Lecture, Discussion, Student Reports, Student Projects, Hands-on/Laboratory Work, Cooperative Learning, Inductive Thinking, Tests or Quizzes, Simulations, Role Play, Teacher Demonstrations, Field Trips, Inquiry, Discovery, Problem Solving, Learning Cycle, Constructivism, Project-Based).]
As with the use of science methods and perceived preparation, it is also informative to note the science methods that were reported as “not effective” in a science education program. “Learning cycle” and “constructivism” were viewed as “not effective” by 33% of the respondents. One-fifth of the respondents (20%) reported “role-play” as being “not effective.” Twelve percent of the respondents reported “simulations” as “not effective” in the classroom. Lastly, both “inquiry” and “project-based science” were reported as “not effective” by 10% (see Figure 11).

Figure 11: Perceived Effectiveness – Not Effective
Discussion

Of the five most used methods, four could be described as constructivist methods. The predominant constructivist methods being used by these teachers were “discussion” (71.8%) and “student projects” (46.2%). This can be interpreted to mean that teachers were striving to serve as guides and mediators in the learning process of their students, rather than only transferring information from themselves to their students. Also, most teachers (19) were using at least five different methods on a routine basis. It is encouraging to note that more than half of the respondents varied the type of methods used in their science education program.

The methods that teachers felt most prepared to use in their science education program were “discussion” (87.2%) and “tests or quizzes” (79.5%). The relative magnitudes of these data correspond with the data reported for use of these science methods, 71.8% and 61.5%, respectively. Data seems to indicate that because teachers felt prepared to use certain methods, those were the methods they were implementing in their science education programs.

Similarly, the methods of “simulations” (69.2%) and “role-play” (66.6%), which teachers said they were “not prepared” to use or teach, show a relationship with the reported data on use of these methods (7.7% and 0%, respectively). It can be inferred that because the respondents do not feel prepared to use these methods, they were not using these methods in their classrooms.

The two methods reported by the largest number of teachers as “never heard of,” “learning cycle” (53.8%) and “constructivism” (43.6%), also correlated in the same fashion with the data on reported use (7.7% and 5.1%, respectively). The same inference can be made regarding why these teachers were not using these methods in their classrooms. Teachers have “never heard of” these methods, and thus were not using them. It is interesting to note that these two methods are directly related to or have emerged from the field of science education.
Similar comparisons can be made when looking at the date related to perceived effectiveness of the methods. In terms of perceived effectiveness, “discussion” (87%) and “hands-on/laboratory work” (82.1%) were the two highest rated methods. However, in comparing “effectiveness” with “use,” the data demonstrated the percentage of teachers who used “hands-on/laboratory work” as a “regular” practice (41%) is only half the percentage of those who viewed this method as “effective” (82.1%). Although teachers felt that “hands-on/laboratory work” was one of the most effective methods for science, only half of that number was actually implementing it into their science education programs.

The two methods reported as “not effective” by the largest number of respondents, “learning cycle” (33.3%) and “constructivism” (33.3%), were the two methods the largest number of teachers “have not heard of” (53.8% and 43.6%, respectively). Consequently, it was not surprising that teachers felt these methods were “not effective” because they did not know what these methods were or could accomplish.

As documented in the literature review, certain science methods, constructivism, inquiry-based science, learning cycle, and hands-on/laboratory, are vital to the achievement of national goals and standards for science education. This study provides data on teacher perceptions regarding their use of these methods, their perceived preparation to use these methods, and their perceived effectiveness of these methods (see Figure 12).

From this graph, the data describes what is taking place in these fifth- through eighth-grade classrooms. A large percentage (43.6) of the respondents had never heard of “constructivism,” a method directly related to science education. This helps explain why the “use” (5.1%), “perceived preparation” (7.7%), and “effective” (12.8%) values are all low for
“constructivism.” It is probable that these teachers did not use “constructivism” in their science education programs primarily because they had not heard of it.

“Learning-cycle,” which emerged from science education reform efforts, had similar results in terms of responses. Fifty-three percent of the teachers had never heard of the “learning cycle,” thus they were also not using it (38.5%), did not feel prepared to teach with it (33.3%), and consequently found that it is not effective (33.3%).

The last two methods, “inquiry” and “hands-on/laboratory work” were very similar in terms of what the data yielded. The level of effectiveness for “inquiry” was approximately twice as much as that of use, 41.1% and 24.3%, respectively. This was also true for “hands-on/laboratory work” (82.1% and 41%, respectively). Looking at the results in this study naturally leads to the creation of more questions.
Questions for further Study

This study on science methodologies in fifth- through eighth-grade classrooms of a selected Seventh-day Adventist Conference has raised questions, which suggest topics for further study. These include:

1. Does the availability of resources influence teachers’ use of such methods in the classroom?
2. Is there a difference in the use of science methods by new teachers when compared to experienced teachers?
3. Do these teachers have access to professional development focused on science education?
4. Does use of these methods, which have emerged from science education, vary by type of classroom: subject-specific, single-grade, or multi-grade?
5. Do teachers feel that these methods help meet the needs of the diverse learners in their classrooms?

Conclusion

This study documents positive aspects of the fifth- through eighth-grade science education program in this selected conference of the Seventh-day Adventist school system. Most teachers tend to use a variety of methods regularly in their science classes. These teachers reported using several methods that can be described a “constructivist,” such as “discussion,” student projects,” “hand-on/laboratory work,” and “student reports.” These types of methods are approaches that help further the goals of science education and thus help the Seventh-day Adventist system meets its goals for student achievement in science.

This study also documents a potentially disturbing trend in the relationship between teachers’ perceptions of the effectiveness of certain methods and their actual use of those
methods. For six of the methodologies studied, approximately twice as many teachers reported a perception of effectiveness for the method when compared to their use of the method. These methods included “hands-on/laboratory work,” “cooperative learning,” “teacher demonstrations,” “inquiry,” “discovery,” and “project-based science.” Further study is needed to determine reasons and potential solutions for this discrepancy between perceived effectiveness and classroom use.

This study also generated implications for the professional development of elementary/middle grades science educators. Many of the least used methods identified in this investigation are important in facilitating the meeting of national and Seventh-day Adventist goals for science education. It is clear from the data, teachers don’t use methodologies if they don’t feel prepared to use them. Often teachers equate preparation with formal training. Since formal training in classes, workshops, or in-service sessions is the most common venue used to prepare teachers, it would follow that specific opportunities for professional development in science education methodologies need to be provided for practicing teachers if we expect them to expand their current teaching repertoire to include more constructivist approaches.

As the field of science education continues to develop and as national, state, and church-based goals for science are refined for both students and teachers, it is imperative that educators are provided with ongoing professional development opportunities and administrative support as they work to fully meet the needs of their students. Translating research into practice is a lifelong, dynamic process.
References


