Effective Ways of Teaching Science Teachers to Use Strategies

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Research Interests

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Abstract

Teaching science teachers how to use instructional strategies is often neglected in textbooks and by researchers. This article consists of a synthesis of research that discusses selection of instructional tools and 4 common vehicles for teaching science teachers to use instructional strategies: professional development, in-service programs, study groups, and mentoring

Teaching contributes socially and academically to our human resources. If teachers are responsible to mold characters, supply knowledge, and provide students with the tools they need to become life long learners then they should be highly trained. Teacher training tends to focus on the subject content rather than on pedagogy. The research on teaching has consistently suggested that theory must be complemented with practice (Crawford, 2000; Kiewra, 2002). Teachers must master a myriad of teaching strategies so that they can meet the learning needs of all students (Crawford, 2000; Walker Tileston, 2004).

Numerous studies have indicated that classroom interaction is important to students' developmental learning (Bianchini, Johnson, Oram, & Cavazos, 2003; Ornstein, 2000; Walker Tileston, 2004).Good classroom interaction and student achievement have been attributed to teacher enthusiasm (Murphy & Walls, 1994). Classroom interaction is also effective in promoting students achievement. With the greater accountability policies that are in force at the school district level and the high stakes testing, teachers are expected to be more creative in their classroom practices. Academic rigor is the order of the day in most school systems, but can it be achieved without focusing on the approaches that are used in the classroom? In this paper, I will explore four common vehicles for teaching science teachers how to use instructional strategies: professional development, in-service programs, study groups, and mentoring

Teaching Science to Urban Students

Teaching science to urban students is a complex and challenging task embodied in the large class size, teachers' lack of awareness of best practices, high poverty level, and the ethnic and linguistic barriers between students and teachers (Settlage, 2004; Tobin, Roth, & Zimmmerman, 2002). Despite the large number of urban and impoverished

American public schools, little information is available about how to teach science in such settings (Settlage, 2004). Settlage classified high poverty level as a complex issue in urban schools. The current standards-based reform movement may profoundly affect urban schools that are preparing students to be scientifically literate with inadequate funding and lack of resources (Chiappetta & Koballa, 2006; Kozol, 1991; Lynch et al. 1996). The shrinking budgets and a shortage of highly qualified science teachers contribute to the crisis in urban high school science teaching (Tobin, 2000; Settlage, 2004).

Research needs to be conducted on the issues that surround urban science teaching to reveal how to improve this venture. Investing and using of relevant instructional resources are necessary to "renew" urban science teaching. In some cases little attention has been given to science in urban settings because students might not be required to do a statewide assessment. This is sometimes linked to the minimal time that is allotted to science teaching (Knapp & Plecki, 2001).

A high level of organization with the establishment of a daily routine is necessary to teach science to urban students. These students also benefit more when a variety of teaching strategies are used to stimulate their learning. Strategies such as cooperative learning groups, hands-on inquiry, and experimental activities will enhance their learning (Marzano, Pickering, & Pollock, 2001). Bianchini, Johnson, Oram, and Cavazos (2003) argued that the nature of science is tied to inclusive and equitable educational practices. They explained that there is now a greater need to educate an increasingly diverse student population with different linguistic and cultural backgrounds. Therefore, it is imperative that research be done to improve our knowledge of how teachers in the urban classroom

can be more effective. Loucks-Horsley, Hewson, Love, and Stiles (1998) also argued that diversity is a challenge that must be addressed.

Rodriguez and Kitchen (2004) have suggested some promising strategies for helping the urban science teacher to teach science better. Field trips to culturally diverse communities can help teachers build cultural understanding. Conducting teacher action research projects can improve teaching practice and better understanding of students' cultural background and learning styles. Rodriguez and Kitchen also encouraged science teachers to make connections between science instruction and students' home language. These strategies have clearly highlighted the need for teachers to "model respect for diversity" in learning by using strategies that will meet the needs of all students (p. 68). When teachers are meeting the needs of minority students they do not see them as culturally different. Kameenui and Carnine (1997) explained the difference between diverse learners and the average achiever. They argued that because diverse learners are deficient in the basic skills they experience more problems connecting and transferring information.

It is important that urban science teachers reflect on their mode of teaching. For example if their methods of instruction rarely work for minority students then obviously these students are denied the opportunity of learning. It is therefore imperative that science teachers use "well-designed tools and instructional approaches that make science accessible to less able students" (Kameenui & Carnine, 1997, p. 2).

Why the way Teachers Teach is Important

Walker Tileston (2004) encouraged teachers to examine the modalities that affect how they teach and how students learn. The teaching methods selected by a teacher are

usually grounded in the teacher's philosophy of teaching. An educator's philosophy of teaching serves as a guide to the actions and choices made to support the teaching and learning process. Embedded in the teacher's philosophy is also the teacher's desire for the students that he or she works with.

Nearly all of what we learn comes through our sense. Walker Tileston noted that the brain takes about 15 seconds or less to decide what to pay attention to and what to get rid of. Thus, every teacher needs to think about whether his or her classroom provides a one-size-fits all dispenser of knowledge or an eclectic approach to teaching and learning. Modalities become a concern here. Teachers need to teach so that the tactile, kinesthetic, auditory, and audiovisual learners can benefit from every lesson. According to Gayle and Chapman (2002) to meet the needs of all students teachers must differentiate instruction using various strategies, tasks, resources, and feedback techniques.

Selection of Instructional Tools or Strategies

Instructional tools are used to enhance the teaching and learning process. Researchers have shown some concerns for the role of the most commonly used tools for teaching science (Kameenui & Carnine, 1997). The effectiveness of an instructional tool depends on the purpose of the tool. For example some tools are specifically designed to use in inquiry-based lessons. In this case a lab-based instructional tool is very effective. Students can connect reading or lecture notes (class notes) to carrying out an experiment to verify a scientific law.

The teacher selects the teaching strategy to be used in a lesson. Most times, the strategy used is selected because of the availability of materials to be used with the teaching method. A number of things should be taken into consideration during the

instruction strategy selection process. The instructional level of the students, the needs of the students, students' learning styles, the concepts of the lesson, students' sensitivity to differences in prior knowledge, and the objectives of the lesson must be taken into consideration during the selection process (Kameenui & Carnine, 1997). Regardless of the tool used it must make science accessible to all students. If a strategy is misused it will lose its effectiveness.

With the myriad of research that has been conducted in the past about teaching and also the brain research that is available now, we are more able to evaluate which teaching strategy will have the greatest effect on our students (Souza, 2001; Walker Tileston, 2004). Instructional tools that are effective will "help students to see, experience, and hear the information clearer and in a sequence that is more brain friendly than some of the tactics we have used in the past" (Walker Tileston , 2004, p. xi).

Teaching Science Teachers to use Strategies

Crawford (2000) examined the beliefs and practices of a high school biology teacher who developed an inquiry-based learning environment and demonstrated effective teaching. The teacher communicated directions clearly, paced his lessons appropriately, involved students in decision making, monitored students' progress, and give feedback to students. The teacher's actions here have demonstrated that this teacher used a combination of strategies with the students. The results of Crawford's study are consistent with Chiappetta and Koballa's (2006) observation of capable science teachers.

Teachers must be taught how to use the teaching strategies that research has proven to be effective. These include strategies such as inquiry-based strategies, cooperative learning strategies, problem-based learning, and small group work (Chiappetta & Koballa,

2006; Gayle & Chapman, 2002; Kameenui & Carnine, 1997; Marzano, Pickering, & Pollock, 2001). The research is mainly directed to demonstrate the use of effective teaching strategies for science. The theoretical and practical aspects of science sometimes pose difficulties for learning science. Teachers of science are usually good content dispensers, but often times weak supporters of instructional tools.

Teachers' colleges and universities should be at the forefront in teaching teachers to use strategies. Settlage (2004) conducted a study to determine the philosophies and practices of university-based science educators that are associated with programs supplying teachers for metropolitan school systems. The results indicated that further exploration needs to be done on the role of student ethnicity in teaching strategies because science educators at the colleges and universities showed low regard for students' ethnicity. Despite the importance that is placed on professional development for teacher, professional developers rarely focus these programs on actually teaching teachers how to use these strategies. Some professional development programs will give teachers the names of the most effective instructional strategies in their subject, but not necessarily model how to use them effectively in the classroom.

Effective Ways of Teaching Science Teachers to Use Strategies

Teachers can be taught how to use teaching strategies in a variety of ways. Examples of these strategies include student-centered teaching strategies that respect diverse learners such as problem-based learning, small groups (cooperative, team-based) learning, guided discovery, and laboratory investigative learning. The principles of adult learning provide a foundation from which we can select different methods of teaching science teachers to use strategies. Science teachers could be taught these strategies through

science educators modeling strategies for teachers, teachers participating in group activities and using the strategies, and utilizing digital video learning, whereby teachers will watch video clips of strategies being used in the classroom. Adults comprehend more when they play an active role in their learning. According to the principles of adult learning, the most effective ways of teaching science teachers to use strategies will involve teachers as active participants and will also allow them to use their experiences in the learning process. The information below discusses four effective methods of teaching science teachers to use strategies.

Professional Development Programs

In the 21st century, professional development programs are the main method of training in-service teachers. Professional development geared towards teaching teachers instructional strategies is usually divided into two sessions. Session one usually focuses on the research and theory components, thus verifying the effectiveness of each strategy while session two involves teacher participation or skill training, through active involvement. This approach sets the tone for a strategic way of teaching teachers to use various instructional tools.

The effectiveness of this strategy lies in its ability to connect teachers from various backgrounds. This method of teaching teachers to use teaching strategies provides collaborative networking, questions and answers, active listening, individual reflection and whole group sharing. These activities will cause participants to be engaged in meaningful, respectful, and engaging conversations. Teachers could be gathered for a few days to learn how to use effective strategies to teach a subject area in science. Through clear and specified objectives, which include a preplanning element that is carried out through a

need assessment and taking into consideration that teachers are self-directed learners. Professional development can be an effective strategy to teach teachers how to be masters of effective teaching strategies for teaching science.

Ellis (1990) explained that “enabling teachers to become effective strategy instructors appears to be an arduous task, both at pre-service and in-service training levels” (p. 59). The difficulty of helping teachers to develop competencies is usually greatly influenced by a variety of factors: personal knowledge of the learning process, philosophy of teaching, commitment to instructional strategies, and use of the curriculum and delivery models.

The ultimate goal of effective professional developers is the “need to make difficult decisions about what to teach their teachers about strategies, how to teach them, and how much to teach them” (Ellis, 1990, p. 62). The accessibility to professional development programs is also easy for science teachers whether at the school district level or the school-based level. Teachers have often complained that professional development does not provide them with “substantive support for the improvement of teaching science” (Knapp & Plecki, 2001, p. 1095). This argument supports the notion of professional development being disconnected from the science curriculum. A sound “professional development infrastructure” is needed for the investment and use of instructionally science related strategies (Knapp & Plecki, 2001, p. 1089).

Study Groups

Another approach that provides an effective way to teach science teachers to use strategies is study groups. Teacher study groups provide opportunities for professional growth through the investment of collegial work. Science teachers can develop a

foundation for professional development through the active roles of a study group. The goals of the study group must also be in alignment with the school's and science department's mission and vision. The most important element of a teacher study group is its nature to provide support for improvement of instructional strategies that are not easily realized when teachers work in isolation. The science teachers' needs are the center of such study group.

Through the activities of a study group, teachers are involved in reading current research literature on science strategies, implementing strategies as they develop competent skills in strategy use, sharing successes and failures in using the strategies, and discovering how to change failure to success by exchanging ideas. This small community of adult learners provides a safe environment for learning while building the trust of all the teachers involved.

The effectiveness of this tool for teaching science teachers to use strategies is its ability to provide an "object of strategic planning to help teachers in planning together and sharing their teaching experience" (Ornstein, 2000, p. 129). It provides a venue for teachers to determine instructional problems, study, reflect, and collaborate for answers. The power of this tool is its ability to cater for the diverse needs of all science teachers by including them in the planning of the objectives of the study group. Other important characteristics of the study group approach to teaching science teachers to use strategies are its continuous exploration of instructional tools of interest and relevance, providing self evaluation through learning and practice, building on shared practice, conducting investigations, modeling how to use strategies, and finding time to grow through exchange of ideas.

Teachers (both special education and regular education) are expected to work collaboratively to master using different instructional strategies. Knapp & Plecki (2001) explained that a professional peer community "establishes expectations for, provides images of what is possible and desirable, and offers a first line of help and advice" (p. 1095).

In-Service Courses/Programs

Courses offered by colleges and universities for practicing teachers are another approach to help science teachers to learn to use different teaching strategies. In-service courses offered for professional growth to teachers often come in two forms: (a) "formal lectures which last for most of, or the entire class session" (Ornstein, 2000, p. 173) and (b) instructor models practice and student participate in activities to develop their skills. Ellis (1990) argues that traditionally teacher education programs do not include adequate modeling and practice of instructional strategies in the courses that they offer. Ellis called for a restructuring of these programs. Kiewra (2002) also believes that good strategy instructors must know two things: (a) which strategies are effective and (b) how to teach them by embedding strategy instructions into content teaching. Teachers enrolled in a science teaching methods class should be exposed to specific step-by-step instructions of using the strategies effectively.

As Margolis and McCabe (2004) suggested, teachers should teach struggling learners to work to overcome their difficulties. Instructors of in-service teachers need to teach teachers to systematically develop competencies in mastering how to use these strategies. Adequate practices should be given to teachers enrolled in these courses to use what they have learned in a practical way to improve the teaching and learning process,

with the hope of higher student achievement. Teachers should also contribute to the planning of the course objectives for these courses. Their contribution should help the course to provide them with the tools they need to function as strategy experts.

Peer Coaching or Mentoring

Peer mentoring is a widely used method of professional development especially for new teachers. Subject specific mentoring is needed in the case of helping science teachers to use strategies effectively. Knapp and Plecki (2001) explained that "various kinds of people can offer instructional leadership such as mentor teachers, department heads in secondary schools, and science specialist teachers" (p.1096). Peer coaching, which is commonly called mentoring, provides a supportive and nurturing type of environment that leads to collegial coaching.

The collaborative component of this approach makes it an ideal way to help science teachers to learn how to use effective strategies. Teachers and mentors work in small groups, allowing teachers to get individualized attention while learning from each other. When this approach is used effectively, mentors model effective teaching strategies and build a team support system with the teachers involved. Teachers and mentors will discuss and dissect teaching strategy issues in a non-threatening way. Consequently, this approach provides help with being critical and objective concerning one's own ideas and progress. Mentors also provide constructive feedback for teachers by providing step-by-step nurturing as they become adjusted to the change process.

Comparison of the Effectiveness of the Strategies

The study group and mentoring approach as effective ways of helping science teachers to use strategies are similar. They show concerns for individuality and teacher

choice. These approaches allow for constant exploration of science teaching methodology to the contribution of teacher professional development. They both display genuine care for constructive feedback that will help to focus on changing the teacher's needs.

The professional development and in-service approaches to teaching teachers to use science strategies have some commonalities. They are designed to address a larger group of teachers throughout their course. They are also more likely to focus on multiple tasks, for example content and skill development. The timing periods are usually shorter or only for a specific time during the course of the school year.

There are differences among these strategies in their delivery approaches, teacher support, and provision of feedback for teachers. The professional development and in-service courses are different in the delivery of knowledge and skill development. Time is crucial to these two approaches. The limited amount of time allocated for them limits the amount of practice that the teachers involved would get to develop competency in using science teaching tools. Minimal teacher support is given in these approaches because there is rarely any follow up at the end of these sessions to check or reinforce the teachers' developmental skills. Communication is limited in these two ways of teaching science teachers to use teaching strategies. There is no assessment or feedback process at the end of these sessions to complement or to help teachers with further skill development.

Summary

How to teach science teachers to use teaching strategies regardless of their career stage is essential. Unfortunately, the research on science teaching strategies does not focus on the different ways in which faculty developers can teach teachers to be effective users of the various types of teaching strategies.

Researchers have demonstrated the effectiveness of teaching strategies such as inquiry-based, investigative strategies, alternative assessments, and use of graphic organizers as powerful teaching tools. The available literature shows a gap in the research focus on teaching strategies. More study is needed on which methods are more effective to teach science teachers to use strategies. These studies should also explore the elements of each approach that make them effective methods of helping to develop teacher skills.

We cannot assume that teachers will automatically develop competency in using teaching strategies as they use them (Settlage, 2004). Appropriate training must expose teachers to the rudiments of effective teaching strategies. Professional developers should also model strategies and should not assume that if how to use each strategy is merely discussed, teachers will walk away knowing how to use all the strategies.

Professional development should provide a support system for teachers when they return to their classrooms. Knapp and Plecki (2001) described the need for professional development to be coherent with curriculum support. The authors suggested that leadership is needed at the school district level and school-based levels for science teaching. Without carefully examining the instructional process and training for science teachers, there will always be a gap in preparing teachers to be fully functional in their classrooms.

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