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Effective teaching strategies in mathematics and science

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Effective Teaching Strategies in Mathematics and Science

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Abstract

Seven teaching strategies identified by Sousa (2001) were examined to develop implications to improve teaching in classrooms for deaf students. A literature review and an analysis of my student teaching experience and two videotapes of experienced teachers were related to Sousa's work. These analyses support the recommendations of Sousa that more active, student-centered activities are more effective with deaf learners. Recommendations are provided to teachers based on the literature review.

Introduction

The main purpose of this project is to focus on seven different strategies identified by Sousa (2001) related to teaching and active learning and to draw implications for improving teaching in classrooms for deaf students. These strategies included: lecture, reading, audio-visual, demonstration, discussion group, practice by doing, and having students teach others what they just learned.

I have also studied the strategies of two different mathematics and science teachers on videotapes. The strategies used by each teacher were analyzed along with some supporting ideas from the literature review.

While I was in California, I developed my own strategies for my student teaching. These strategies were also analyzed in relation to Sousa's strategies. I used a journal to record my experiences for my reference to guide me in writing my final paper.

My final project presentation will include short movies to demonstrate a few examples from the videotapes that apply to some of Sousa's strategies.

The importance of the project is in identifying research that relates to Sousa's summary of best practices for helping students with retention of information learned.

Sousa's strategies are based on hearing subjects. Therefore, my main focus is to find literature relating Sousa's strategies to deaf subjects. New information based on deaf subjects will benefit teachers who want to improve their instruction. A variety of strategies is important to use in the classroom to make deaf students enthusiastic and successful in active learning.

My objectives for this project are to help meet teachers' needs by describing research as it relates to the important best practices suggested by Sousa, to make recommendations for teachers who want to be successful in teaching deaf students, and to find which strategies improve deaf students' learning and understanding in mathematics and science. My research question is: What strategies promoted by Sousa (2001) are supported by research for use with deaf students?

Literature Review

There are many studies with deaf students found in the literature related to Sousa's (2001) seven different strategies. These seven strategies are identified as lecture, reading, audio-visual, demonstration, discussion group, practice by doing, and having students teach others what they just learned. I have identified and analyzed the strengths and weaknesses of some of these strategies as they relate to teaching deaf students.

Lecture

Three kinds of research studies have been located that involve deaf students in lecture environments. The first category of research compares lectures with other strategies. Lang and Steely (in press) summarized three empirical research studies with deaf students in science. All three studies showed significant learning gains when

multimedia computer programs are used in comparison with traditional lectures. Hearing learners have the access to the information through hearing lecture materials such as audio clip and annotated graphic presentations on a web page. However, deaf learners often have no visual text options to access the information, such as captioning or other types of text presentation to improve their comprehension of the lecture.

Quinsland (1986) focused on comparing a traditional lecture and an experiential learning strategy for deaf students. Quinsland (1986) stated that the experiential learning strategy showed more retention on a three-day delayed test of factual knowledge. This study supports the use of experiential education to aid in retention of science material as compared to a traditional lecture with the same material.

Second, various problems related to lectures with deaf students have been identified. Matthews and Reich (1991) explained that "line-of-sight methods share the limitation that the receiver of the message must look at the sender" (p. 14). Understanding communication in classrooms is a very serious issue for deaf students. Unfortunately, Matthews and Reich (1991) found that deaf students look at the teacher who is signing during the lecture only forty-four percent of the time. In hearing classrooms, a teacher may assume that hearing students are listening even though they are not watching. When two deaf students had a collateral conversation, there was only one-fourth of the time (Matthews & Reich, 1991). Matthew and Reich (1991) also stated that "these exchanges, which took place simultaneous to the teacher's efforts, are one mechanism by which misinformation can be propagated in classrooms for deaf students" (p. 16).

Third, Lang, McKee, and Conner (1993) and Lang, Dowaliby and Anderson (1994) have conducted research on the characteristics of effective teachers. They identified key characteristics that have implications for lecturing, as well as other strategies. Research on the characteristics of teachers of deaf students shows that both teachers and students highly rate the importance of teachers' content knowledge and the ability to emphasize important information in the class, to give clear lectures, to use visual materials, and to communicate well. Deaf students feel it is important to have a teacher's good pace of lecture for them because they will be able to understand the materials well. Involving students in learning activities seem to be problematic for teachers because students rate such involvement significantly lower than teachers do (Lang, McKee, & Conner, 1993). One possible explanation is that students are less willing to participate in discussion or answer the questions because they will have to spend more time preparing for class. Teachers have to make the effort to get students involved by introducing stimulating questions or encouraging the sharing of the opinions with one another during classes. Before starting a lecture, a teacher can warm up for five minutes with a short conversation with students about something interesting or funny that happened to him or her. Establishing rapport will make deaf learners more interested in the class. Lang et al (1994) found that providing clear lectures and explanations is a characteristic highly valued by deaf students. Using appropriate examples in lectures is also perceived as very important by deaf students.

Reading

Several types of research studies show that reading is problematic for deaf students in the classrooms. Glennon (1981) found that deaf students have difficulty with

transferring their learning from one specific area to another. In a study by Mousley and Kelly (2001), deaf college students' comments about solving math word problems were summarized. One deaf student wrote, "When I see it (a word problem), my mind freezes." Another said, "There are too many words. It confuses me more" (Kelly & Mousley, 2001, p. 260). The results show that deaf students have a hard time understanding specific words in problem-solving such as: if, when, greater than, the most, not, without, should, could, because, since, it, and/or something. Their research identifies other problems based on deaf students' reading comprehension in word problems. Deaf students tend to work quickly and make simple mistakes. They lack motivation in breaking down the information to be given as a problem situation. Deaf readers also show an inability to evaluate a problem carefully. These impulsive behaviors possibly cause deaf students to become stressed and frustrated in dealing with math word problems (Mousley & Kelly, 1998).

LaSasso (1993) summarized that many deaf students have a problem with WH-question forms which influence their reading comprehension. LaSasso (1993) assumed that "reading without questions can be also related to lack of motivation on the part of the reader, which is frequently the explanation for deaf children and adolescents who have too few questions" (p. 438).

Marschark (1993) reported that more than thirty percent of deaf students who are illiterate leave school compared to about one percent of hearing students. Reynolds and Rosen (1973) summarized that using pictorial signs is more effective for deaf readers to identify unfamiliar words than the text-only. Stoefen-Fisher and Lee (1989) also explained that word identification and immediate retention were significantly better when

the subjects received words with signs than when they received the printed words only. In a study by Kelly (1998), silent motion pictures were used to examine whether deaf adults develop comprehension of the sentences which include both relative clause and passive voices. Kelly (1998) stated that deaf readers who were weak in reading did not succeed when learning through video instruction. Dowaliby and Lang (1999) focused on multimedia support for comprehending science text. The result indicates that science information may be better recalled by deaf students when adjunct questions are used, or when a combination of adjunct questions, signs, and animations are employed (Dowaliby & Lang, 1999).

In a study by Kelly, Albertini and Shannon (2001), deaf readers were found to have difficulties with monitoring their own reading comprehension. The major problem is that deaf readers cannot identify the main idea of text or a sentence that does not fit in a passage. They appear to focus on reading the words and phrases rather than on understanding the whole meaning of the passage. Kelly, Albertini and Shannon (2001) also wrote that deaf readers do not have enough experience with critiquing the meaning of text. They recommended several effective strategies that proficient readers use such as setting goals, analyzing the text, and examining learning. For those readers who have a hard time understanding the text, they suggest that comprehension can be improved by restating the text in simple words, reviewing the text, ordering relationships, in which the information is clarified in the following text, and finding any kind of problems to be resolved. There are two different comprehension strategies that will help both lower-level and higher-level readers improve: rereading the text; and looking up new vocabulary words in the dictionary (Kelly et al, 2001).

Audiovisual

In Lang and Steely's research (2003), they found that the use of audiovisual materials greatly benefits learning science by deaf students. They wrote that "the use of visual materials to support the comprehension of text and the opportunities for the deaf learner to become actively involved in the instructional process" (Lang & Steely, 2003, p. 3). Deaf students without visual text alternatives will experience more difficulties in learning in the classroom. The study found that deaf students improve their comprehension in science classes through reading the text screen, then watching the American Sign Language (ASL) movie, and lastly viewing the animations. These triads are beneficial for deaf students with comprehension difficulties (Lang & Steely, 2003).

In Andrews and Jordan's (1998) study, they demonstrated that using video dictionaries with sign language is most effective for deaf learners because they have opportunities to see the elements of facial expressions, head tilts, eyebrow raises, and body movements. These elements facilitate deaf students encoding of the grammar of American Sign Language (ASL). Evidence shows that deaf students really enjoy using video dictionaries without feeling obligated to ask the teacher or interpreter for help. As a result, video dictionaries gain their vocabulary words. According to Cerra, Watts-Taffe and Rose (1997), pictures help deaf learners understand the text's meaning through the important clues. "Teachers can help young children gain meaning from pictures by involving them with wordless picture books" (Cerra et al, 1997, p. 384).

Luckner, Bowen, & Carter (2001) summarized that sign, fingerspelling, speech reading, overhead projectors, bulletin boards, computers, televisions, pictures, illustrations, slides, and computer graphics are all useful for deaf students as visual

learners. Using a variety of communication methods is beneficial for deaf students. Seeing the visual representation of information helps students remember what they learn than reading the text. With visual support, deaf students will improve their class participation and understanding new things through learning. Luckner et al (2001) emphasized how important graphic organizers are to deaf student because they are able to become actively involved through listening, speaking, signing, reading, writing, and thinking. Lang et al (1994) concluded that using visual aids are perceived as a characteristic of an effective teacher by deaf students. For instance, pictorial aids can be used for demonstrations by clarifying students' understanding the information in text such as animations (Dowaliby & Lang, 1999). These approaches have shown successful results with deaf students recalling the information. Mertens and Rabiu (1990) also stated that "visual imagery, which has a stronger influence on cognitive processing than does verbal information, should be used" (p. 399).

Demonstration

Little research has been done with demonstration strategies with deaf learners. Mousley and Kelly (1998) wrote that solving math problems can be facilitated by writing the goal, rules, and some other strategies to assist students to walk through each problem. This is a form of demonstration. Research has shown that deaf students can enhance their word problems by analyzing and explaining. They also can apply a procedural model which the teacher demonstrates in class. "When demonstrating procedural models for problem solving, teachers need to provide detailed, step-by-step explanations to students in sign language, spoken, and written form" (Mousley & Kelly,

1998, p. 335). Deaf students should be encouraged to demonstrate their explanations to either the teacher or students as well (Mousley & Kelly, 1998).

Discussion

Several research studies have been found which focus on discussion among deaf students in classroom environments. LaSasso (1990) stated there are strategies that can improve deaf students' comprehension of WH-question forms. One strategy is to ask deaf students WH-questions about some experience and have them share with the teacher. According to this strategy, the teacher needs to make sure that they have enough information to answer, including the vocabulary words (LaSasso, 1990). LaSasso (1990) explained "this will eliminate the possibility that failure to answer a question is due to not knowing the answer or to not having the vocabulary to express it" (p. 410). Students can use a variety of forms for sharing experiences and ideas with the teacher. The more deaf students are exposed to questions and answers, the better they become involved with giving the answers. Research suggests that teachers should give students a chance to answer the questions before giving the students the answer too quickly (LaSasso, 1990).

Discussion groups in a mainstream school where deaf students address the challenge without an interpreter may be even more difficult. Zapien (1998) wrote that if deaf students were isolated from other hearing peers in a mainstream school, then they would face the barriers with the teacher and other peers such as lipreading. Many educators tend to walk around or face the blackboard during the lecture. Deaf students feel that they miss a lot of information and have lack of communication with other hearing students. On the other hand, having an interpreter provides the opportunity for

deaf children to access their learning among other hearing students through the discussion groups. Having an interpreter also helps deaf students improve their understanding of what is going on in the classroom with other students and teachers (Zapien, 1998).

Mousley and Kelly (1998) provided a number of problem-solving activities for improving deaf students' skills. Teachers can guide the students in discussing the answers and questions with one another. Teachers should strongly encourage deaf students to think, explain, analyze, and summarize word problems through sign language, oral, written, and acting. They should allow students to create their own word problems through their understanding and demonstrate the task to others. Cerra, Watts-Taffe, and Rose (1997) showed that group activities can promote deaf students to open discussions with each other about what they observe or demonstrate in the classrooms. Opening discussions gain more questions and answers which are beneficial to deaf students' understanding.

Kelly, Albertini, and Shannon (2001) found that self-questioning, generative learning, and self-monitoring are all metacognitive strategies which may be used to facilitate students become enthusiastic to get actively involved with others through discussions. These metacognitive strategies encourage deaf students by "checking the outcome of any attempt to solve a problem, planning one's next move, monitoring the effectiveness of any attempted action, and testing, revising, and evaluating one's strategies for learning" (Kelly et al, 2001, p. 386). The study by LaSasso (1993) indicates that having group discussions will help increase students' motivation based on the topic of their reading. Cerra, Watts-Taffe, and Rose (1997) found a few strategies

that enhance deaf students' comprehension through reading. Having teachers ask deaf learners the questions is helpful for students to express their feelings, opinions, and experiences. Breaking down the passages into short and building background knowledge can also improve their reading comprehension. Group activities are effective for encouraging students to understand the text well through the discussions.

There are several reasons for deaf students to write math journals with a teacher. Students have the chance to find personal connections to the material they learn in the classroom or textbook (Schieper & Paradis, 1991). Math journals give deaf students time to explore their thoughts about what they learn and to understand the material. Students can practice a variety of math concepts through writing to help them study for tests. There is an opportunity for students to combine the writing and math processes. Writing math journals is another way for students to recognize the mistakes in any problems that a teacher corrects. That facilitates student comprehension in solving math problems and develops the vocabulary to become familiar with (Schleper & Paradis, 1991). Bailes (1999) discussed how dialogue journals are successful for deaf students because they have the opportunity to make choices of what to write. This strategy will lead to more questions and answers through discussions between teachers and students in the journals. Both writing and discussion about science experiences gain deaf learners' thinking skills through verbal representations and comprehension (Fellows, 1991; Keys, 1994). "Thus, dialogue journals are an excellent tool to encourage student writing" (Bailes, 1990, p. 11).

Reich, Matthews, Goldman, Brienne, and Matthews (1991) pointed out that using two different kinds of software such as Bank Street Writer and Bank Street Filer are

helpful for deaf students to communicate with the teacher through electronic mail both personal and lesson-related messages. That encourages deaf students to start working on science activities when they check the messages from the teacher. They have the advantage of writing lab reports, keeping logs, asking questions, and sending messages to the teacher. Reich et al (1991) concluded that these activities show an improvement in deaf students' science grades. "A computer network system can be an effective communication channel for deaf students and their teachers" (Reich et al, 1991, p. 7).

Practice by doing

Many research studies show a positive impact on deaf students' learning when active learning strategies are used. Cerra, Watts-Taffe, and Rose (1997) explained that deaf children should be encouraged to ask themselves questions based on their knowledge about what they are reading. This strategy is an active learning approach that helps them promote the questions about the important meaning of what they are reading. "Providing practice in dealing with graphic information can occur when teachers design activities requiring students to take information they have read and reinterpret it graphically" (Cerra et al, 1997, p. 384). LaSasso (1993) suggested a possible strategy to enhance deaf students' comprehension through active learning. Deaf learners can use an activity such as a "mystery box" with an object inside and they are encouraged to create their own WH-questions about a mystery box. Questioning provides some assistance by increasing comprehension through active learning. Bettencourt (1993) pointed out that hands-on science develops students' structure of questioning, reflecting, and re-questioning through the activities. Bettencourt (1993) emphasized that hands-on activities are important to students' active learning. Science process skills are

included thinking and high-order reasoning skills, which are beneficial to deaf learners. Students have opportunities to observe, describe, hypothesize, plan, design, and/or interpret through science inquiry (Gagne, 1967; Roth & Roychoudhury, 1993). Rothkopf (1996) showed that adjunct questions as 'acts of rehearsal that strengthen memory' help students with low reading ability increase their learning performance. Dowaliby and Lang (1999) demonstrated that adjunct questions are effective for deaf students' long-term memory. Mertens and Rabiu (1990) emphasized that all three strategies of repetition, practice, and feedback would strengthen deaf students' memory processing with the new information they receive. These strategies would promote deaf learners' thinking skills through practice questions in each lesson.

Mousley and Kelly (1998) examined two different groups of visualization and non-visualization while playing the Tower of Hanoi puzzle to see which one completes first. The purpose of visualizing the puzzle is to force deaf students to think carefully about making their final moves and assuming what results will occur before they move the disk. In their study, the results show that the visualization group performed better than the non-visualization group. Van Wagner (1980) focused on 13-17-year-old deaf students and found different results for experimental and control groups. The experimental group with hands-on activities improved much more on a science content test than the control group. Boyd and George (1973) studied 10-13-year-old deaf subjects using two different kinds of materials: Science Curriculum Improvement Study (SCIS) and Science: A Process Approach (SAPA). In this study, they reported higher scores in the experimental group that used hands-on activities. Elefant (1980) set up an eight-week inquiry training session for twenty-seven deaf students. Deaf students had

the opportunity to explain events and ask questions based on the experiments. Elefant (1980) concluded that the large amount of time deaf students spent on inquiry training and doing the experiment made them more effective than the ones who spent time doing "non-involved tasks."

Lang, Stinson, Basile, Kavanagh, and Liu (1999) examined six different kinds of learning styles on deaf subjects: dependent, independent, participative, avoidant, collaborative, and competitive. They reported that deaf subjects are highly dependent and need clear outlines, notes, deadlines, and instructions. Lang et al (1999) explained that deaf students who are highly participative receive higher grades than the ones who are less participative. The participative learning style shows a significant correlation with grades. Lang et al (1999) strongly advise that teachers encourage deaf learners to participate in classes by using less traditional lectures, focusing on more discussions, and using active learning strategies.

Teach others

In Mousley and Kelly's (1998) study, they focused on deaf students who have linguistic difficulty with math word problems. However, there are some possible strategies for deaf students to improve their critical thinking and problem-solving skills. For example, one classmate acts as an observer and one student explains in sign language to the observer about the goal and rules of the word problem. Then, the observer is asked to write down the goal, rules, and strategy for solving the problem. Writing and speaking (in sign language) are both suggestions for deaf students to improve their thinking skills. These suggestions are considered vocalization as "thinking out loud" for students to understand the word problems. According to the "thinking out

loud" strategy, the research suggests that a teacher should give deaf students a copy of sample word problems for them. The purpose of sample word problems is to help them walk through other similar procedural models as a guideline. Teachers should allow students create their own word problems through their understanding and demonstrate the task to others. More importantly, deaf students are encouraged to approach word problems with an "I can perform the task" attitude, which can influence them to become effective in solving the problems (Kelly & Mousley, 1998).

Lang and Albertini (2001) experimented with deaf students explaining to others what they just learned through informal writing in science. Frequent writing experiences are highly valued by the science teachers in this study, who felt that their deaf students' learning was enhanced through sharing the messages with teachers and peers. For example, they wrote that guided free writing encourages deaf students to use science processes such as predicting, observing, recording, and interpreting. This type of writing helps teachers evaluate deaf students' understanding through their construction of meaning to see if they remember what they just learned in science class. That helps teachers to be alerted by deaf students' possible misconceptions and they have the opportunity to make clarifications.

Mayer (1999) also examined a variety of cognitive tools, which are used for deaf students' learning such as "recalling previous exposures to print, remembering what had been directly taught, using fingerspelling, and mouthing with or without signs" (p. 44).

Student Teaching Experience

My student teaching experience at California School for the Deaf in Fremont, California was helpful and challenging. I used a journal to record my teaching strategies.

These strategies, in relation to Sousa's (2001), helped me analyze which were more effective for deaf students' learning experiences. I attempted to experiment with all seven strategies, often a combination, while teaching deaf students in mathematics classes.

Lecturing was my least favorite strategy to use for deaf learners. I knew this strategy would be more important for deaf students' learning because some of them never saw many topics before. Normally, I would warm up with an informal conversation with deaf students before starting a lesson. Then, I introduced a new topic to deaf students and explained what I plan to do for the rest of the class period. I always wrote down the important key words on the board for deaf students to see and copy them in their notebooks. I started questioning deaf students about what they know about this topic and encouraged them to give me answers before I explained anything. My lectures would last between twenty to thirty minutes, depending on how complicated each topic would be for deaf students to understand.

Reading was quite difficult for some deaf students. I did not always make deaf students read independently without getting some help. For example, I wrote down short sentences on the board for them to read. I waited for them to finish reading the sentences and asked them questions about what they know about the sentences. My job was to test their reading comprehension. When some of them failed to understand what the sentences meant, I rephrased the sentences in American Sign Language (ASL). They understood immediately. In another class, I used overhead transparencies for deaf students to read several word problems. I stepped back and waited for them to finish reading. Sometimes deaf students asked for some clarifications related to a word

problem. I asked them if they understood what the word problem asked. Some of them did not understand and I signed in ASL while pointing at certain words to emphasize. They picked up quickly.

Audiovisual materials were one of the most effective strategies for deaf students in mathematic classes. All deaf learners loved visual aids along with the lessons because they understood what they were supposed to do. For instance, one class with a low function level had struggled with rounding off to whole numbers. I first gave them a brief lecture based on this topic, and got the feeling that they did not fully understand how to round off the whole numbers because of lacking their responses. I decided to attempt an audiovisual strategy to assist them. I used my two hands as "numbers" to visualize what they were reading from a practice worksheet. The worksheet asked them to find the next number after the bold-faced number and they needed to decide which way to round up or down. Deaf students had the opportunity to look at the next number after the bold-faced number through using my two hands. My right hand was used for one bold-faced number and another was used for the next number. I asked them to identify the next number after the bold-faced number and questioned them which rounds up or down. They understood what I asked for. The next day, deaf students forgot how to round off the whole numbers and still did not understand. That strategy I used was not effective. Therefore, I had to recreate another visual strategy for this topic. I developed a table with four different titles such as "round to nearest", "original number", "round up/down", and "rounded number." I guided them on the board with this table and wrote down examples like: round to nearest: TEN, original number: 7**6**1, round up/down: DOWN, and rounded number: 760. All loved this strategy. One student

stated, "I like the table better than the previous class!" and another said, "I want more practice with that table!" These statements showed me how well they understood how to round off the whole numbers.

Demonstration was one of the other strategies that helped deaf learners. For instance, I taught and showed deaf students how to use lattice multiplication (lab activity). I had a big poster of lattice multiplication on the board for them to see. I also created several small lattice multiplication boards for students to use after the demonstration. I explained the rules for how to use this activity. I also demonstrated how to add the numbers through nine boxes with a diagonal in each box. I used different color markers in each diagonal to be more noticeable. Deaf students really enjoyed the lab activity. There was no sign of frustration. Another example of demonstration was to show deaf students how to find the least common multiple (LCM) and greatest common factor (GCF) through the prime factorization. I explained the rules about the difference between LCM and GCF. After demonstrating an example of LCM, I pointed at matched numbers to write down and cross over the matched numbers. I emphasized deaf students that the other non-matched numbers are always welcome to join other "matched-number" friends. I also gave them another example of GCF in the same procedure as LCM except the non-matched numbers are not welcome to join other "matched-number" friends. Deaf learners realized how easy the procedure is for them to do and understood the difference between LCM and GCF successfully.

Discussion, practice by doing, and teaching others were all combined in one lesson which was successful for deaf students' understanding. I taught deaf students how to set up a number line and label the numbers. I provided them the numbers to

label and encouraged each of them to come to the board and label it. This was the practice by doing strategy. And, I asked each of them to explain how they found the right place to mark. After explaining their reasons, other students started discussing. I noticed one mistake on the number line without informing all students. One student later identified the mistake and explained it to other students. These are both discussion and teach others strategies. All three strategies promoted all students' comprehension of how to use the number line correctly.

An analysis of two videotapes

At Virginia School for the Deaf and the Blind in Staunton, Virginia, a deaf mathematics teacher named Wayne Frick taught algebra in a class with deaf students. I have analyzed his teaching style and how he used some strategies to support his teaching in the videotape. Frick decided to reteach deaf students the lesson related to slope because he felt that they did not fully understand the concepts of slope. He reviewed lines with different slopes and asked deaf students what a horizontal line represented, and they replied "zero slope." Frick signed and spelled "zero" to emphasize while writing down on the board and pointing at the line. He did the same thing with other slopes by signing and spelling the words of "positive" and "negative" to emphasize on the board. Frick asked deaf students what a vertical line represents, making a serious facial expression when he said "be careful" with a pause. He stated this is "undefined", emphasizing the meaning of "undefined": "no number", "no number" (he repeated it twice). Frick let deaf students use their calculator to find the answer for 5 divided by 0. He again emphasized 5 divided by 0 three times and made a surprised expression, stating "not work?" At that moment, he encouraged students to give a

reason why that does not work. The teacher replied, "can't because error (spelling e-r-r-o-r), no answer" and explained that it is undefined, making sure deaf students understood why this happened. This teacher used audiovisuals, discussion, demonstration and practice by doing strategies for that lesson. Frick used audiovisual, discussion, and demonstration as drawing four lines in different directions, labeling the words, signing and spelling the words, and questioning deaf students. He also used this practice by doing strategy by letting deaf students use their calculator to find the answers.

At American School for the Deaf in West Hartford, Connecticut, a hearing science teacher who taught science to deaf students. I have analyzed her teaching style and how she used some strategies to support her teaching in the videotape. The teacher started discussing the term of "intensity" with deaf students in the beginning of class. She got the visual aids ready on the board for deaf students to see. During their discussion, one deaf student corrected others through questioning. Deaf students experimented with a wooden bar by hitting it against the table with different sounds. The teacher asked one student who stated that it is loud, "what is it called?" and that student replied, "intensity" with an explanation of the meaning. A ruler was another object for deaf students to experiment with. One student mentioned that long wavelength has high frequency, but the teacher caught his mistake and explained that low frequency is for long wavelength and high frequency is for short wavelength. She demonstrated the ruler with low and high frequencies in front of deaf students, explaining why they had different frequencies. The teacher used audiovisual, demonstration, discussion, practice by

doing, and having students teach others in a combination in the classroom. These strategies promoted deaf students' learning and comprehension.

Conclusion

These analyses have shown a variety of ways to enhance deaf students' active learning experiences. I have listed several recommendations for teachers who want to improve their instruction with Sousa's (2001) seven strategies. These recommendations will encourage deaf students to become more enthusiastic to learn from their teacher.

- Reduce long lectures
- Encourage and involve deaf students with readings (no avoidance)
- Use different visual aids as much as possible
- Demonstrate concepts and involve deaf students in providing responses and explanations about what they observe
- Involve deaf students with discussions through answering and questioning as much as possible
- Allow deaf students to practice by doing the activities, which promote their understanding and memory
- Give deaf students the opportunities to become a "teacher" and encourage them to teach others what they just learned in the class

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