Teaching strategies, learning strategies, and communication in the mainstream biology classroom. A study of the perspective of deaf students

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In Partial Fulfillment of the Requirements
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Teaching Strategies, Learning Strategies, and Communication in the Mainstream Biology Classroom: A Study of the Perspective of Deaf Students

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Abstract

This qualitative pilot research study explores the perceptions of deaf students who are a minority in the mainstream college classroom. It focuses upon the effectiveness of teaching and learning strategies used in the biology classroom, and how communication with hearing peers affects the deaf student's ability to learn in the classroom. Through questionnaires and interviews, participants provided insight on their experiences in the mainstream biology setting. Through research articles and interview responses, suggestions for effective teaching, learning, and communication were constructed and are provided to benefit all in the education profession.

Purpose

Science in general is one of the most difficult areas for deaf students to fully comprehend due to its complex and analytical nature. Science literacy requires students to understand the plethora of terminology, to understand highly complex concepts and to apply the information they learn to explain and discover reasons for why things happen. Most of the concepts in science require some sort of memorization because of all the tightly knit information contained in certain areas.

Along with the extreme complexity of this content area, the way that teachers present the information and students learn the information will impact the student's ability to perform their best in the course they are taking. Many times, deaf students are required to work together with their hearing peers in the laboratory and during class. The adequacy of communication will also determine the performance of the deaf student. The purpose of this pilot research study was to determine how deaf students were taught, how they prefer to learn, and whether or not communication with their hearing peers was
successful or not. Suggestions for teachers for improving these areas will be provided from the data obtained as well as recommendations for more in-depth research follow-up.

**Importance**

This qualitative research pilot study was conducted to obtain information from deaf students by way of interviews and questionnaires. The responses collected from the participants were used to develop preliminary suggestions for mainstream teachers to improve teaching, learning, and communication and thus make it more effective for the deaf and hard of hearing students in their classrooms.

Each of the areas researched in this pilot study, impact education for all students. Deaf students in particular are not accommodated in some respects and struggle with communication and learning information that require application level work, and highly complex information. It is for this reason that teaching effectively is necessary. This pilot research study focused on biology in particular, however the findings and suggestions presented in the pilot research study applies to other areas of study and interest.

**Literature Review**

**Introduction**

Deaf students have had the option of several different educational settings they could attend including mainstream settings in which deaf students are educated fully or partly in classes with predominating hearing students. An increasing number of deaf students are currently in the mainstream setting. These deaf students are educated among their hearing peers and many need special accommodations to succeed in a mainstream setting. In the mainstream, deaf students as well as students with disabilities are protected
under laws that grant these students services and accommodations in school. From preschool to high school, students are protected under the IDEA Law of 1997 which provides free and appropriate public education, appropriate evaluation of services, and independent educational plan, a least restrictive environment, parent and student participation, as well as procedural safeguards and are further protected under Section 504 of the Rehabilitation Act of 1973 (Horne, 1996). Once they leave high school or reach the age of 21, these individuals will be protected under the Americans with Disabilities Act of 1990. These laws prohibit discrimination against people with disabilities and require equal and appropriate education for all students. As important as these laws are, there are other variables that affect the effectiveness of mainstreaming.

In order for mainstreaming to be successful, it must be able to integrate the deaf and hard of hearing students effectively into the social milieu and learning activities of the school and classroom (Stinson, Lang, 1994). However, deaf students in the mainstream program often encounter frustration and negative experiences with their hearing, non-disabled peers which will lead to delayed development of social skills, a lack of participation in extracurricular activities, loneliness and often impacts the student’s ability to learn effectively in the classroom. Stinson and Whitmire (1992) found that extensive mainstreaming did not promote relational bonds with hearing classmates and hearing peers. Deaf students’ commitment to and emotional security with deaf peers and classmates was significantly higher than with the hearing peers and hearing classmates. This occurred even when the deaf students were substantially mainstreamed. With this in mind, mainstreaming may not be the best way to encourage social development in the deaf students. This is why teachers need to work to involve deaf
students and take action to set the 'mood' and 'flow' of the classroom by supporting deaf students in the classroom and solving any problems in the first week of school; the most critical time for setting 'ground rules'. This is also the time where students, teachers, interpreters, and notetakers become acquainted with each other figure out arrangements for successful participation in the classroom for the entire school year.

**Services**

While in the mainstream setting, deaf students are provided services, modifications, and accommodations based on their Individualized Education Plan, which are intended to grant them equal access to the same information as their hearing peers. Some services that can be rendered are: Interpreter, Notetaker, Itinerant teacher/Teacher of the Deaf, Special Education Teacher, Teacher’s Aide, Real-Time Captionist, Audiologist, FM systems, and Sound Fields among others. These may or may not be provided depending on the child’s needs, the parents’ knowledge of special education, and special education services rendered by the district. A lack of services can cause deaf students to become delayed in their educational development. Advocates for mainstreaming support this path of education for deaf and hard of hearing students because they believe that educating disabled students with their non-disabled peers provides equal access to learning experiences in the least restrictive environment for that student which is supported by the IDEA law of 1990 (Stinson, Whitmire, 1992). Yet, there are many people who are against mainstreaming because it poses a more restrictive environment for deaf students. Communication, socialization, development and education are restricted in the mainstream setting.
Language and modifications

Deaf students often struggle with the English language with regard to abstract concepts that are found in science. Integrating language with science is one way to help deaf students with the concepts and language variables; textbooks, vocabulary, writing down observations, and writing lab reports; that are associated with learning science (Stewart, 2001). Other modifications that may need to be made are as follows: deaf students need additional and improved access to vocabulary that is conductive to the acquisition of scientific knowledge and scientific concepts, opportunities to discuss science-related matters with other individuals, science role models that may or may not be deaf themselves and authentic learning experiences.

Authentic learning experiences are what students would obtain in the laboratory or outside in the environment. They are real life experiences that students can experience in nature or that apply to their life directly. Research done by Yore (2000), stressed that writing tasks and instruction should be embedded in the authentic (real) context of scientific inquiry as a major part of learning science. This type of instruction should increase the students' metacognitive awareness and create abundant opportunities for students to generate ideas in the realm of science. Authentic learning experiences aid students in learning and understanding new concepts and challenge their previous knowledge on information and help them to construct further understanding in the field of science. The more experiences students have, the greater their knowledge becomes. It is with these experiences that students also apply the knowledge they already have (Stewart, 2001).
Communication barriers and accommodations

Although deaf students are exposed to the same information as their hearing peers, the communication barriers they experience may prohibit them from benefiting from the information provided (Stinson, Whitmire, 1992). Therefore, adult-mediated and peer-mediated communication is critical for a child’s social and language development. Authentic learning helps to eliminate some communication barriers and allows the students to discover things for themselves. There is little to no lectures and some socialization required.

Beyond communication difficulties in communicating ideas for class activities, deaf students have a difficult time communicating in class with hearing teachers and peers because more than one person is talking, or there is a problem with the lighting. It is important for the deaf student to see each of the people they are working with and to have one person talk at a time. The interpreter needs to be able to sign for each individual and there is a lag time for interpreters, so deaf students do not get the information right away. Secondly, deaf students may lip read and they need to be able to follow each person to the best of their ability. It is only common courtesy for one person to speak at a time.

Eye contact is also important so the deaf student can supplement information with lip reading although the majority of the message is not obtained. The Art of Itinerant Teaching for Teachers for the Deaf and Hard of Hearing by Mary Deane Smith (1997) provides insight on the “Swiss Cheese Learning” deaf students’ experience. Smith explains that if a teacher or student utters a sentence “Find the sentence that shows how Carla felt” the deaf student may hear “ind e en en a how how arla el.” She continues
to explain that what a deaf student may lip read is “F th s th show how arl f” (p. 43). The lip reading sentence does provide more letters here than what might be read, the same should be taken into consideration for what the student has heard since that varies from student to student. It is for this reason that teachers should avoid speaking and writing on the board or setting up activities or putting up overheads at the same time (Lang, Basile et al. 1984). It is also important for individuals to annunciate and speak at a ‘normal’ speed to best benefit the deaf or hard of hearing individual listening and lipreading.

Visual Accommodations

There are other accommodations that should be integrated into the classroom to assist deaf students in obtaining an equal amount of information to that of their hearing peers. Many of these relate to the need by the deaf student to obtain information visually, even if they have some significant residual hearing. Some situations can been visually difficult for the deaf student such as a teacher who is writing on the board, talking and then showing visual aids without adequate pausing, while the student is relying on an interpreter for the information. It has been recommended that one person at a time should be communicating to ensure that the student can follow all of the conversations to their entirety. The teacher should provide visual cues as to who is speaking and visual cues to support learning in the classroom (Smith, 1997). As topics are being discussed in lecture, teachers should pause between topics so the student knows there is a topic shift. It will also help the interpreter as well as the student if the teacher watches the interpreter as to
make sure the pace of the lecture is okay for both interpreter and student
(www.rit.edu/~classact).

Learning styles

As students are learning, each of them prefers a different method of learning. Therefore, writing may not be a student’s strong point or the preferred way for the student to learn. This is where the idea of learning styles comes into consideration. Learning styles are the preferences that students have for thinking, relating to others, and learning in particular types of classroom environments and experiences (Lang, Stinson et al., 1999). Styles can vary from writing, presenting, drawing, and acting, moving or using musical means for learning. Topics in a content area that may be easy for some students can be hard for others and it does not necessarily have to do with whether or not the students are paying attention or studying. It may be the case that students are not retaining the information because they do not understand it. To help them understand the information, it will need to be related to something they can relate to or instructed through their preferred learning style. Thus, it is important that the teacher take these learning styles into consideration when educating students; not only deaf students but hearing students too. By using a variety of different means to instruct, students can learn to the best of their ability. In a study done by Lang et al. (1999), learning style preferences related to the students’ motivation, academic achievement, and the way they utilized resources. When students’ learning preferences were utilized, students performed better on the areas mentioned. In a classroom it is impossible to accommodate all students’ learning styles at once; therefore it is important to teach different lessons in
varying ways. This way all students have a chance to learn through their preferred learning style and strengthen other learning styles that may in turn also prove to be successful.

**Hands-on learning**

One of the learning style foci is “hands-on” learning. Hands-on learning has been recognized as particularly vital for facilitating cognitive growth and interaction in deaf and hard of hearing students (Lang, Propp, 1982). Many students are visual learners, not only deaf students but hearing students. This type of activity is beneficial to those types of learners because the concepts are concrete, they are tangible and not abstract as text on paper can be. When doing the hands-on activity, students should be encouraged to discuss the activity to help them structure their thinking about the activity and the related concepts (Stewart, 2001). The group discussions from these activities may in turn provide intellectual stimulating conversations that will challenge students’ thoughts about concepts and background knowledge and may also increase the student’s vocabulary. Here is again where communication issues are critical.

**Inquiry based Learning**

Many times science teachers do not include inquiry based learning in their curriculum and thus tend to portray science as a collection of facts, principles, and concepts with little or no instructional attention to the process of how scientific knowledge is made public and validated. Inquiry based learning focuses on assessing, observing and drawing conclusions in the environment or the laboratory. Unlike authentic
learning experiences, inquiry based learning focuses on laboratory based work, instead of experiencing content first hand. As discussed before, facts, principles may be straightforward for students, but they do not help to apply concepts and do not promote significant understanding. Inquiry based learning allows the students to investigate, observe, assess, and draw conclusions. All of these skills are necessary for promoting true understanding since they require application of information and ideas and drawing inferences from data and facts. However, many teachers have a tendency to disregard inquiry based teaching because there are several barriers to this method such as safety issues, lack of equipment, management difficulties, and the need to teach a mandated curriculum (Wallace, 2004).

Other than inquiry-based teaching, according to the deaf learners in the study done by Lang and Stinson, effective teaching requires the teacher to be structured, organized, meaning using notes, outlines, clear deadlines, and teacher-centered activities (Lang, Stinson et al., 1999). Regardless of the students in the classroom, it benefits the class when teachers offer a variety of teaching approaches during a course of study in order to allow every student in the class to learn through their preferred learning styles of learning and to strengthen other potential preferences to learning.

**Writing to learn activities**

Writing to learn activities and journal writings are also of benefit to deaf students. Just as authentic learning experiences are meaning creating, so are writing to learn activities (Lang, Albertini, 2001). They benefit deaf students by allowing students to think about the activity, the meaning of the activity, and the theories behind the activity.
Students need to apply information they have learned to the demonstrations and this process encourages retention of information because they are putting the information to use. Writing to learn activities are what a teacher can use in the classroom to help the students express their thoughts, hypotheses, and observations in the classroom. Teachers can be flexible with the types of exercises they do using writing to learn strategies. For example, a teacher could prepare a demonstration and show the students the materials for the demonstration and explain what he/she will do during the demonstration. Students are to write what they think will happen during the demonstration. Once they have finished, the teacher begins the demonstration. When the teacher is finished, the students are to write what they observed, the outcome of the demonstration, whether or not they were correct, and the explanation for why the demonstration worked the way it did. Writing while learning science material is essential in developing a sense of curiosity and understanding in the students (Lang, Albertini, 2001). It also leads to better learning than activities that only incorporate reading and studying. Rivard (1994) supports this view in saying

"Writing can enhance science learning when teachers tailor tasks to attain meaningful curricular goals, when learners possess the necessary metacognitive knowledge, and when the instructional environment sustains a view of scientific literacy that embraces deep conceptual understandings rather than encyclopedic knowledge" (p. 978).

Journal writing encourages students to assess their prior knowledge, to think about the process executed, to state what they have learned and to integrate the English language with scientific knowledge and skills. Although similar to journal writing,
writing to learn activities are more than just recording thoughts, and laboratory
experiments, the students deriving hypotheses, come to conclusions, and apply their
knowledge of science (Stewart, 2001). Many teachers incorporate both of these activities
in the laboratory wherein students are required to keep a journal and write about the lab
activity, their hypothesis, their observations, data, results, and formulate conclusions.

Vocabulary

Just as applying concepts is difficult, vocabulary is a difficult area for any student,
but especially for deaf students. The level of difficulty for the deaf student depends on
many factors such as the level of deafness, the amount of family participation,
communication, the quality of the foundation language, and the ability of the student to
use that language. Vocabulary needs to be in English and in some cases in sign language
depending on the communication preference of the student. The more English vocabulary
a student knows, the greater the ability to communicate, construct and reconstruct
meanings (Stewart, 2001). It is necessary that teachers do not reduce the amount of work,
simplify language, or reduce the amount of vocabulary because of the deaf student’s
current language abilities, but to provide a picture, or relate the concepts with something
the students already know, with the new vocabulary word(s) to help the student
remember the meaning of the word and utilize other strategies for accommodating the
students needs and abilities (www.rit.edu/~classact). Teachers should have high
expectations for all of their students no matter the disability.

It is important for teachers to treat deaf and hearing students alike and not have
‘pity’ on the deaf students. Nonetheless, sometimes deaf students may need less work,
more time, simplified language, and reduction of vocabulary. If this is the case, the teacher should assess the situation and determine what the problem is. Is the student having trouble with English? With the content? With the production of the assignments? Depending on what the area of difficult is, the teacher can accommodate the student. Projects can be done explaining a concept instead of a research paper on a topic, proper vocabulary can be taught and applied but pictures can be added along with an explanation of what it means, and signed explanations can be provided if that is the student’s primary mode of communication.

Advance Organizers and Visual Approaches

Continuing with the idea of learning styles, some students are more visual learners and they need to organize information in a way they can understand and piece things together. Some students need to organize their thoughts before they can continue with the learning process, and others may need to know what is happening before class to better prepare themselves.

Graphic organizers and concepts maps help students understand the material taught in class. With graphic organizers, deaf students, hearing students and disabled students can see the relationship between concepts and ideas. It is also a good way for students to show that they have constructed knowledge in a particular area and understand those concepts and related ideas. Concept maps also relieve concern for students that struggle with written expression to convey their thoughts, they are a simple method for organizing thoughts, it can be used to recall information, it can introduce new
scientific vocabulary, and it can provide a basis for a report that needs to be completed (Stewart, 2001).

To help prepare the students who need to know what will be happening in the classroom or laboratory ahead of time, teachers can provide the students with a class agenda or a weekly agenda. This will especially help the students with interpreters in the classroom. The interpreter will be better prepared for class if they have one as well and can meet with the deaf student to discuss concepts and signs if they choose to do so. Deaf students will also have a chance to look over the agenda, look over the material, and possibly read other sources of information on the topic to better prepare themselves for lecture and/or lab that day. Many interpreters are not certified in science and so it is hard for the interpreter to interpret higher level science classes if they do not understand the concepts and terminology themselves. The deaf student in the classroom suffers in the long run because they are not obtaining adequate information from the uninformed source. Therefore it is important to inform both the students and the interpreters of what will be happening in class. Agendas also provide students and interpreters with time to examine the agenda items and express any questions or concerns to the teacher before the lesson begins.

Going back to the learning styles, I mentioned that many students are visual learners. Many deaf students fall under this category since this is their primary way to obtain information everyday. Visual learners need pictures, models, and other visual sources to help them retain information and help them apply concepts. Visual aids provide considerable assistance with comprehension in the classroom. Maps, pictures, graphs, tables, and charts are also necessary for visual learner in aiding their
comprehension of complex information; such information is taught in science. Reynolds and Rosen (1973) reported from their research that the use of pictures with printed verbal labels along with a brief description/explanation produced better learning and retention of information than a textbook for deaf students. Logan (1870) stated that pictures provide pleasure, they are definers of text, and they convey far more correct ideas than you can gain from printed text alone.

Above all, is visual dependence, one area that is often a problem for deaf students in the classroom. Deaf students in a typical mainstream classroom will have classmates sitting in rows, a teacher in the front of the room talking and writing on the board, handouts on the desk that are to be filled out, following the teacher’s instruction in class, and an interpreter in the classroom trying their best to follow and interpret everything. The overhead might also be being used at this same time. This is presents a challenge for deaf students visually. They need to fill out papers, watch the board, the teacher, the interpreter and wants to make sure they know who is speaking in the classroom and so they turn their head. A lot of information is lost for that deaf student. Knowing this, teachers need to do their best to reduce the amount of visual complexity for that student. Notes or printed handouts should be provided to the students to reduce the amount of visual complexity or the amount of time the student will spend looking away from the teacher and other classmates, and it will provide the student with the information so they can refer to them later (Lang, Basile et al. 1984) Teachers can also provide the visuals, pause between topics, make sure the interpreter is following by checking the pace, point to the students that are speaking one at a time, and make sure they wait for the deaf
student to catch up without making the student look more 'different' than they already are (www.rit.edu/~classact).

Peer Discussion of Science Context and Socialization

Deaf students do not have the same opportunity as hearing students to discuss scientific materials with others. At times, students are provided with interpreters but this does not increase the communication between the students inside or outside of the classroom. Interpreters are generally used to relay the information being taught in the classroom and questions are being asked to the deaf student.

Interpreters do not capture the side conversations that are happening in the classroom, and deaf students cannot participate in those conversations because of communication barriers. Outside the classroom, the interpreter is not there. Deaf students do not get the socialization they need in the mainstream setting. They miss out on a lot of information because they simply cannot hear what is going on around them, and not many hearing high school students are willing to talk to someone who is 'different'. Therefore teachers need to try to incorporate more discussion in their classrooms. Discussion of science content will help deaf students retain the information, apply the information, and possibly get into opposing arguments on a controversial topic. This will also help the deaf students work on their social skills and learn more about the current events since many miss out on what is going on in the world either because they cannot listen to the radio, they don’t read a newspaper, they have low reading levels, or they don’t watch the captioned news at home.
Motivation of students

Learning is not only based on teaching and learning strategies; it is also based on the motivation of the student to learn the material and how positive the student is about learning the content material. A study done by Kluwin and Lindsay (1984), found that a positive student attitude resulted from less teacher monitoring rather than more. Another predictor was a teacher’s willingness to give attention to a student until that student fully understood the task. Surprisingly, it was found that deaf students preferred classroom environments where emphasis was on the task to be completed and not on the individual student. The reason for this was that the deaf students didn’t want to draw more attention to themselves as ‘different’ or needing more help than others. Directing the focus of instruction on the individual was seen as being a negative thing.

Motivating students can be a difficult thing especially with a topic like science that many students do not think they need. Many different strategies can be used but it depends on the individual. As before, learning style preference can achieve this goal, so can relating the information to what a student already knows, or enjoys, allowing the student to be a part of the instruction, and incorporating hands-on or research/presentation based work in the curriculum. Teachers are encouraged to try as many modes as possible to motivate their students. Each student is different and that is why it is important to learn about your students and what ‘makes them tick’.

Role models

Role models are important for everyone. Hearing students naturally have role models, someone they can relate to. Deaf students need role models too; deaf role
models. In the ‘hearing world’ we live in, it is not often we hear about a deaf person becoming successful and accomplishing some great feat. In fact deaf people have done so; For example Thomas Edison and Robert Weitbrecht. Both of these men were deaf and played a part in the technological advancement of society. Deaf students need to be aware of the accomplishments of deaf scientists. They need to learn about what deaf people did in the past, and they need to meet today’s successful deaf people to provide them some validation that they can succeed in the field of science, history, and whatever area they choose to pursue. It is highly unlikely that public schools will provide this opportunity. Teachers need to consciously incorporate not only deaf scientists but disabled scientists in their curriculum; not to point out their disability, but to point out that people with disabilities can become successful as well. Not having a role model or someone to look up to is likely to complicate the deaf or hard of hearing’s development of self-identity and self worth (Stinson, Lang, 1994).

State and National Standards

In the mainstream, teachers are required to educate students based on the National Science Education Standards. These standards require students to be able to pose scientific questions, to construct procedures to answer their questions/hypotheses, to look for patterns and meanings in their data, to construct a knowledge claim to answer their questions/hypotheses, to support claims with evidence, and to explain their findings in light of a framework of scientific information (Wallace, 2004). Unfortunately, the current standards that teachers need to cover exceeds the amount of time necessary to cover the topics in depth, with sufficient inquiry based and student centered learning.
Therefore students are often given a shorter period of time in which to absorb and understand the concepts taught in their science class (Stewart 2001). This places more pressure on the learning disabled and deaf students in the classroom. To level the playing field for deaf students, Lang and Dowaliby (1999) suggest the addition of adjunct questions, questions pertaining to the text that are given to the students directly preceding or following text, in textual instruction for student with varying reading levels, pictures with explanations and/or signed explanations of the text, pictures, and explanations for the deaf students.

Conclusion

All of the areas covered in this review are areas of focus for some training programs provided to teachers with deaf and hard of hearing students. At RIT, a program called Class Act (www.rit.edu/~classact) has provided in-service training to faculty about teaching deaf students effectively. Likewise, other schools have a need for in-service training and pre-service training programs for mainstream teachers (Lang, Propp, 1982). Most of the current programs are not meeting the needs of schools and programs for deaf and hard of hearing students and therefore must be improved as to accommodate the learning of the students. It is important for deaf students to have access to information in the Least Restrictive Environment, and thus it is the job of the teachers to make mainstreaming as least restrictive as possible by instructing class using different modes, by considering all of the students in the classroom, by providing adequate resources to support learning, and for setting ground rules from day one.
Teachers, professional organizations serving the deaf, and organizations concerned with science education all need to improve their lines of communication to 'bounce' information and ideas off one another. With an increase in communication between these three groups of people, the awareness of the importance of infusing education concepts into science activities can be discussed and improved.

Schools are always trying to budget effectively and it is apparent that the budget support in some schools for science educational facilities, equipment, and supplies suffers. The whereabouts for funds for improved conditions in the science classrooms and opportunities for students to have those authentic experiences might need to be sought for elsewhere.

**Research Questions**

The research focused on three major areas in the mainstream biology classroom; how the teacher instructs the classes, how the students learn, and if the communication among deaf students and their peers in the classroom is effective or not. This pilot research study was conducted using a questionnaire to obtain background information about the respondents as well as what areas of biology they tend to struggle with. The interviews elaborated on the information obtained in the questionnaires on each of the three foci of the research. The results of the interviews were used to devise suggestions for teachers in the mainstream biology classroom setting.
Participants

Participants were selected based on a few requirements for the study. First, all of the deaf student participants had to have taken a biology class at the Rochester Institute of Technology. It was not required for the participants to be biology majors or science majors. Second, the participants had to have worked with hearing students in their biology class or classes to ensure all of the questions could be answered. All degrees of deafness were accepted as well as all methods of communication. Certain characteristics of family members were not required. To locate participants, I contacted advisors in the college of science and asked if they knew of any students that fit the requirements and that would be willing to participate in a pilot research study. The advisor sent me names of students with emails and a little bit of information about their background in science. I sent out a mass email to all of the students who fit the requirements explaining my background, and the purpose of the pilot research study. I asked them to contact me and let me know if they were interested. Three students responded.

A total of three (3) individuals were interviewed: one hard of hearing student, and two deaf students; all three were born with their current level of hearing loss. All participants were science majors at the college and obtained As and Bs in their courses. Two of the participants had deaf or hard of hearing family members whereas one of the participants didn’t. All of the participants use sign language to communicate, although they learned it at different ages. Two of the participants grew up oral and used Spoken Language to communicate with family members and one of the participants uses sign language to communicate with family, although one or two family members of the participants know some form of sign language. All of the participants prefer to
communicate at school and with friends using American Sign Language (ASL) or Pidgin Signed English (PSE). All participants obtain note taking services and have an interpreter in the classroom to aid in communication.

**Interviews and questionnaire**

In preparation for the interviews, literature regarding teaching strategies, learning strategies, and communication was collected and read. The majority of the literature was obtained from a number of research studies conducted by professors at the National Technical Institute for the Deaf (NTID) and at the Rochester Institute for Technology (RIT) since many professors and researchers at the college are working to improve the education of deaf students in mainstream settings through studies and grants. Most of the work took place during March 2005 and April 2005.

After the literature review began, preliminary questionnaire and interview questions were developed reflecting the three areas of interest. After reading more literature, questions for both the interview and questionnaire were finalized. A letter of introduction to the participant was developed (Appendix A) with a statement of the researcher’s background and purpose for the interviews was given to each of the participants. The consent form (Appendix B) was given to the participant to sign and date and the researcher verified each of the students were the age of eighteen or older by asking for the participants’ driver’s licenses. Finally the questionnaire (Appendix C) and the interview (Appendix D) were developed using the finalized questions.

The questionnaires contained basic background related questions about the participant’s communication preference, learning styles and family background related to
deafness. The questionnaires were conducted at the initial meeting after paperwork was signed and age was verified. After the participant completed the questionnaire and all questions were answered, the researcher had time to review the responses and prepare some follow-up questions that were not contained in the finalized interview questions.

The questionnaire focused mainly on the following topics: (a) identity, (b) family, (c) school, and (d) biology curriculum. The last topic, biology curriculum focuses on the general topics of: (a) Organizations of Life, (b) Heredity and Genetics, (c) Evolution: Change over Time, (d) Reproduction and Development, (e) Homeostasis, (f) Ecology, (g) Human Impact on the Environment, (h) Scientific Inquiry and Laboratory Techniques, and (h) General Areas. The interview questions generally focused on: (a) services, (b) communication with peers, (c) science curriculum, (d) teaching strategies, (e) learning strategies, and (f) general questions relating to education.

During the follow-up meeting with the participant, the researcher conducted the interviews face to face and documented all responses using a laptop computer. As participants responded to the questions, more specific questions were asked related to the participant’s response. If the initial interview questions are too specific, the researcher is limited with the kinds of responses he or she will obtain from the interviews. It is essential for a researcher to expect any kind of response to their question and then be able to “think on their feet” to create a follow-up question on the spot that relates to the participant’s response to further obtain an insight into the life experiences of the participant.

Questionnaires and interviews were conducted on a one-on-one basis in an area in which the participants were most comfortable meeting. After the interviews, responses
were sent to the participants to verify the accuracy in the responses obtained. Modified responses were added in a different color than the actual interview leaving the original text so the researcher could use the information accordingly.

**Methodology**

Questionnaires and interviews were conducted by Denise Lengyel, a second year Masters in Secondary Science Education for Students who are Deaf and Hard of Hearing (MSSE) Program at the National Technical Institute for the Deaf (NTID). Each questionnaire lasted between 15 minutes and 20 minutes, whereas each interview lasted between one and two hours. All interviews with the deaf and hard of hearing participants were recorded using a laptop computer and then sent to the participants to check for accuracy of responses. Each questionnaire and interview was coded using letter codes for each of the participants. After the interviews were complete, a final coding occurred and thus seven categories emerged from the data.

The seven themes that emerged from the data were the following: (a) Lecture vs. Hands-on Experience, (b) Communication, (c) Deaf Students vs. Hearing Students, (d) Learning Strategies, (e) Suggestions, and (f) Importance of Science. Some of the content pertained to different themes and was thus coded in two categories. Information was summarized accordingly after the coding process was complete.

This pilot research study was developed before the researcher was aware that the college of science at RIT recently finished a research grant called Class Act. This grant was provided to RIT so they could develop a website to “improve existing teaching practice regarding “access” to learning for deaf and hard of hearing students in post-
secondary classrooms” (www.rit.edu/~classact). The website covers site accessibility, challenges/ strategies, a discussion board, student perspectives, teacher perspectives, teaching tools, and information about the grant and contacts for further assistance.

After interviewing one of the participants, the researcher found that the participant had participated in the Class Act grant. The participant’s knowledge of the grant and the fact that the participant has been interview before with questions similar to this one, proved to provide interesting results regarding her perspectives on the areas covered in this pilot study.

Findings/Results of the Questionnaire

Three deaf science majors participated in this study; two are female and one is male. Their ages range from 20 to 22 and all participants were born deaf. Two of the participants consider themselves as deaf and function as deaf students, and the other considers herself hard of hearing and functions as a hard of hearing student. Of the three participants, two of them have at least one deaf sibling who was also born deaf.

All three of the participants use sign language but learned at different times in their lives. One participant learned at birth, one at the age of one, and the other at the age of 18 after entering college. The participants used different forms of sign language at school, at home, with friends and in general. One participant preferred American Sign Language (ASL) and Pidgin Signed English (PSE), while the other two preferred PSE. At home, the participants preferred different styles as well. One participant preferred spoken English, the other spoken English and Signed Exact English (SEE) and the last preferred PSE.
At school, two participants preferred using PSE and one participant preferred ASL. Lastly, when communicating with friends, one participant preferred PSE, one preferred ASL, and the other preferred ASL, PSE, and spoken English.

All participants stated they had a family member(s) that used some form of sign language. One participant has two family members that sign, while the other two only have one family member that can communicate in sign language. Only one of the participants has parents that sign. The other two participants have a sibling that signs. In two of the cases, the family members were learning sign language either shortly after the participant was born or before the participant was born.

Growing up, two of the participants used oral communication and only one participant was manual using PSE. One participant uses sign language when she is home, one participant fingerspells and the other participant is strictly oral at home. Only one student grew up signing in high school. All of the students expressed that their families were very supportive of them when they were growing up.

All of the students spent some of their time in a residential school either teaching the manual method or the oral method. They have all decided to go to college in the mainstream and have taken advantage of the interpreting and note taking services at the college. The interpreters that two of the participants use are oral and the other participant uses a PSE interpreter. All students are comfortable with PSE or ASL interpreters. For a listing of the individual questions and summarized answers, please refer to Appendix E.

The following is a table from the questionnaire asking the students to rate the difficulty of each of the sections on a scale from 1 – 5. The easiest information was to be marked as a 1, and the hardest information for the participants were to be marked as a 5.
The “N” stands for Not Applicable. The letters “A”, “B”, and “C” stand for the individual participants.

Table 1 – Biology Curriculum

<table>
<thead>
<tr>
<th>Organizations of Life</th>
<th>ABC</th>
<th>Ecology</th>
<th>ABC</th>
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<tr>
<td>Living vs. Nonliving</td>
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<td>Biotic vs. Abiotic</td>
<td>NNN</td>
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<tr>
<td>Population Diversity</td>
<td>331</td>
<td>Energy Flow</td>
<td>NNN</td>
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<tr>
<td>Organizational Levels</td>
<td>131</td>
<td>Material Cycles</td>
<td>NNN</td>
</tr>
<tr>
<td>Cell Structure</td>
<td>131*</td>
<td>Organism Relationships</td>
<td>3NN</td>
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<tr>
<td>Life Functions</td>
<td>131*</td>
<td>Biodiversity</td>
<td>NNN</td>
</tr>
<tr>
<td>Cellular Communication</td>
<td>141*</td>
<td>Ecological Succession</td>
<td>NNN</td>
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<table>
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<tr>
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<th>Human Impact on the Environment</th>
<th>ABC</th>
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<tr>
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<td>131*</td>
<td>Interrelationships</td>
<td>12N</td>
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<tr>
<td>Asexual vs. Sexual Heredity</td>
<td>132*</td>
<td>Technological Developments</td>
<td>22N</td>
</tr>
<tr>
<td>Protein Synthesis</td>
<td>141*</td>
<td>Improvements</td>
<td>22N</td>
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<tr>
<td>Genetic Engineering</td>
<td>N51*</td>
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<table>
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<th>ABC</th>
<th>Scientific Inquiry and Laboratory Techniques</th>
<th>ABC</th>
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<tr>
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<td>423</td>
<td>Scientific Methods</td>
<td>131</td>
</tr>
<tr>
<td>Mutations</td>
<td>422</td>
<td>Organization and Analysis of Data</td>
<td>131</td>
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<tr>
<td>Variation</td>
<td>322</td>
<td>Safety</td>
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<td>Instrumentation</td>
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<td>Measurement</td>
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<td></td>
<td>Indicators</td>
<td>141</td>
</tr>
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<td>ABC</td>
<td>Dichotomous Keys</td>
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<td>Dissection</td>
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<td>Sexual Reproduction</td>
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<th>ABC</th>
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<td>Organization of Ideas and concepts</td>
<td>242*</td>
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<tr>
<td>Disease</td>
<td>433*</td>
<td>Compare and contrast</td>
<td>243*</td>
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<td></td>
<td></td>
<td>creating, predicting, inferring</td>
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<tr>
<td></td>
<td></td>
<td>solutions/ideas/results</td>
<td>353*</td>
</tr>
<tr>
<td>Feedback Mechanisms</td>
<td>432*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Participants are labeled as A, B, and C. Each participant’s response is listed under the corresponding letter for each of the categories. Participants rated the difficulty of each topics on a scale from 1-5; 1 meaning extremely easy for the participant, and 5 meaning extremely difficult for the participant. If a participant has not studied a particular category, the participant placed an ‘N’ in the space provided instead of a level of difficulty. When a * is present, this means that it is an area that I would personally consider difficult because of all of the information involved in these topics.

There are some areas that hearing students struggle with as well because they are extremely complex for one reason or another. The starred (*) areas on the chart are the areas that I would consider to be difficult for all students no matter their hearing status. It was interesting to see the variation in the data between students. I had expected all of the
areas under Homeostasis to challenge the students because each of those areas is highly complex and have many parts to them for the students to learn and build upon. I was a little surprised that the areas in the “In General” section were not more difficult for the deaf students. It was just my luck that I interviewed really good students that scored As and Bs in their classes and that were studious. Aside from that, all of the areas in the “In General” section are areas that deaf students often struggle with. All of the other areas rated as I had expected. Some of the areas are easy for some and hard for others. This all depends on whether science comes easy, what the interest level of the student is with regards to the topic and whether or not they have had some of the topics in other classes. These are all variables that affect this data. Unfortunately I did not account for that since that was not one of the objects of this research study.

Findings for the Interviews

For each of the sections below, the students were frequently split on the responses of many of the questions asked. For a listing of the questions and summarized responses, please refer to Appendix F.

A. Lecture vs. Hands-on Experience

This section contained nine different questions which all focused on how the teachers instructed the classes. To summarize this section, all of the students stated that the teachers had a tendency to lecture a lot more than to do hands-on activities or demonstrations/student presentations in the classroom although they have done some student presentations in their biology classes. Higher class levels
tended to be smaller which allowed the student to participate in hands-on activities more. Some teachers did provide visual aids but most of them are in the text book and the teacher references them. Other teachers were thought of as being creative. One student remembered a teacher who would develop games and jokes to remember the material while another teacher held class gatherings with food and presenters, and another teacher developed creative lectures and challenged the student to learn.

Students stated that lab had a mini-lecture or pre-lecture and then sometimes demonstrations on what they should be doing in the lab or special techniques that are to be used. Teachers did ask questions during lab preparation and exposed the students to inquiry based learning techniques.

One student stated that teachers did utilize the white board during lab and lecture. Sometimes important science terminology was listed. The other two students stated that some teachers do not use the board much and they don’t prepare deaf students well enough.

Writing to learn activities were not used in the classroom or the laboratory. The students had no idea what ‘writing to learn’ activities were and so I therefore explained. The students had never used them here at RIT; however they have used lab journals to record information about the labs, the data, and used this to develop their lab reports. With regards to the lab reports, students rarely ever developed their own lab experiment. Two of the student experienced this at RIT, one in research and not in a regular biology class, and the other student did it once
or twice since she has been at RIT. The last student was not exposed to this at all throughout her 4 year stay at RIT.

One thing that is rarely considered is the use of Teacher Assistants. One student brought up that Teacher Assistants instruct labs sometimes and they don’t explain things clearly and they don’t really care about the student’s performance. They may not have had the preparation and awareness training, that faculty members have had.

B. Communication

This section also contained nine questions regarding communication in the classroom, the use of interpreters, communication with peers, captioned materials, following directions, and how often the students felt as though they were guessing in class.

Students all used an interpreter in the classroom and felt as though they benefited from having one in the classroom. The students also utilized the note taking services here at the college. One student stated that she uses the notes when she doesn’t understand the interpreter and other times the interpreter is better than reading the notes; that depends on the topic that is being taught in class.

As far as group work is concerned, the students stated that this does not happen often. They have lab partners but in the class there are not a lot of activities that involve group work. In the lab however, two students stated they had other deaf/hard of hearing people in their program and they tended to be lab partners together. One student was solely mainstreamed and needed to work with hearing
students in the lab. When working one-on-one and in groups, students stated they work with hearing students.

When working with the hearing students, the students stated they use an interpreter and write, or lipread. One student said that some of her classmates know how to fingerspell and that helps a lot. The last student said she talks to her classmates when working with them in the classroom. All of the students were satisfied with the communication between themselves and the hearing students. They said that it was successful most of the time.

The students communicated with the hearing students face to face, they lip read, they wrote, pointed, gestured, fingerspelled, and used an interpreter. One student preferred talking and signing, or talking and listening.

As for positive and negative experiences, one student could not think of any positives to provide me for this pilot study. She said that it was hard to follow and to keep up with the hearing students. Another student expressed his joy for when hearing students try to learn sign language to communicate and when they make sure they understand each other and make sure communication is going smoothly. On the other side of the coin, students felt that some hearing people don’t make an effort to try and communicate. They don’t care. It was also said that they miss out on information because the interpreter cannot interpret all of the ongoing conversations that the hearing students are having in the classroom and in the lab.

In the classroom, students gave varying responses on whether or not the teachers used captioned materials in the classroom. One students stated that they don’t have a problem with that anymore, while other students stated that the videos in
the class were short and the interpreter signed them either verbatim or summarized the information in the video. Whether or not the interpreter signed the video also depended on the age of the movie. According to one student, older movies are not captioned and therefore the interpreter will need to sign the movie. During class and lab, sometimes teachers provide the students with information as "side notes" when the students are working. Students said that the teachers will inform them through the interpreter, but most of the time will write information on the board or hand out handouts with the information on it. One student stated that it was difficult to figure out what was being said because the teacher would 'beat around the bush.'

With this in mind, the students were asked how often they felt as though they were guessing in class. One student stated he really did not feel as though he guessed in class. The other two students felt that it happened more often than they liked but they would ask their teacher or lab partner in one case. Sometimes as one student put it, "it was just a matter of having to go back and look and check the information again and that is clarified through reading."

C. Students vs. Hearing Students

This section only contained one question in relation to whether or not deaf students felt that it was beneficial working with hearing students or not. They were also required to explain their reasoning for their answer. Two of the students in the pilot study felt that it was beneficial working with hearing students because they can answer questions that deaf students might have. "Hearing students know
what is going on because they can hear it.” The third student felt as though he was the one that understood the concept more because he is always prepared for class and science is easy for him. He stated that he tends to make sure the hearing students are understanding and have no problems with the work.

Many of the comments made by the deaf students led me to believe they prefer working with hearing students; one deaf student felt as though deaf students tend not to know what is going on in the classroom and hearing students do. One student preferred working with hearing students because they know what is going on the majority of the time. And they know what they are doing. The student stated “Sometimes I feel like deaf students work harder to prepare for class because we need to download the notes and study them so we can understand the interpreter better.”

D. Teacher’s Knowledge of Deaf Students

This section had five questions that summed up what the participants felt about their teacher’s knowledge on deaf students and how to benefit them. It also focused on the accessibility of the information in the classroom.

It was commonly stated that the teachers informed the students through their interpreters. One student stated that the teacher informed her personally of information in and after class.

As far as the facilities are concerned, two students felt they were ok overall and one student made comments about how awful the acoustics were in the classrooms. She stated they were not adequate but they were improving.
Communication does tie into the previous response. All of the students’ language needs were met with the interpreter, but for the student who relies on the FM system, the auditorium was not sufficient. The student still could not hear the information or other student’s questions and so she was forced to learn how to use an interpreter freshman year in college.

Two students were satisfied with their education while one student was not. “There are problems with the educational system in general; like memorizing. Many classes are based on memorizing and not learning.” Although not satisfied, the student stated that she did learn a lot while she attended this college.

Two students thought the teachers in the science department at RIT were knowledgeable about deaf students and the needs of deaf students. As before, one student was not. Students that thought the teachers were knowledgeable stated that power points were used, and that RIT is not a typical college. Some teachers know finger spelling, some are really involved with deaf people and most of them try to make an effort. Comments about teachers preparing the deaf students before lab and during the pre and post lab were made but regarded this as a rare occurrence. This same student commented on the Class Act Grant at RIT. She stated that even with this training, the teachers are not knowledgeable. She felt that many teachers think they know what deaf people need, however they really don’t.
E. Learning Strategies

In this section, students were asked nine questions regarding if they enjoyed biology, if they learned proper terminology, why certain areas were harder than others for them (refer to table 1 or Appendix E for easy and difficult area for each participant), what their learning strategies were for the different areas, whether they learned the material or memorized it, and what factors influence the learning process.

All of the students stated they enjoyed biology although different areas appealed to them. One student enjoyed all areas pertaining to human and animals that were like humans, one student enjoyed more nature oriented areas and areas on how the universe worked and all of the intricate details and processes that lie within things and the last student enjoyed anything that was interesting and challenging, like biochemistry.

As students varied in the areas they enjoyed, so did the areas that were hard and easy for them. All students stated that when information was new and complicated, it was harder for them as were areas with many intertwined parts, products, back products and intermediate steps. Of there is a lot of vocabulary, one student said that it was harder to learn. To learn this material, students read the book, reviewed the class material, notes and sometimes worked with other students to prepare for class. Students asked the professor for clarification and sometimes saw a tutor for assistance. Other students drew pictures or tried to make compare and contrast tables to help retain the information.
The information the students considered easier, they did so because it was straight-forward, basic knowledge, hands on, or facts and review from other classes. For the easier material, students stated they tended to study less than for the harder material, but they still read the text book and looked over the notes. All of the students did learn proper science terminology and they all stated that the best way to learn it was by reading the book. Some students memorized it but they all tried to learn it in the process. If the material was repetitive, common sense, basic, if they visualized it, or if they were interested in it, they retained it. Students had a tendency to memorize information first, and as they used the information they learned it and thus remembered it. I asked the students if they preferred environments where the emphasis was on the work or in the individual and two students stated they preferred when the emphasis was on the individual and the other student preferred when the emphasis was on the work.

Of the factors that influenced learning, students were positively influenced when the teacher was caring, when there was adequate communication, when there was effective teaching and demonstrations. Students stated that it was helpful when the teacher was organized and when tutoring was available and utilized.

F. Suggestions

For this section, the students were to suggest ways that deaf and hard of hearing students could improve the quality and level of communication with hearing students in the classroom setting. The students provided fairly similar answers to this question. The students stated, deaf and hard of hearing students should do
whatever they feel comfortable with and with whom they are comfortable with, using pictures and writing back and forth, as well as using an interpreter to improve communication. Depending on the degree of hearing loss, one student suggested voicing and lip reading. Recapping (summarizing and repeating information to make sure it is correct) information was also suggested by one of the students. This technique is used to make sure you fully understood what the other person said.

G. Importance of Science

This section focused on the opinions of the students to whether science was important or not. All of the students gave a resounding “Yes” to this question. The reasons behind their thoughts were that science applies to many areas in life. We are living organisms, and whatever happens in the environment it will affect us in some way. It was said that science helps us understand problems and it also creates more problems for us. Another student stated that science is human curiosity and progress and that without it we would still be living in the caves. The final student stated that we need to know science because it is everywhere. She stated that science also teaches us how to think and how to question things and that it can be applied anywhere in the real world.

H. Grade in Biology

All of the students used in this study received As and Bs in all of their science classes.
Discussion

This pilot study was developed to provide teachers with some suggestions on how to accommodate deaf students by teaching effectively, by helping students become effective learners and by increasing the communication between hearing and deaf students. From the research done and the articles collected it is safe to say that many of the strategies and accommodations that are used for deaf students are also beneficial to hearing students.

In this pilot study, three deaf students participated; one of whom previously participated in a research grant called Class Act that was designed to inform teachers about the needs and accommodations deaf students need in the classroom. It also focused on the perspectives of the deaf students and teachers in the science department at RIT. This one particular participant had responded to similar questions in the Class Act training, therefore she provided more thought out answers compared to that of the other two participants.

One of the participants was also hard of hearing so it was interesting to obtain her perspective to that compared to the other deaf participants. Prior to attending RIT, the participant never used an interpreter so that was a new experience for her. Two of the three participants also grew up oral and so the varying differences between the participants proved to be an exciting study.

From the responses obtained, all participants were motivated, they enjoyed science, they understood the need for science in the world and in education, and they are hard working students who obtained As and Bs in their studies. They all had adequate support, still do, from their families for them to achieve the best possible. This helped to
make the participants successful students in the long run. Beyond their successes the participants still had some ‘issues’ with their education. All educational programs need to be improved one way or another and cannot be changed in merely a blink of an eye. Other ‘issues’ can, such as obtaining information and what teachers can to better educate their students. It is understandable that huge freshman classes and sophomore classes are mainly based on lecture for the simple reason that there are so many students. However teachers can incorporate poster presentations, or assignments where they chart out some complex process as protein synthesis in the cells. Group activities can help promote socialization, sharing of ideas, and student centered teaching/learning.

I admit that I was a bit shocked that RIT, such a reputable college did not incorporate writing to learn activities or ‘open labs’ in their curriculum. In higher level classes, writing to learn activities can best prepare students for working in the industry because they need to apply prior information, facts, and theories to the activities they are doing. It would be great for medical majors to use this method as well. Open labs on the other hand help students to develop the problem solving skills they need in industry. They learn how to construct experiments and find solutions to problems. The only thing that cookbook labs or normal labs do is teach students how to follow directions.

The focus on teachers and their method of instruction did not surprise me. Teacher personalities vary immensely and some are primarily there to do research, while others are teaching because they enjoy it. Those are truly the effective teachers. They are the creative ones and the ones that will bend over backwards to help students learn information by incorporating jokes, puzzles, activities, stories, lyrics, and hands-on activities. The participants agreed that there are SOME teachers like this, but many only
lecture, which as the participants stated, "Often the instruction is dry..." and "Is not the best way to learn."

The level of group work amazed me; there really was not a lot of it. Most of the deaf/hearing interaction was in the lab and even that varied. Many times interpreters did not catch what the other students were saying in lab and one student commented that she could not keep up, or missed out on important information because the interpreter did not pick up on it and no one informed her. Teachers really need to get everyone’s attention when they make changes or comments and pay close attention that the deaf students received the information necessary to complete the lab or activity correctly. Participants however stated that some teachers were good about handing out papers with information or marking changes on the board to make the students aware.

Now what about the teacher assistants that instruct and supervise labs at times? Teachers are expected to be aware of the needs of their students and yet teacher assistants are not held to the same standards because they are students. It is important that if there is a deaf student in the classroom, anyone instructing or supervising is aware of the needs of deaf students and should have some awareness of deafness to best accommodate the student and make sure they are receiving all information possible. Training programs should be offered to anyone working with deaf and hard of hearing students.

In training programs, services should be covered as well as captioned materials. Knowing the science department at RIT recently went through the Class Act research grant, I was extremely surprised when participants stated that some videos are not captioned and that was due to the age of the video or the length. Either way, there are captioning services on campus that can caption videos that are not already captioned. The
teacher would need to consider their lesson and send the video in to get captioned. In situations where the video is not captioned, the interpreter is signing the video. As stated in the lit review, there is a lag time with interpreting and many interpreters are not certified or knowledgeable about science topics. One area of future research could be focused on whether or not interpreted videos are interpreted correctly, and whether or not the sign used are conceptually accurate. Is the student getting the correct information from the interpreter? These are some of my concerns relating to interpreted videotapes for students.

With this in mind we have to question whether or not teachers are knowledgeable of the needs of deaf and hard of hearing students. From the interview responses, two of the three participants seem to think so. The two participants had nothing negative to say regarding the teachers' knowledge of deaf students, the language needs or the classroom facilities. The third student who was previously in the Class Act study was not satisfied with the teacher's knowledge. The participant only received information from the interpreter, the acoustics in the auditorium were awful, and the language needs were only met through the interpreter. The participant was not satisfied with the education she received at RIT, but stated that she did learn a lot and has become the scientist she wanted to become. Teachers need to better prepare deaf students for class, check up on their learning, and make sure all of their needs are met.

As far as the learning strategies that the participants used, many asked the teacher questions, reviewed the text, the notes and diagrams, and one utilized the tutor. To my amazement, their learning styles didn't change with information that was easy or came natural, and information that was challenging for them. The participants simply studied
less. Students should be taught in high school or in orientation about the different learning styles and what benefits them. They should know what they need to succeed and what they can do to make success happen. Many people have an innate feeling about how they learn but many don’t know how to utilize it. This is another area that could be followed up on with a future research study.

Last, participants suggested that deaf and hard of hearing students should communicate in the way they feel comfortable and stated that interpreters are the key role to communication. Writing is beneficial as well as listening and speaking if they are comfortable doing so. It is always helpful if the hearing students know sign language or fingerspelling and know to speak crisply when someone is lip reading. A positive attitude and patience for all participants in a conversation is almost a requirement when there are communication barriers to be overcome.

Teaching programs and in-service programs need to educate students and teachers about resolving the issues presented in this pilot study. Future research can be done to determine if the current programs for educating the masses on deafness and deaf education are beneficial and successful, and if they are not what needs to be done to improve upon them.
Appendix A

Dear Participant,

My name is Denise Lengyel and I am a graduate student at the National Technical Institute for the Deaf (NTID) at the Rochester Institute for Technology (RIT). As a part of my program I am conducting a small research study in my area of interest. I obtained a Bachelors Degree in Biochemistry and have taught high school physical science, biology, chemistry, general science, and coordinated science for deaf students at the California school for the Deaf in Riverside, California. I have also co-taught a Forensic class for non-science majors, a freshman Chemistry class, Genetics and Human Evolution for non-science majors and a Gross Anatomy class at the undergraduate level at NTID.

I am interested in learning your perceptions of effective teaching and learning strategies in a biology classroom and how communication with peers has affected your learning process.

I appreciate your willingness to share your experiences with me in hopes that this may be of benefit to yourself and other students in the future.

Thank you for your time and I look forward to working with you.

Sincerely,

Denise Lengyel
MSSE Graduate Student
Researcher
Appendix B

Informed Consent Form for College Students

Teaching Strategies, Learning Strategies and Communication in the Mainstream Classroom: A Study of the Perceptions of Deaf and Hearing Students

February 2005 – April 2005

The purpose of this qualitative research study is to gather information regarding the mainstream education of deaf students in Biology by focusing on the teaching strategies the teachers use as well as certain factors that influence the students’ learning such as communication. After the research is complete, suggestions for biology teachers will be made based on an analysis of the student interviews.

Ideas will be gathered from college hearing students, hard of hearing students and deaf students (pre and post lingual) on what teaching strategies are most effective for them and how communication with peers in the classroom influences learning and what can be improved.

This interview will remain confidential. Each student will be assigned a letter code and that will be kept for my records only. I understand that some examples and quotes may be a good indicator of the speaker, and these will be stated in such a way that the speaker cannot be identified. I also understand that the researcher will not use any example or quote that would clearly identify me. If there is doubt, the researcher will ask my permission.

I have the right to look over the interview once complete to verify all of the information is correct and I may request that certain parts be changed/rephrased or removed from the interview. I also understand that it is my prerogative to withdraw from the interview at any time before, during or after the interview.

I hereby accept these conditions.

Name

Date of Birth

Date
Appendix C

Deaf Student Questionnaire

Student # __________

Gender: male    female

Age: ______

Identity:
Do you consider yourself deaf or hard of hearing? Deaf    Hard of Hearing
Do you function as deaf or hard of hearing? Deaf    Hard of Hearing
At what age did you become deaf/Hard of hearing? Age ______

Family:
Are any members of your immediate or extended family deaf or hard of hearing?
    Y    N
If yes, how many of your family members are deaf or hard of hearing? ______
What age did your family members become deaf? (Please list)
Age ______
Age ______
Age ______
Age ______
Age ______

Do you use sign language?    Y    N
If yes, what age did you start learning? Age ______
If yes, what form(s) of sign language do you use (check all that apply)?
SEE ______ ASL ______ PSE ______ Signed English ______ Other ______

What form(s) of communication do you prefer at home?
SEE ______ ASL ______ PSE ______ Signed English ______
Spoken English ______ Writing ______ Home Signs ______
Other ___________________
What form(s) of communication do you prefer at school?
SEE _____ ASL _____ PSE _____ Signed English _____
Spoken English _____ Writing _____ Home Signs _____
Other __________________________

What form(s) of communication do you prefer with friends?
SEE _____ ASL _____ PSE _____ Signed English _____
Spoken English _____ Writing _____ Home Signs _____
Other __________________________

Do any of your family members use sign language?  Y  N
If yes, how many of your family members sign language?  _______
What age did your family members start learning sign language?
How long after you were diagnosed as being deaf did your family begin learning sign language?
At home when you were growing up, were you raised using the oral method (speaking and lip reading) or the manual method (sign language)?
  Oral  manual

School:
Were you in a mainstream setting all your life?  Y  N
Did you have an interpreter or support services at school?  Y  N
If yes, what kind of interpreter; ASL, PSE, SEE, oral, Cued Speech, other?
ASL _____ PSE_____ SEE _____ Oral _____ Cued Speech _____
Other __________________________

Did you use the interpreter and/or services?
Interpreter  Y  N
Services  Y  N
### Biology Curriculum

For each of the following areas please rate them using the scale below:

1 – This area was extremely easy for me  
2 – This area was easy for me  
3 – This area was not hard or easy for me.  
4 – This area was challenging but not hard for me  
5 – This area was extremely hard for me  
N – Does not apply

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<td>Feedback Mechanisms</td>
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Appendix D

Deaf Interview Protocol

School:
Did you benefit from the interpreter and/or the services?

Have you ever worked one-on-one or in a group with hearing students while in the classroom?

How do you interact with them?

What were you doing while you were working with the hearing student(s); lab, project, class work?

Was the communication successful?

What communication strategies did you use; pointing, gestures, taking face to face, writing?

If yes, how often do you work with hearing students?

What are some of your positive and negative experiences working with hearing students?

What learning strategies with the hearing students did you use; role playing, compared information to something they already knew or were interested in?

Does working with hearing students help or hinder your learning process? Why?

Please list some suggestions that may be beneficial for hearing/deaf students in order to increase communication and mutual learning in the classroom.

Science:
Did you enjoy Biology? Why or why not?

How did the teacher instruct the class; lecture, demonstrations, discussion, labs, activities? (List strategies)

Questions Related to the Biology Curriculum Survey
Hard:
Of the areas that were hard for you, please name common reasons why they were difficult for you.

How did the teacher instruct these units/subjects?
What were your learning strategies for each of these areas (please name successes and failures)?

**Easy:**
Of the areas that were easy for you, please name common reasons why they were easy for you.

How did the teacher instruct these units/subjects?

What were your learning strategies for each of these areas (please name successes and failures)?

**In General:**
Did you retain the knowledge of biology or was it rote memorization?

In your opinion is science important and why?

**Factors that influence learning:**
Factors that influence learning:
Teasing/bullying   printed notes
Tutoring          communication
Caring teacher    demonstrations
Difficult lessons student centered activities
Lectures only     organization

Of these factors that influence learning, which have influenced you?

How have they influenced you; positively or negatively?

What grade did you get in Biology? _____
Appendix E

Results to the questionnaire:

Number of participants: 3

Gender: 1 male, 2 females

Age: 20, 21, 22

Identity:
Do you consider yourself deaf of hard of hearing? 2 Deaf 1 Hard of Hearing

Do you function as deaf or hard of hearing? 2 Deaf 1 Hard of Hearing

At what age did you become deaf/Hard of hearing? Age: birth – all three

Are any members of your immediate or extended family deaf or hard of hearing?
Y - Two students
N - One student

If yes, how many of your family members are deaf or hard of hearing?
1 - Sibling
2 - Siblings
0

What age did your family members become deaf? (Please list)
Birth – all three students

Do you use sign language? All students use sign language

If yes, what age did you start learning? Age birth, 1, 18

If yes, what form(s) of sign language do you use?
One student prefers ASL and PSE
Two students prefer PSE

What form(s) of communication do you prefer at home?
One student preferred spoken English
One student preferred PSE
One student preferred SEE and Spoken English

What form(s) of communication do you prefer at school?
One student preferred ASL
Two students preferred PSE
What form(s) of communication do you prefer with friends?
One student preferred PSE
One student preferred ASL
One student preferred ASL, PSE, and spoken English

Do any of your family members use sign language? Y – All three students

If yes, how many of your family members sign language? 2, 1, 1

What age did your family members start learning sign language?
When I was born
Two years before I was born – learned when my deaf sister was born
Age 20 – brother at CSUN

How long after you were diagnosed as being deaf did your family begin learning sign language?
Right away
Two years before I was born
N/A

At home when you were growing up, were you raised using the oral method (speaking and lip reading) or the manual method (sign language)?
Two students were oral
One student was manual

School:
Were you in a mainstream setting all you life?
N- All three were taught sometime in a residential school. They have all been in mainstream college

Did you have an interpreter or support services at school?
Y – All students have an interpreter and use a note taker

If yes, what kind of interpreter; ASL, PSE, SEE, oral, Cued Speech, other?
Two students use oral interpreters
One student uses a PSE interpreter

Did you use the interpreter and/or services?
Interpreter Y – all three students
Services Y – all three students

Did you sign at home?
Yes – one student
No – one student
Fingerspelled – one student
Did you sign when you were in high school?
Yes – one student
No – two students

Is your family supportive of your schooling and of you?
Yes – all three students

Results to the Biology Curriculum Section

Table 1:

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<tr>
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Table 1: Participants are labeled as A, B, and C. Each participant’s response is listed under the corresponding letter for each of the categories. Participants rated the difficulty of each topic on a scale from 1-5; 1 meaning extremely easy for the participant, and 5 meaning extremely difficult for the participant. If a participant has not studied a particular category, the participant placed an ‘N’ in the space provided instead of a level of difficulty. When a * is present, this means that it is an area that I would personally consider difficult because of all of the information involved in these topics.
Appendix F

A. Lecture vs. Hands-on Experience

How did the teacher instruct the class?

The three students all stated that the teachers lectured most of the time using power point presentations with laser pointers. Some teachers lectured and wrote on the board. One student provided me with a percentage of time spent doing demonstrations and lecturing and a reason for the percentages. The student stated, “The classes are about 80% lecture 20% demonstration because the first and second and third year classes are so big. But if you are in the higher level classes, it is more interactive.”

For lab instruction, the students agreed that there was a pre-lecture to the lab and they sometimes had demonstrations about techniques they were to use in the lab. One student provided me with an example; “In hybridoma techniques class, we did the lab using mice. Our teacher showed us how to cut the mouse and what to look for, the spleen, and how to remove it, also how to kill the mouse. I didn’t kill the mouse. I had the teacher kill it for me. Poor mouse.” Teachers also utilized the board for instructions or necessary information; however most of the information they needed was in the lab manual.

Did the teacher ask questions during lab preparation?

All of the students stated that the teachers asked questions during the lab preparation. One student added that the teachers explained things sometimes during the lab period. Another student added that sometimes the Teacher Assistants taught the lab and they
don’t explain things clearly. The student stated, “If the Teacher Assistants now what we are doing and they think we are doing everything ok, then that’s it. I don’t think I have had one good Teacher Assistant. They generally skip information because they don’t care. They are there getting their degree and nothing else.”

Did the teacher utilize the white board?

The teachers did utilize the white board. Sometimes they listed words the students needed to know, but a couple of students stated that some teachers do not use the board much and they don’t prepare deaf students well enough.

Did the teacher incorporate writing to learn activities or guided writing in the classroom?

All of the students gave a resounding “No” to this question. The students really didn’t know what writing to learn activities were or what guided writing was. After I explained what each of these methods was, the students were sure they have never had this in any of their classes.

Did you do presentations?

All of the students did do presentations in their class or classes. One of the students did not express if they utilized the interpreter to give the presentation where the other students all said they used the interpreter to present to the class.
Were you exposed to inquiry based learning?

All of the students were exposed to inquiry based learning. They were exposed through lab and or research they have done for school.

Did you have open labs where they needed to structure the lab... not a cookbook lab?

I was a bit shocked when I saw the results to this question. First let me explain what the two types of labs are. An “open lab” is a lab that the students are to develop and execute it in the laboratory. Where a “cookbook lab” is when the student follows the lab manual in executing the lab, and then normal data analysis and conclusions are made according to the data obtained. The students provided mixed results. One student stated that a lot of the time they follow the lab manual but once or twice the students had to develop a lab themselves. The other students have never developed a lab in their classes at RIT. One of which did do research and open labs were a requirement of that research project. The last student stated extra reading was required for the labs but that the labs were not hard.

All students did keep a lab journal required by the classes that required the students to explain what they did in the labs and why they did it.

Was the teacher creative?

This question interested me immensely. I was hoping to receive some results focusing on motivation and different learning styles and to my amazement I obtained some. All of the students commented that were was the “standard” teacher who lectured all the time and who was “extremely dry, not creative and straight to the point.” However,
all of the students had some positive things to say about some teachers. "Some teachers have us do a power point presentation, pictures, and models. One teacher had us get together and we had pizza and looked at models and posters. Other people came too and the teacher invited a professor from a different college who was an expert in the area we were studying. The guest speaker presented and we watched." Another student stated "Some teachers find a game to help us remember the vocabulary and what we have learned. I have noticed that some teachers use jokes to help us remember the material; other teachers use real life examples." Another student added that "Some teachers challenge us and find good ways to challenge us. I know one teacher created a different ways to lecture and focused more on group work that forced us to interact more to see if we learned better."

How did the teacher instruct the units in class?

Students again stated that the most common way that teachers instructed the units was through lecture, no matter if the information was easy or difficult. Some stated that pictures were used during lecture, but most of the pictures/visuals are in the book. Therefore not all teachers used visuals in lecture. For some of the complex information, one student noted that tables were used to explain similarities and differences between two things. One student commented that "Often the instruction is dry and I don't really memorize it; it goes over my head and is not absorbed. Often because the information is new to me I don't get it."
B. Communication

Did you benefit from the interpreter and/or services?

All of the students stated that they benefited from the interpreter and the services that were provided. One student stated “Sometimes when I am watching the interpreter and something is said that I don’t understand, the notes help clarify that. Sometimes the interpreter is clearer than the notes but it depends on the topic.” One student commented that communication was not effective using an FM system and so the student needed to learn how to use an interpreter.

Have you ever worked one-one or in a group with hearing students while in the classroom?

The responses to this answer varied as well. One student stated they really don’t have group work in the classes and that during lab work, their lab partner(s) are deaf or hard of hearing as well. Other students stated they work one-on-one and in groups with hearing people.

How do you interact with them?

Two of the students stated they interact with the students through an interpreter but also write, or lip read. One student said that some of the classmates know how to fingerspell and that helps a lot. The last student stated that she talks to her classmates when working with them.
Was the communication successful?

One of the students was completely satisfied with the communication as group work or one-on-one work took place. The other two students stated that communication was successful most of the time.

What communication strategies did you use?

The common responses to this question were face to face communication, lip reading, writing, pointing and gestures, finger spelling and through the interpreter. One student said either talking and signing, or talking and listening.

What are some of your positive and negative experiences working with hearing students?

As for the positives, one student could not think of any positive experiences other than when a hearing person is easy to lip read. Another student stated that hearing people always know what is going on and that is why she prefers working with hearing students in groups or labs. The last student stated, “Some hearing people love to make sure they understand me. They other positive is that they make sure the communication is smooth. I love it when hearing people try to learn sign language. I think the point of college is, people are more mature. So there are more efforts to understand each other to succeed.”

The negative experiences were common among all the students. “Some hearing people don’t make an effort. They just don’t care. They want to do their own thing.” I can’t keep up with the hearing students and I am curious what the rest of the students
are talking about.” “The interpreter cannot interpret all of the conversations that are
going on in the lab or classroom with the hearing students.”

Did the teacher use captioned materials?
The student responses were split on this one as well. One student stated “We don’t
have a problem with that anymore. The videos are interpreted once in a while but it is
rare.” Another student however stated that most movies don’t last that long; only
about 5 minutes. The interpreter signs the movies. The last students stated that it
depended on how old the movie was and that sometimes the movie is captioned and
other times it isn’t. Again the interpreter is left to sign either verbatim or summarize
the information on the video for the deaf students in class. One students was correct
when she stated, “Not all interpreters have science degrees, but it is important for
them to understand the video.”

Did you have trouble with following directions? Were handouts with directions
handed out? Did the teacher write the directions on the board? How did the teacher
make sure you got the directions?

As I looked at the results to this question, some of the students were informed by the
teacher through the interpreter, but most of the time the teacher handed information
out on a handout or wrote it on the board. One student stated that it was hard to figure
out what was being said because the teacher was beating around the bush. Another
student stated that the teachers were good about keeping her informed about what was
happening and what was due. They often reminded her.
How often do you feel you are guessing? If you are guessing, who do you ask?

Again the answers varied with this question. One student stated that he really did not feel like he was ever guessing in class. The other two students felt that it happened more often than they liked but they would ask their teacher or lab partner in one case. Sometimes as one student put it, “it was just a matter of having to go back and look and check the information again and that is clarified through reading.”

C. Deaf students vs. Hearing students

Does working with hearing students help or hinder your learning process? Why?

Two students felt that it is beneficial to work with hearing students because they can answer questions that deaf students might have. “Hearing students know what is going on because they can hear it.” The other student felt as though he was the one that understood the concept more because he is always prepared for class and science is easy for him. He tends to make sure the hearing students are understanding and have no problems.

Many of the comments made by the deaf students led me to believe they prefer working with deaf students. Although, one deaf student felt as though deaf students tend not to know what is going on in the classroom and hearing students do. One student preferred to work with hearing students because they can hear what is going on and they generally know what they are doing. The same student added that “Sometimes I feel like deaf students work harder to prepare for class because we need to download the notes and study them so we can understand the interpreter better.”
D. Teacher’s knowledge of deaf students

Did you have trouble with following directions? Were handouts with directions handed out? Did the teacher write the directions on the board? How did the teacher make sure you got the directions?

One student stated that teachers tended to remind her of things in the class while the other two students only received information from the teacher through the interpreter.

Were the classroom facilities adequate for the students?

Two students felt as though the facilities were ok overall. One student stated the auditorium acoustics were awful and that the facilities were not adequate but they are improving.

Were the language needs met?

One student stated that in the first year of school, they had classes in a big auditorium and attempted to use an FM system. The student still could not hear the information or the other student’s questions and so the student learned how to use an interpreter.

For each student, the language needs were met with the interpreter.

Are you satisfied with your education?

Two of the students stated they were satisfied with their education and the other student was not. The student stated, “There are problems with the educational system in general; like memorizing. Many classes are based on memorizing and not
learning.” Although not satisfied, the student stated she did learn a lot and has become the scientist she wanted to be.

Were your teachers familiar with the needs of deaf students? Who would you tell to talk to if you needed things that were not provided?

One student briefly stated that the teachers were knowledgeable about the needs of deaf students because they use power point which benefits deaf and hearing students. One student stated that RIT is not a typical college. “They are really involved with deaf people; most teachers I know they are really cool. They know a little sign language; I like that they are trying to make an effort.”

One student stated, “During my senior lab, the teacher was an expert and prepared the deaf students before lab; pre-lab and post-lab. I didn’t really struggle because of this one teacher. The others teachers are not the same.” This student also felt that the teachers were not knowledgeable of the needs of deaf students, even with the Class Act Grant. “Many people think they know what deaf people need. They think other people know and are doing it for them. What has to happen is they have to realize they don’t know what deaf people need. They need to experience it to know. Teachers need to be reminded of our needs, and once they realize it, some learn.”

E. Learning strategies

Did you enjoy Biology? Why or why not?

All of the students agreed that they enjoyed biology although the different areas of biology appealed to some and not to others. One student enjoyed all material that was
related to humans and animals that were like humans, one student enjoyed nature and how the universe worked and all of the intricate details and processes that lie within things. The last student enjoyed biochemistry the most and really enjoyed anything that was interesting and challenging.

Did you learn proper science terminology? If so how did you learn it?

There was a general consensus with the students that the best way to learn the terminology was by reading the book. Sometimes the students memorize it but they try to learn it in the process. You need to know the terminology for higher level classes because what you learn in each class is foundation information for other classes.

Of the areas that were hard for you, please name common reasons why they were difficult for you.

For the areas that were difficult for the participants, please see Appendix E or table 1. All of the students stated that when information was new and complicated, it was difficult for them. Some areas such as biochemistry have so many intertwined parts and so many products and back products and intermediate steps that it is hard to keep track of everything. Other times there is a lot of vocabulary to learn and as one student stated, “I have less vocabulary than normal but that is normal I think for deaf people.”

What were your learning strategies for the different areas?
Students read the book, reviewed all the class material and sometimes worked with other students to prepare for class. Some students asked the professor for clarification and saw a tutor for assistance. Some students drew pictures or tried to make compare and contrast tables to help retain the difficult information.

Of the areas that were easy for you, please name common reasons why they were easy for you.

For the areas that were easy for the participants, please see Appendix E or table 1. The easy information was either, straight forward, basic knowledge, facts or review from other classes or high school. Hands-on material is also easier for the students to learn.

What were your learning strategies for the easy areas?

For the easy material the students stated that they tended to study less than for the harder material but some still read over notes and the text book.

Did you retain the knowledge of biology or was it rote memorization?

Students stated that it was easier to remember the information if it was repetitive, common sense, basic, if they could visualize it and most importantly if they were interested it. Students had a tendency to memorize the information at first and as they used the information they learned it and remembered it.
Do you prefer environments where the emphasis is on the work or on the individual?

Two students preferred environments where the emphasis was on the individual where one student preferred environments where the emphasis was on the work.

Of these factors that influence learning, which have influenced you and how?

Students were positively influenced when teachers were caring, when there was adequate communication, effective teaching and demonstrations. It also helps when the teacher is organized according to a couple of students. Tutoring is utilized as well. The students stated that lecture was not the most effective way to teach a lesson. You can learn from the lecture but it is not quality instruction.

F. Suggestions

Please name some suggestions that may be beneficial for hearing and deaf students in order to increase the level of communication and level of learning in the classroom.

One student suggested that deaf and hard of hearing students should do what they feel comfortable with and with whom they are compatible with. The student also suggested using pictures and writing to improve communication. Another student stated that the interpreter plays a group role in aiding communication. If there is not an interpreter around, the student suggested writing back and forth. The last student suggested an interpreter as well but also stated writing was helpful since communication is not always clear and correct through an interpreter. Depending on the degree of hearing loss, the student suggested voicing and lip reading. Above all this student suggested that people are patient, persistent, and trustworthy. You need to
G. Importance of Science

In your opinion, is science important and why?

All the students agree that science is important and their reasons are similar. The students’ comments are as follows: “Science is important and it applies to many areas in life. Because we are living organisms, whatever happens in the environment affects us. Sometimes, the more science can help us understand, the more problems it creates for us.” “Without science we would still be living in the caves. Really, notice how humans try to rationalize things. For example, you know the Greeks and Romans and how they tried to explain everything in nature and related it to the work of the gods. That is their science and progress. “That doesn’t sound right…. or, Why would this or that happen?” It is human curiosity and progress. We progress because of science and technology from science. Where we are now is because of scientific advancement.” “Science is really everywhere. For example, if you can’t do science you can do nothing; if you get nothing from science, what you learn is how to think and how to question things. You can apply it anywhere in the real world. It is important in different ways. In general it is important.
References


Unknown. n.d. Class Act: Promoting Access for Deaf and Hard of Hearing Students. 5/2/05. [www.rit.edu/~classact](http://www.rit.edu/~classact)
