IS IT PROBLEMATIC FOR DEAF/HARD-OF-HEARING STUDENTS IN LEARNING WITH MULTIPLE CLASSROOM TECHNOLOGIES?

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ABSTRACT

The use of modern educational technology in the classroom has forever changed the traditional teaching and learning environment. Digital learning tools, such as computers, overhead projectors, SMART boards, and handheld devices, have positively impacted the teaching and learning process by increasing motivation and self-esteem, improving technical skills, and fostering communication and collaboration among both teachers and students. In short, technology provides endless possibilities to improve teaching and learning.

The adaptation of new technology and processes always comes with inherent challenges. The amount of tools and media that are currently available to aid in the teaching and learning process are vast and will continue to grow at a steady, if not, rapid pace. Teachers are utilizing these tools daily, often combining multiple methods simultaneously in an effort to be as thorough as possible and reach a wider range of learning styles. It means that the students are no longer focused exclusively on the teacher because visual attention is divided between all of the different sources of information. This is problematic for deaf students who use vision as the primary mechanism for engagement.

The purpose here is to focus on how to increase students' effective learning in the classroom. Different educational technologies are examined as to how they are applied in the classroom and whether they meet deaf students' needs and learning style. Comparative studies with acquisition tracking are used to compare different classroom technologies for student effective learning. The results are summarized and recommendations will be made with suggestions for further research.

INTRODUCTION

In the early days of classroom technology, the blackboard was considered an important educational technology. The use of blackboards first started in North American classrooms in 1801 (Swinnerton 2005). By the mid-1800s, a blackboard was to be found in almost every school and had become the single most important educational instructional tool used by the teachers. Keith Greenhalf (2013) stated that there has always been one tool no classroom has gone without — a simple blackboard. As it described in Wikipedia (2015), it has evolved to a whiteboard in the 1960's and to a smart board in the 1990's. When the visualizer (overhead projector) was unveiled it allowed the instructor to write information on a transparency projected on to the screen. Deaf or hard-of-hearing students benefit from overhead projectors used to display visual aids to the lesson or discussion (Smith-Jennings 2015). In the 1980's the personal computer became very popular as an educational tool. As technology advanced, the footprint of the computer became smaller to the size of laptops and tablets. This allowed the overhead projector to be integrated with computers. Now with the advent and heavy use of smartphones, there is a potential opportunity to use them in the classroom. There are other handheld devices such as clipboard that are currently available for answering questions on the whiteboard/smart board in the classroom.

IMPACT OF THE TEACHING AND LEARNING PROCESS

The goal of trying out new educational technologies was to improve learning, and increase motivation and self-esteem in the students. Using computer devices are supposed to improve technical skills in the students. Another reason is to foster communication between the instructor and students that allows for collaboration among teachers and students. Because of visual learners, the instructor uses overhead projection with presentation to maximize the student's effective learning. The new trend is to shift to virtual or online learning, remote tutoring and flipped classroom but this is not the scope of this paper. There are endless possibilities to improve teaching and learning. Multiple learning tools used in the classroom means that students are no longer focused exclusively on the teacher. Visual attention is divided between different sources of information. Hearing

students are still able to remain engaged with the teacher while looking at multiple sources of information through spoken communication. This is problematic for deaf students who use vision as the primary mechanism for engagement and learning.

Background

In addition, since the 1900's standardized testing has consistently demonstrated a median 4th grade reading level for DHH readers. These median-reading results have remained consistent for DHH readers even after national norming of the Stanford Achievement test on the population of deaf school children (Antia, Jones, Luckner, Kreimeyer, and Reed 2011).

Also, the most recent meta-analysis of literacy research conducted on DHH readers over a forty-year period (1963-2003) provided findings indicating few effective-based practices have been developed for classroom purposes (Luckner, Sebald, Cooney, Muir and Goodwin 2005; Luckner and Handley 2008). Consequently traditional approaches of teaching university-level engineering courses often present challenges to students who rely primarily on visual learning such as DHH students.

Currently there are over 31,000 DHH students enrolled in college and this enrollment number is up 15,000 over the past 10 years (Aud, Hussar, Kena, Bianco, Frohlich, Kemp, and Tahan 2011). While careers demand highly qualified engineers with various skills, including visual skills, most engineering classrooms are not designed to utilize students' visual skills and are not fully accessible by DHH students. When classrooms maximize the benefits of visual learning, the common barriers of traditional pedagogy, such as using spoken English as a primary mode of communication with English as Second Language (ESL) students, are partially ameliorated (Marschark, Sapere, Convertino and Pelz 2008)

Challenges for Deaf and Hard-of-hearing Students – Cognitive Overload

Because of the cognitive and sequential processing needs of DHH students who primarily rely on visual input for learning, the classroom requires a structured visual learning environment. In contrast to hearing students who may be able to look at a graph or chart and simultaneously process what the professor is verbally clarifying with respect to the visuals, DHH students do not have the luxury of simultaneous parallel processing. In fact, even the hearing students do not necessarily do well with multi-media presentations due to cognitive overload (Mayer and Moreno 2003).

Challenges for Deaf and Hard-of-hearing Students – Divided Attention

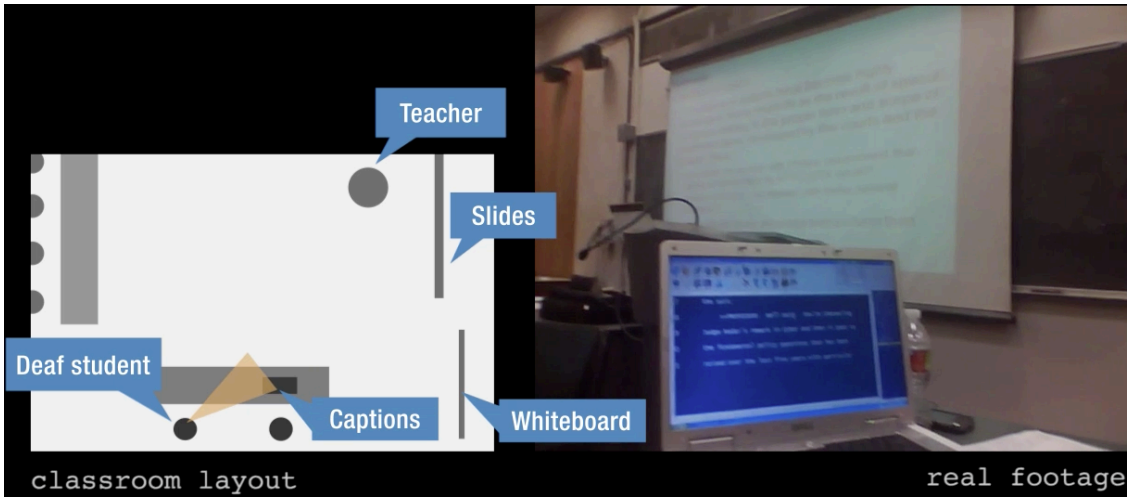
Even when accommodations are provided for DHH students, such as sign language interpreters, note takers, and real-time texting (RT), it is vital for the instructor to understand the needs and the benefits of using visual learning strategies to help DHH students learn.

For example, during a traditional lecture, DHH students have to pay attention to the sign language interpreter or RT to understand what the instructor is speaking, but they also need to divert their vision to the notes on the whiteboard and the presentation slides—forcing them to miss what the instructor is saying. Also, they may need to take notes on the content written from the whiteboard and the students will miss the spoken information.

This results in what Mayer, Heiser and Lonn (2001) have identified as cognitive constraints on multimedia learning. Furthermore, such multiple presentations of information force students into a multitasking mode that may hinder their ability to focus (Richtel 2010). What is even more challenging is the fact that speech, text, and visual information place different demands on short-term and working memory as student processes information within a classroom environment (Baddeley 2003).

Kushalnagar, Lasecki and Bigham (2014) examined whether the challenges of integrating information is even more significant in engineering, which generates heavy use of detailed visuals and explanations via sequential steps. Hearing students are able to look at the visuals and simultaneously listen to the spoken explanation effortlessly. By contrast, DHH students have to constantly look away from the sign language interpreter or RT to search and observe details in the lecture visual as shown in Figure 1. They risk losing information which can slow down or even derail learning. As a result, they spend far less time watching lecture visuals and comprehend less information than their hearing peers (Kushalnagar, Kushalnagar and Manganelli 2012).

Figure 1. *Dispersed Visuals*



Access Services:

The function of access services is to facilitate communication access between the deaf, deaf-blind, hard-of hearing and hearing individuals who work, learn and interact in the classrooms, and laboratories. For DHH students, accessibility is required. The two most prevalent access services are sign language interpreter and real-time texting (RT).

The instructor may not know if there is a DHH student taking the course. It is always good to ask the students in the classroom if they need any specific accommodation. These are additional variables that DHH students need to focus on beside the content information being presented via technology and the instructor.

Below are brief descriptions of what sign a language interpreter and real-time texting do in the classroom.

Sign Language Interpreter

The role of the sign language interpreter is to translate from the instructor's spoken words into visual language. The visual language is usually America Sign Language or other form of signed modes.

Real-Time Texting

C-Print is one type of real-time texting. The basis of C-Print is printed text of spoken English displayed on a laptop or a mobile device in real time, which is a proven and appropriate means of acquiring information for some individuals who are DHH. A trained operator, called a C-Print captionist, produces a text display of the spoken information in classroom or other settings. At the same time, one or more students read the display to access the information. Elliot, Stinson, Easton and Bourgeois (2008) examined that the system has significantly improved access to lectures for DHH individuals in many programs around the country. It also benefits individuals with other disabilities, such as those with a visual impairment or a learning disability.

OBSERVATION OF A TYPICAL CLASSROOM

Based on our teaching experience at a university a large number of DHH students, different sources of information in the classroom are usually not in close proximity to each other: between an instructor and DHH students, an interpreter, a PowerPoint presentation, and a whiteboard. The Instructor should remain the primary focal point. DHH students have to constantly scan the classroom in order to take in all of the resources that are available to aid in their learning. DHH students often become distracted, and may or may not be looking at the right source of information at the right time. Constant scanning results in eye fatigue and disengagement. Degree of eye fatigue depends on the length of discussion and the type and quality of information. An increase in eye fatigue results in a decrease in focus and learning comprehension.

The goal of this project was to develop a high-level model of measuring the effective learning of DHH students. Engagement is the main focus and it is one of the critical

parameters of effective learning. Classroom animations were developed to demonstrate the lack of engagement and information that DHH students are normally dealt in the classroom. In Figure 2 is a scenario of a DHH student in the classroom looking at the sign language interpreter while the instructor is talking over the whiteboard and the presentation. As indicated in the scenario, there are four different parameters that were observed. Color coded red is when the sign language interpreter is signing what the instructor is talking. The gap of the red bar is when the instructor is not talking. The blue color is the student's focus to the source of information (looking at the interpreter, whiteboard or presentation). The light blue is when the student is watching the interpreter. The dark blue is when the student is looking at the presentation or/and whiteboard. The yellow color represents engagement of student's learning. Engagement usually occurs when the DHH student is focusing on the context of information through the interpreter. When the student is not looking at the interpreter, engagement is broken because the student is looking at the presentation or whiteboard without know what the instructor being said. Green color is the effective learning. Dark green represents full engagement whereas light green indicates that the student is not fully engaged when the student is distracted from the presentation or whiteboard. As you can see, the overall effective learning is not fully optimized as result of engagement fragment. The purpose of classroom animation, is to observe the effectiveness of DHH student's learning.

Figure 2. *A Deaf/Hard of Hearing student in the classroom*

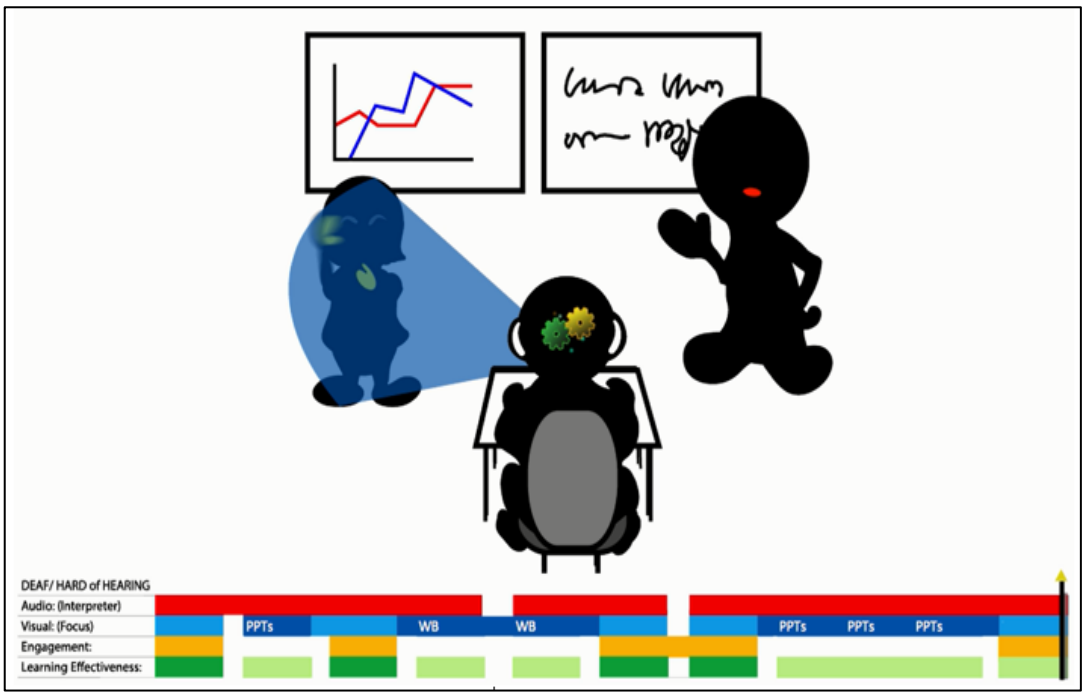


Figure 3 is the same diagram as Figure 2 except that the student is looking at the whiteboard instead of focusing on the interpreter. Note the black line bar scroll through the four parameters from left to right as an indicator of where the student's learning take place.

In Figure 4, it is same diagram as Figure 3 and 2 except that the student is hearing. Note that the hearing student's engagement time is much longer with less disruption. Because of longer engagement time, the hearing student's effective learning is higher as shown in the diagram.

Figure 3. *A Deaf/Hard of Hearing student in the classroom*

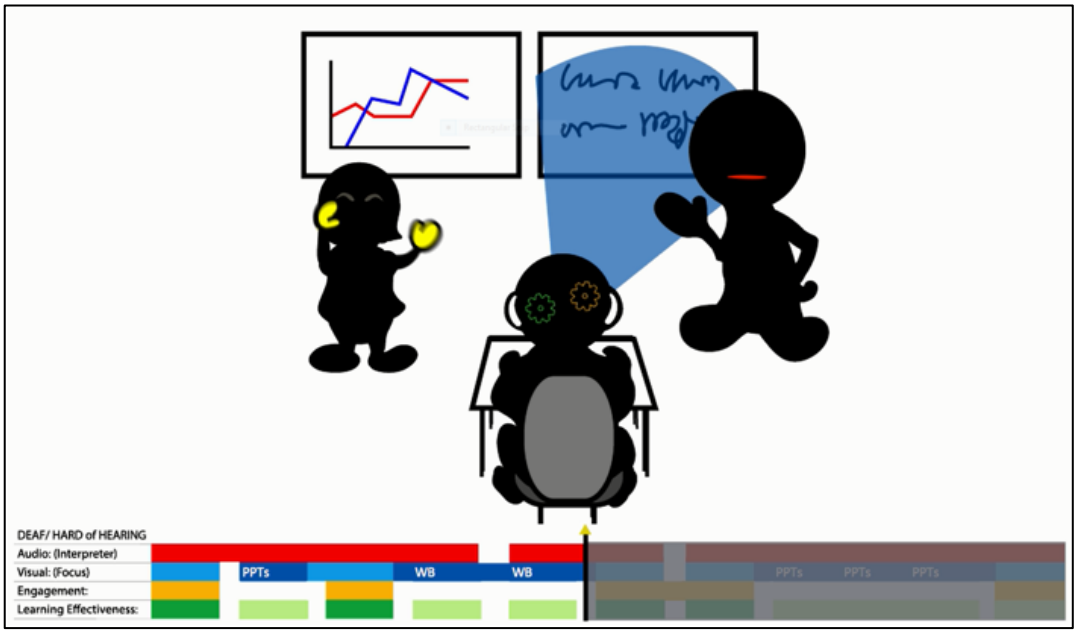
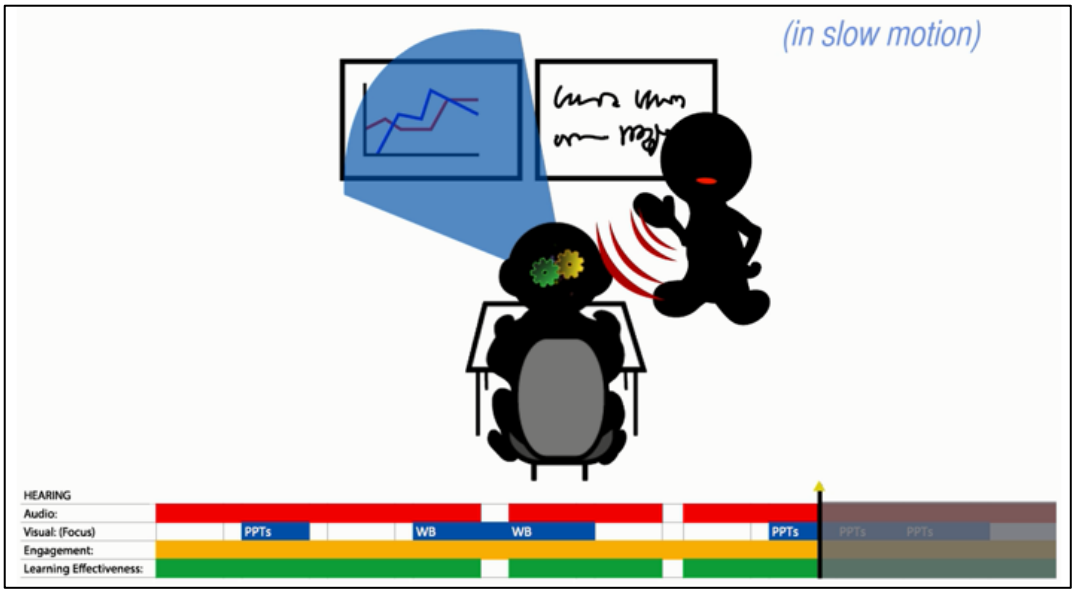


Figure 4. *A Hearing student in the classroom*



For comparative analysis, the attempt was to compare the effective learning engagement between DHH and the hearing students in a typical classroom. It was based on the eye tracking of where the student's focus on the instructor. For DHH students, it was through the sign language interpreter. The assumption was that engagement occurred when DHH students' focus on the sign language interpreter,. To validate the assumption, a plan of measuring cognitive and sequential processing is required.

RECOMMENDATION

As a result, the new and typical technologies such as PowerPoint presentation and smart board/whiteboard in the classroom with an instructor, an interpreter or real-time texting, often disrupt DHH students' engagement and thus learning. It is due to dividing their visual attention (too many focus points and steps) between the information sources which are often spatially distributed around the classroom.

The recommendation is to pursue further study of improving this model of measuring the learning effectiveness of DHH students. The model is a proof of concept and the plan is to validate the model through further research.

A temporary solution for accommodation is to have the instructor adjust so as to utilize more visual strategies of teaching in a sequential logical manner that allows DHH students to focus and process relevant content without missing out on parallel messages that are being presented verbally. Below are effective *Communication Tips for Deaf and Hard-of-Hearing Students*:

- With a basic understanding of what visual communication is involved, the instructor can design a class lecture that minimizes the focus points, such as the following:
- Create a classroom environment where students are fully engaged to the instructor by having close proximity between the instructor, support service and different sources of information. Minimize the interactive distance between students, instructor and support service. Minimize the number of tools and media that are currently available to aid in the teaching.
- Create time to allow students to absorb presented visual aid/information

REFERENCES

Antia, S. D., Jones, P., Luckner, J., Kreimeyer, K. H., and Reed, S., (2011). Soecial outcomes of students who are deaf and hard of hearing in general education classrooms, *Except. Child.*, *77*(4), pp. 489–504.

Aud, S. D., Hussar, W., Kena, G., Bianco K., Frohlich L., Kemp, J., and Tahan, K. (2011). The condition of education 2011. NCES 2011–2033. *National Center for Education Statistics*. ERIC.

Baddeley, A., (2003). Working memory: looking back and looking forward. *Nat. Rev. Neurosci.*, *4*, 829–839.

Elliot, L. B., Stinson, M. S., Easton, D., and Bourgeois, J., (2008). College students learning with C-print's education software and automatic speech recognition. *American Educational Research Association Annual Meeting*.

Greenhalf, K. (2013). The rise of the classroom blackboard, blogs.ubc.ca. Retrieved from http://blogs.ubc.ca/etec540sept13/2013/10/27/the-rise-of-the-classroom-blackboard/

Kushalnagar, R. S., Lasecki, W. S., and Bigham, J. P. (2014). Accessibility evaluation of classroom captions. *ACM Trans. Access. Comput.*, *5*(3), pp. 1–24.

Kushalnagar, R. S., Kushalnagar, P., and Manganelli, G. (2012). Collaborative gaze cues for deaf students. *Dual Eye Tracking Workshop at the Computer Supported Cooperative Work and Social Computing Conference*.

Luckner, J. L., and M. C. Handley, M. C., (2008). A summary of the reading comprehension research undertaken with students who are deaf or hard of hearing. *American Annals of the Deaf*, *153*(1), 6–36.

Luckner, J. L., Sebald, A. M. Cooney, J., Muir, J. and Goodwin, S., (2005). An examination of the evidence-based literacy research in deaf education. *American Annals of the Deaf*, 150(5), 443–456.

Marschark, M., Sapere, P., Convertino, C., and Pelz, J. (2008) Learning via direct and mediated instruction by deaf students. *Journal of Deaf Studies and Deaf Education*, *13*(4), 546–561.

Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When Presenting more material results in less understanding. *Journal of Educational Psychology*, *93* (1). 187–198.

Mayer, R. E., & Moreno, R. (2003) Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 43–52.

Smith-Jennings, V. (2015). The Use of the projector in Education. eHow. Retrieved from http://www.ehow.com/facts_7200654_use-overhead-projectors-education.html

Swinnerton, J. (2005). The history of Britain companion (p. 128). London: Robson. Retrieved from http://blogs.ubc.ca/etec540sept13/2013/10/27/the-rise-of-the-classroom-blackboard/