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Science for Visually Impaired Students and Accessible Technology

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Abstract

Blind and visually impaired students need appropriate methods and accessible technology in order to compete and advance in learning the science concepts. The study investigated the attitudes, perceptions, and knowledge of assistive technology used by science teachers of the visually impaired from a Mid-Atlantic state and how they are incorporated in the classroom. The participant response gives notice to what forms of assistive technology are used in frequency, and the training and comfort level to use the assistive technology. The open responses stated themes of teachers needing more training in visual impairment college programs to use assistive technology to increase proficiency and use in the classroom with blind students.

Keywords: accessible technology, assistive technology, biology, blind, chemistry, physical science, physics, science, visual impairment

TABLE OF CONTENTS

Chapter 1: Introduction

Science for the visually impaired is a challenging subject for which to prepare and instruct, as well as to take as a student unless the right accommodations, modifications and assistive technology are used. With the right methods and assistive technology, the science student who is visually impaired, can learn and do the same assignments as other science students (Beck-Winchatz & Riccobono, 2008; Rice, 2011; Winograd, 2007). Teacher preparation programs are generally taught through distant learning and are not meeting the educational demand of the growing blind and visually impaired population (Ambrose-Zaken & Bozeman, 2010). Teachers shy away from science education for the blind and visually impaired (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; Smith & Kelley, 2007). Those instructors who do not shy away prepare, create, or implement their training in methods and assistive technology for the visually impaired in order to effectively instruct their students. The purpose of this research is to investigate the challenges, attitudes and perceptions of science education for the blind or visually impaired, as well as how difficult it is to accommodate those students, and what are teachers currently doing about it.

Statement of the Problem

Many students, teachers, and parents feel science is a subject better left alone by blind and visually impaired students (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; Smith & Kelley, 2007). Because the population of blind students is small but growing, compared to other special needs, the field of low vision does not attract many to teacher preparation programs (Ambrose-Zaken, 2010; Wild & Allen, 2009).

Instructing students using assistive technology, accommodations, modifications and specialized training is often very expensive (McCollum, 1999). Teacher preparation programs for blind and visually impaired instruction are not plentiful and inconsistent in terms of proficiency levels acquired in assistive technology and methods upon completion (Ambrose-Zaken & Bozeman, 2010; Wild & Allen, 2009).

Many science teachers don't know how to instruct the visually impaired and have not been trained. There is little communication of successful teaching methods used among science teachers of the visually impaired (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; Smith & Kelley, 2007).

Purpose of the Study

The purpose of the study was to investigate attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students and what they are currently doing about it. A frequent attitude found among educators, who were not trained in methods or to use assistive technology to teach the visually impaired, is science is too difficult or inappropriate for blind or visually impaired students to take because it is such a visual subject (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008). Other educators perceived it as too challenging to teach the same concepts and materials used for regular classroom (Ambrose-Zaken & Bozeman, 2010; Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; McCollum, 1999; Rice, 2011; Smith & Kelley, 2007; Wild & Allen, 2009; Winograd, 2007).

At the beginning of the study, a checklist of assistive technology, modifications and accommodations designed to be used for instruction of science students who are blind or visually impaired was administered to science teachers of the visually impaired. With each item of the checklist, they were asked if they were previously trained to use that method or accessible technology. Lastly, with each item on the checklist, they were asked to rate their comfort zone for using that form of accessible technology or accommodation.

Rationale of the Study

Blind and visually impaired students are not exposed to or instructed in the subject of science as often as students who are not visually impaired. There must be accommodations made in order to make the science materials and laboratory procedures accessible for those students. Teacher preparation programs for the blind and visually impaired are not plentiful, consistent in program content or proficiency levels of mastery of accessible technology and methods upon completion. It is important that all students have the same opportunities in their education in order to pursue their academic and career interests. Visually impaired students need instructors who can create modifications and use technology when needed.

Research Question

The purpose of this current study was to investigate the attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students. Through the research the following question was investigated: What forms of assistive technology do science teachers of the visually impaired use, have they been trained to use them and what is their comfort level in using them?

Chapter 2: Review of Literature

Science Education Blind/VI and the Challenges

Many teachers are not familiar, trained, or have access to methods to educate the blind and visually impaired (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; Smith & Kelley, 2007). Science education for the blind and visually impaired is very challenging and expectations are low (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008; Smith & Kelley, 2007). Visually impaired students often do not have confidence or advocate for themselves as non-visual learners (Beck-Winchatz & Riccobona, 2008; Fraser & Maguvhe, 2008). Teaching materials and accommodations are frequently not available in an accessible form (Beck-Whinchatz & Riccobona, 2008; Kouroupetroglou & Kacorri, 2009) or viewed as too expensive for schools to acquire for students who are usually educated in a public school setting along with sighted peers (Beck-Winchatz & Riccobona, 2008).

Sue A. Wilder, director of Purdue University's program, Tactile Access to Education for Visually Impaired Students, also describes science material for the blind as very expensive and of short supply (Wild & Allen, 2009). One main challenge of science education for the blind and visually impaired is the difficulty of translating equations, graphs, and diagrams into an accessible format. Braille readers use the Nemeth Code developed by Abraham Nemeth in 1946 or 1947 (Navy, 2009) to transcribe mathematics and scientific notation into braille (Holbrook, D'Andrea, & Sanford, 2011). These challenges make it difficult for blind and visually impaired students to continue in the field of science (Kouroupetroglou & Kacorri, 2009; McCollum, 1999).

A United States and Canadian study of teacher preparation programs yielded results from 30 of the 38 universities contacted (Smith & Kelley, 2007). A broad range of competency levels was found in those using accessible technology for the visually impaired. The knowledge of using assistive technology in the curriculum was 93% of the 28 faculty members who responded. The ability to determine students' needs and appropriate assistive technology was ranked at 87% by 26 of the universities who responded. The need for a greater competence level among those in the visually impaired teacher preparation programs is apparent from the Smith and Kelley (2007) findings.

The assistive technology devices Smith and Kelley (2007) studied were, low vision devices, Braille output devices, access to the curriculum, and independent living devices. Interestingly, the braillenote had a 43% awareness by 13 of the universities, 37% ranking proficient in 11 responding universities, and only 20% at advanced proficiency. The embosser also had a low ranking of 20% by six universities in the advanced proficiency level. Encouragingly, the Perkins Braille writer had a higher percentage rate, 77%, of 23 universities at the advanced level of proficiency, and 23% at the proficient level for the remaining seven universities (Smith & Kelley, 2007).

Teacher of Blind/VI Attitudes and Perceptions

Teachers often lack knowledge of multisensory learning techniques, modifications and accommodations (Beck-Winchatz & Riccobono, 2008). Many teachers of the visually impaired are not able to adequately use assistive technology or instruct their students how to use it (Beck-Winchatz & Riccobona, 2008; Smith & Kelley, 2007). Blind and visually impaired students are commonly isolated within their own school, have inadequate materials, and if they take an interest in science are discouraged from pursing it (Beck-Winchatz & Riccobona, 2008).

Embracing Challenges

According to Rice (2011), Austin Community College of Texas Computer Science instructor Mr. Baldwin and blind physics student Ms. Lacy developed a solution to make college physics material accessible for blind students. Together they made open-access online tutorials for blind physics students to understand accommodations made to the material offered by the college. Typically blind students are given digital copies of their textbooks for use on a braille note display or to listen to on the computer. Ms. Lacy's digital book translated symbols unrecognizable by the computer onto her braille note display. Between Ms. Lacy and Mr. Baldwin, they developed a solution which enabled her to do her physics coursework. Without the newly made accommodations she would not have been able to access the textbook. The physics equations on the braillenote display were converted into symbols found on a computer keyboard and given in a readable format for the blind (Rice, 2011).

Teacher of the visually impaired, Marilyn Winograd and high school science teacher Dr. Lillian Rankel collaborated to adapt materials in chemistry, physics, and physical science for students who are blind and visually impaired (Winograd, 2007). Dr. Rankel has a PhD in chemistry from Princeton University. Ms. Winograd is a teacher of the visually impaired with years of experience as an itinerant education consultant for the New Jersey Commission for the Blind and Visually Impaired. Together they successfully taught a blind Honors Chemistry and

Advanced Placement Chemistry student in every aspect of the class (Winograd, 2007). Both believe there is no reason for a student who is blind or visually impaired to be excluded or discouraged from studying science. Every piece of material, instrument, or text can somehow be modified to make science accessible for the blind and visually impaired population with creativity, skill, and tenacity (Winograd, 2007).

An innovative form of assistive technology called computer haptics offers another way for visually impaired students to learn various science concepts through the sense of touch and hearing. The device is connected to a computer downloaded with apps purchased by eTouch services. Topics of the apps include the cell, volcanoes, three-dimensional figures, textures, shapes, volume and area. The electronic haptic device is similar to a game joy stick attached to a computer but allows the user to interact by listening to directions and feeling different levels of resistance or vibrations through its tri-armed peripheral handle (Darrah, 2011).

To Raise the Expectations of the Blind and Visually Impaired

Recent studies found the cognitive abilities of blind and visually impaired students compared to sighted students to be within the same range (Kouroupetroglou & Kacorri, 2009). Blind and visually impaired students need appropriate methods and accessible technology in order to compete and advance in learning the same science concepts as their sighted peers (Kouroupetroglou & Kacorri, 2009). The lack of access to science materials for the blind is an overall deterrent not to pursue the field of physics. Making accessible materials is a great challenge but possible in a reproducible tactile format or interactive auditory mode (Kouroupetroglou & Kacorri, 2009). Creative outreaches for blind students interested in science have seen recent growth through organizations such as the National Federation of the Blind Youth in Science (Beck-Winchatz & Riccobono, 2008).

Together, NASA and the National Federation of the Blind, and others, offer programs such as, National Federation of the Blind Science Academies Youth Slam and the Yerkes Astronomy Camps, to raise interest and lessen isolation in blind or visually impaired youth (American Foundation for the Blind, 2006; Beck-Winchatz & Riccobono, 2008).

Materials/Technology for Teachers and Importance of What They are Currently Doing

To aid in the advancement of blind students participating in science, the National Federation of the Blind, National Center for Blind Youth in Science, and the National Aeronautics and Space Administration have joined to create methods and opportunities for blind youth to study science. Materials, curriculum, science academies for blind middle and high school students, mentoring and internship programs for college students, and tactile space science books have been developed (Beck-Winchatz & Riccobono, 2008).

Students who are blind or visually impaired have less negative impact on them when educated and instructed by professionals who have been prepared and trained through university programs. The independent life skills the visually impaired acquire from professionally trained instructors and therapists is greater than those received under the care of paraeducators (Ambrose-Zaken & Bozeman, 2007). There is a demand for teachers of the visually impaired as the population of individuals who are blind or have low vision continues to rise in the United States and Canada. Accessing teacher-preparation programs is difficult for those in rural parts of the country and in areas where teacher preparation programs are not available (Ambrose-Zaken

& Bozeman, 2010). University teacher-preparation programs for the visually impaired are absent in 46% of United State universities (Ambrose-Zaken & Bozeman, 2010). Universities are slowly acquiring teacher preparation programs, but the needs are not being met throughout the United States, even with a federal mandate for highly qualified teachers (Ambrose-Zaken & Bozeman, 2007). Recruitment of professionals into the field of serving the visually impaired has been slow and difficult (Ambrose-Zaken & Bozeman).

Teacher Preparation

Studies show teachers of the visually impaired lack preparation and knowledge in the use of assistive technology (Abner & Lahm, 2002; Candela, 2003; Edwards & Lewis, 1998; Kapperman, Sticken & Heinze, 2007; Smith & Kelley, 2007). The studies spurred the Division of Visual Impairments of the Council for Exceptional Children to create the standards that university teacher preparation programs include instruction on assistive technology and methods of instruction for students with visual impairments. As a result, the inclusion of assistive technology training into teacher preparation programs for the visually impaired began to increase (Smith & Kelley, 2007).

An online survey was emailed to the program directors of the 38 universities that have teacher preparation programs for students with visual impairments in the United States and Canada. The survey asked if assistive technology was in their teacher preparation program and received a response from 30 of the universities. Fifteen teacher preparation programs provided an assistive technology course. Three universities provided a multidisciplinary assistive technology course for teachers of the visually impaired and 12 universities offered no course. Half of the universities with no assistive technology course reported no plans to create one. The study also found assistive technology training in preparation programs for teachers of the visually impaired is important but proficiency levels are varied. Similarly, the overall training of the program produced teachers varied in their competency levels of knowledge and ability in use of assistive technology devices (Smith & Kelley, 2007). The authors strongly suggest professional competencies and standards for assistive technology be developed for teachers of the visually impaired.

Beck-Winchatz and Riccobona (2008) suggest teachers, students and parents use the National Federation of the Blind's web portal blindscience.org to improve science instruction and common perspectives for the visually impaired. Teachers of science for the visually impaired can also grow professionally, positively affecting their students, through contact and involvement in the National Federation of the Blind's National Center for Blind Youth in Science and its resources.

Mr. Baldwin, Computer Science instructor at Austin Community College, Texas, recognized the need to accommodate blind students' science textbooks and graphs in accessible ways. He also developed online tutorials for understanding the physics concepts he and Ms. Lacy worked together to reformat and created computer software that enables the blind to draw sketches (Rice, 2011). Due to the readable format of the modified physics text, visually impaired student Ms. Lacy, was able to complete her introduction to physics class with an A, progress to the next physics class using the completed computer software drawing program, and answer all of her homework questions (Rice, 2011).

Ms. Wilder began the Tactile Access to Education for Visually Impaired Students, Braille and large type, internet transcription service, at Purdue University to provide needed science course materials to students and professors for a fee. Other universities use Purdue University's program to create Braille textbooks and materials needed by their students and professors (McCollum, 1999).

Accessible technology and accommodations can be provided in many ways. A screen-reading software called JAWS is commonly used, but for science problems and equations the material must be written in linear format by the teacher to enable the screen reader to be understood by the student using it. Models, visual aids, diagrams, and instruments can be modified in a tactile format or with tactile markings, including the use of Braille for labels. Practical suggestions for a science lab include, using plastic spoons, and short and wide mouth containers and squat jars to prevent tipping. Electric probes and sensors connected to the computer for data collection read out loud by JAWS are also recommended for lab use by visually impaired science students (Winograd, 2007).

Pennsylvania State University's Independent Laboratory Access for the Blind is a resource for accessible technology, equipment and chemical laboratory experiments a student who is blind can operate independently. Tactile Adaptation Kits can also be used to make diagrams, graphs, and drawings (Winograd, 2007). The biggest teaching strategy Winograd (2007) recommends for science students who are visually impaired and their instructors, is to be resolved to always find a working solution and never have an attitude of science being inaccessible or unteachable.

Chapter 3: Procedures and Methods

The purpose of this research is to investigate the challenges, attitudes and perceptions of science education for the blind or visually impaired, as well as how difficult it is to accommodate those students, and what are teachers currently doing about it. A description of the methods and procedures of this study are expressed. This includes the research question, research design and the collection of data from surveyed teachers within a mid-Atlantic state who teach middle and high school science to the visually impaired.

Research Questions

The purpose of this current study was to investigate the attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students and how they were incorporated in the classroom. As previously stated, through the research the following question was investigated: What forms of assistive technology do science teachers of the visually impaired use, have they been trained to use them and what is their comfort level in using them?

Research Design

Setting and Participants

The participants in this study were eight teachers of the visually impaired within a Mid-Atlantic state who taught science. Of those eight teachers the level of education was six with a Bachelor degree, one a Master degree and one a Master degree plus. Years of teaching science to the visually impaired for all eight was 1 to 5. The grade level taught ranged from elementary to high school, one taught middle school science and two high school. The other instructors taught a combination of classes and grades, ranging from middle school to high school to life skills or fundamental academics. Science subjects taught by the teachers of the visually impaired were elementary general science, middle school science, high school physical science, biology, chemistry, physics, environmental science, life skills or fundamental science.

Materials

Teachers of the visually impaired who taught science in the Mid-Atlantic state were asked to complete a questionnaire to gather demographic information at the beginning of the survey. A survey of Likert formatted questions was given. The survey first asked if training had been completed in using different forms of assistive technology. Secondly, if the form of assistive technology is used in teaching science to the visually impaired. Each question was followed in a Likert format based on a five point scale rating the comfort level using different forms of accessible technology. The questionnaire survey ended with open ended questions for comments and responses.

Procedures

The survey was given to a coordinator of special education of a mid-Atlantic state who emailed it to teachers of the visually impaired. A reminder to complete and return the survey was forwarded on from the coordinator of special education after ten business days to the teachers of the visually impaired. Teachers returned the survey after completion to the coordinator of special education. The anonymous surveys were forwarded to the researcher for data collection.

At the beginning of the study, a checklist of assistive technology, modifications and accommodations designed to be used for instruction of science students who are blind or visually impaired was administered to science teachers of the visually impaired. With each item of the checklist, they were asked if they had any previous training to use that method of accessible technology followed by the Likert scale rating of their comfort zone for using that form of accessible technology or accommodation.

All information and data collected from the questionnaire survey was for the purpose of evaluated, analyzed, recorded, categorized and shared. The survey consisted of nominal variables of gender, level of education, years of experience teaching the visually impaired and grade level taught. A five point Likert scale was used to rank the level of comfort for using assistive technology when teaching science to the visually impaired.

Chapter 4: Data

The purpose of this study was to determine the attitudes and perspectives of teacher of the visually impaired towards science education. The questions in the survey were constructed to acquire perceptions from teachers of science for the visually impaired within a mid-Atlantic state, their level of comfort using different forms of accessible technology and how they address or adapt science for their students. Demographic information, science classes taught, and if training was received using accessible technology were collected. Comments and suggestions were gathered in an open format as well.

Surveys were sent to 81 teachers of the visually impaired, of which 14 emails were returned as undeliverable. From the 67 requests delivered, 12 responded, creating an 18% response rate. Of the 12 responses, four should have been eliminated due to the no response regarding teaching science. Since these four respondents completed the survey, their results will be reported separately and only included in the final totals. Two other respondents did not answer the survey in its entirety.

Of the 12 who agreed to take the survey 67% taught science while 33% did not. Some of the respondents taught more than one set of grades or population of visually impaired students. Of the eight science related teachers 25% taught elementary. Another 25% taught middle school or sixth to eighth grades, high school or ninth to twelfth grades and life skills or fundamental academics, grades six to twelve. Two science related teachers solely taught life skills or fundamental academics. Lastly, 13% reported teaching kindergarten science and another 13% all grade levels.

A total of 100% of the respondents were female. Those age 21 to 29 or 40 to 49 was 38% each. Those 30 to 39 and 40 to 49 totaled 38% and 25%, respectively. Among the highest level of education were those with a Bachelor's Degree plus, 75%, a Master's Degree, 13%, and a Master's Degree plus, 13%. All 100% of the science related teachers of the visually impaired teaching experience was reported it as 1 to 5 years. Whereas 50% of the non-science related teachers reported 1 to 5 years' experience, followed by a 25% response each for 11 to 15 and 21 to 25 years.

The science classes taught by the 11 of 12 who responded to the question consisted of four, 36%, teaching none but two of them offer assistive technology and accommodations to the blind students to make science accessible. General elementary science is taught by 3, 27%, and 2, 18%, taught a combination of classes including sixth grade science, chemistry, physical science, biology, earth science, environmental science, life skills or fundamental science, and or agricultural science.

The second part of the survey focused on what forms of assistive technology science teachers of the visually impaired use, if they have been trained and their level of comfort. The level of comfort or proficiency throughout the survey was ranked 1 for none, 2 below average, 3 average, 4 above average, and 5 mastery or excellent. Those science related teachers already trained to use a low vision device was 7 or 88%, yes and one, 13%, no. The use of a low vision device in instruction was six, 75%, yes and two, 25%, no. The level of comfort or proficiency of one respondent was one, 13%. The ranking of two was one, 13%. Two teachers, 25%, choose comfort level as 3. Three teachers chose level 4 and one respondent rated herself as 5.

Training to use the hand held magnifier by science related teachers of the visually impaired in instruction was both 50% for having been trained and for those not. Its use in instruction was five, 63%, yes and three, 38%, no. Two teachers each chose 1 and 3 as the level of comfort or training, 25% each. One teacher, 13%, rated comfort level 4, but the ranking of 5 received the most responses, five, at 38%. Both training to use a Braille Note and use during instruction was three yes, 38% and five no, 63%. Four ranked level of comfort or proficiency as 1, 50%. Two, 25% of the teachers rated themselves a 2 as did two other teachers a 3 for average.

Every respondent has been trained in use of a Perkins braille writer, seven or 88% use it in instruction, and one or 13% does not. The level of comfort or proficiency ranked highly in this category, four teachers or 50% at 4 and three or 38% of the science related teachers at 5. One, 13% of the respondents ranked their level of comfort at 2. Seven, 88% had been trained to use the slate and stylus and one, 13% had not. All eight do not use the slate and stylus during instruction. One, 13% rated themselves 1 in level of comfort or proficiency and four, 50% 3 for average. Two, 25% of respondents had a rating of 4 while one or 13% a 5 for excellent or mastery. Training had been received for the braille embosser by two, 25%, of the teachers. Six, 75%, reported having no training. Four or 50% use the braille embosser and 50% do not. Three respondents rated themselves as having no level of comfort. A rating of 2 and 5 were chosen by one teacher each whereas 38% had a comfort level of 3.

Those respondents trained and who do use the assistive technology called Duxbury or Perky Duck, a computer based braille emulator which allows electronic braille files to be made using six keys to represent the dots of a braille cell, were four or 50% each. Half of the science related teachers of the visually impaired reported receiving no training nor using Perky Duck or Duxbury during instruction. Three, 25%, sets of two respondents, 75% total, evenly rated themselves as having either a 2, 4 or 5 level of comfort or proficiency. Two teachers separately responded with a 1 or 3 rating on the Likert scale at 13%.

The remainder of the survey was completed by ten respondents, eight being science related teachers of the visually impaired. The data reported is based on those eight surveys' results. The following set of questions involved science related visually impaired teacher training in accessing curriculum through computer screen magnification or screen reading such as Zoom Text, or the screen reader computer program called JAWS. Two, 25%, reported having been trained in Zoom Text and use it while six, 75% have not. Three, 38% use it in instruction and 63% do not. Three, 38% rated themselves as having no level of comfort or proficiency, 25% a score of 2, while three separate instructors each reported to be average, above average or the highest level of 5, respectively. Five, 63% teachers had been trained in JAWS and three, 38% had not. Six, 75%, use JAWS during instruction and two, 25% do not. One, 25%

rated themselves a 1, five participants or 63% reported to be average and one, 13% above average or 4 in level of comfort or proficiency.

Two teachers reported having been trained to use the Talking Calculator and six responded no. Three, 38% use it during instruction and five, 63% do not. Four, 50% reported a comfort level of 1 and one, 13% a level of 3. Two participants, 25% rated themselves a 4 and one the highest level of 5. Concerning the Haptic Falcon device, two of the teachers received training and six, 75% did not. One uses the Haptic Device during instruction and seven, 88% do not. Six science related teachers rated their level or comfort or proficiency as a 1. Lastly, one teacher each reported either a level 4 or 5.

Five, 63% of the respondents had been trained to use 3-dimensional models and use them during instruction, while three or 38% responded no to both questions. Of those, two respondents rated themselves at either a level 1 or 3. Three, 38% reported above average and one, 13% rated their level of comfort or proficiency as mastery or excellent. Those trained to use tactile graphics were five, 63% and three, 38% reported having no training. All science related instructors of the visually impaired used them and two reported a 1 or 2 on the Likert scale. Two rated themselves as average and four at above average on their level of comfort or proficiency.

The last Likert scale set of questions asked the participant if they had been trained to use tactile and braille labeled science equipment, such as scales, balances, beakers and graduates. Two, 25% reported yes and six, 75% reported no. Half of the instructors use that form of assistive technology during instruction and 50% do not. Two sets of three teachers separately rated their comfort level at none or above average while the remaining two responses were divided between a rating of below average or average.

The survey closed with one open ended question asking for any techniques, modifications or accommodations not mentioned that respondents have had success with. Methods mentioned included use of a Smart Board when not doing hands-on activities, or to use with a computer to adapt the screen to accommodate their students' level of visual accessibility. This instructor also used the zoom tool with webpages and the movement of the mouse for locating what they wanted their students to attend to. They also create pages that have low visual clutter, using the Smart Notebook application program.

Another instructor commented how they have had success using thermoform, raised line paper, and draftsman for tactile graphics. To create drawings they have had success using Duxbury QuickTac.

The list of materials used for accommodations and modifications of another teacher of the visually impaired who teaches science has had success using a tactile graphing kit, Wiki sticks for tactile markings, verbal instruction and reading, projects using technology such as power points or movies with iPad movie maker, reports read back from a Braille Note, labeling materials in braille, a talking scale, and the Smart Board for many uses.

The last section of the survey gave opportunity for comments to be shared. One non science related teacher of the visually impaired said they use the braille note daily and have so for several years. She had a brief training on it but mostly she and her students figured it out on their own as did most of the other assistive technology. Another teacher said they have thought about the training and that there isn't really any. One mentioned how they have had to figure out the accessible technology on their own by reading manuals and exploring it. Lastly, one science related instructor mentioned how the training of using different forms of accessible technology should be part of the teachers of the visually impaired education programs in colleges.

Limitations included some potential participants who had a Mid-Atlantic state school system email not being able to access the survey. The survey also did not submit immediately after the response of not being a teacher of the visually impaired who teaches science but rather remained open.

Table 1: Level of Comfort or Proficiency for Science Related Teachers of Visually Impaired

Form of Assistive Technology	Respondents N	Science Instructors Trained and Percentage	Science Instructors Who Use in Instruction
Low Vision Device such as video magnification	8	Yes-7, 88% No-1, 13%	Yes-6, 75% No-2, 25%
Hand Held Magnifier	8	Yes-4,50% No-4, 50%	Yes-5, 63% No-3, 38%
Electronic Braille Note or Note Taker	8	Yes-3, 38% No-5, 63%	Yes-3, 38% No-5, 63%
Perkins Braille Writer	8	Yes-8, 100% No-0, 0%	Yes-7, 88% No-1, 13%
Slate and Stylus	8	Yes-7, 88% No-1, 13%	Yes-0, 0% No-8, 100%
Braille Embosser	8	Yes-2, 25% No-6, 75%	Yes-4, 50% No-4, 50%
Duxbury or Perky Duck	8	Yes-4, 50% No-4, 50%	Yes-4, 50% No-4, 50%
Zoom Text	8	Yes-2-25% No-6-75%	Yes-3-38% No-5, 63%
JAWS	8	Yes-5, 63% No-3, 38%	Yes-6, 75%, No-2, 25%
Talking Calculator	8	Yes-2-25%, No-6-75%	Yes-3-38%, No-5-63%
Haptic Device with Computer Applications	8	Yes-2-25%, No-6-75%	Yes-1-13%, No-7-88%
3-Dimensional Models	8	Yes-5-63%, No-3-38%,	Yes-5-63%, No-3-38%
Tactile Graphics	8	Yes-5-63%, No-3-38%,	Yes-8-100%, No-0-0%
Tactile and Braille Labeled Science Equipment	8	Yes-2, 25% No-6, 75%	Yes-4-50% No-4, 50%

Table 2: Level of Comfort or Proficiency for Science Related Teachers of visually impaired

	Respondents	**None**		**Below Average**		**Average**		**Above Average**		**Master or Excellent**	
	N	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Form of Assistive Technology											
Low Vision Device such as video magnification	8	1	13	1	13	2	25	3	38	1	13
Hand Held Magnifier	8	2	25	0	0	2	25	1	13	3	38
Electronic Braille Note or Note Taker	8	4	50	2	25	2	25	0	0	0	0
Perkins Braille Writer	8	0	0	1	13	0	0	4	50	3	38
Slate and Stylus	8	1	13	0	0	4	50	2	25	1	13
Braille Embosser	8	3	38	1	13	3	38	1	13	0	0
Duxbury or Perky Duck	8	1	13	2	25	1	13	2	25	2	25
Zoom Text	8	3	38	2	25	1	13	1	13	1	13
JAWS	8	2	25	0	0	5	63	1	13	0	0
Talking Calculator	8	4	50	0	0	1	13	2	25	1	13
Haptic Device with Computer Applications	8	6	75	0	0	0	0	1	13	1	13
3-Dimensional Models	8	2	25	0	0	2	25	3	38	1	13
Tactile Graphics	8	1	13	1	13	2	25	4	50	5	0
Tactile and Braille Labeled Science Equipment	8	3	38	1	13	1	13	3	38	0	0

Table 3: Level of Comfort or Proficiency of Non Science Related Teachers of Visually Impaired

Form of Assistive Technology	Respondents N	Amount of Non Science Related Instructors Trained and Percentage	Instruction and Percentage Yes/No
Low Vision Device such as video magnification	4	Yes-0, 0% No-4, 100%	Yes-4, 100% No-0, 0%
Hand Held Magnifier	4	Yes-4, 100% No-0, 0%	Yes-3, 75% No-1, 25%
Electronic Braille Note or Note Taker	4	Yes-4, 100% No-0, 0%	Yes-4, 100% No-0, 0%
Perkins Braille Writer	4	Yes-4, 100% No-0, 0%	Yes-4, 100% No-0, 0%
Slate and Stylus	4	Yes-2, 50% No-2, 50%	Yes-0, 0% No-4, 100%
Braille Embosser	4	Yes-1, 25% No-3, 75%	Yes-3, 75% No-1, 25%
Duxbury or Perky Duck	4	Yes-2, 50% No-2, 50%	Yes-2, 50% No-2, 50%
Zoom Text	2	Yes-2-100% No-0-0%	Yes-1-50% No-1, 50%
JAWS	2	Yes-0, 0% No-2, 100%	Yes-1, 50% No-1, 50%
Talking Calculator	2	Yes-0-0%, No-2-100%	Yes-1-50% No-1-50%
Haptic Device with Computer Applications	2	Yes-0-0%, No-2-100%	Yes-0-0%, No-2-100%
3-Dimensional Models	2	Yes-2-100% No-0-0%	Yes-2-100%, No-0-0%
Tactile Graphics	2	Yes-2-100%, No-0-0%, NR-2-50%	Yes-2-100%, No-0-0%
Tactile and Braille Labeled Science Equipment	2	Yes-0, 0% No-2, 100%	Yes-0-0% No-2, 100%

Table 4: Level of Comfort or Proficiency for Non Science Related Teachers of Visually Impaired

	Respondents	None		Below Average		Average		Above Average		Master or Excellent	
	N	n	%	n	%	n	%	n	%	n	%
Form of Assistive Technology											
Low Vision Device such as video magnification	4	0	0	0	0	2	50	1	25	1	25
Hand Held Magnifier	4	0	0	1	25	0	0	1	25	2	50
Electronic Braille Note or Note Taker	4	0	0	1	25	1	25	1	25	1	25
Perkins Braille Writer	4	0	0	0	0	0	0	1	25	3	75
Slate and Stylus	4	2	50	1	25	0	0	1	25	0	0
Braille Embosser	4	1	25	1	25	0	0	1	25	1	25
Duxbury or Perky Duck	4	2	50	0	0	0	0	1	25	1	25
Zoom Text	2	0	0	1	25	0	0	0	0	1	25
JAWS	2	1	25	0	0	1	25	0	0	0	0
Talking Calculator	2	0	0	1	25	1	25	0	0	0	0
Haptic Device with Computer Applications	2	1	25	1	25	0	0	0	0	0	0
3-Dimensional Models	2	0	0	0	0	2	50	0	0	0	0
Tactile Graphics	2	0	0	0	0	0	0	2	25	0	0
Tactile and Braille Labeled Science Equipment	2	1	25	1	25	0	0	0	0	0	0

Chapter 5: Discussion

The purpose of the study was to investigate attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students and what they are currently doing about it. The results of an electronic survey sent to teachers of the visually impaired in a Mid-Atlantic state are discussed along with the study's limitations and suggestions to additional research. The data and responses were gathered to investigate science related teachers of the visually impaired, their training, teaching methods and level of comfort or proficiency using assistive technology.

Interpretation and Implications of Results

The collected data from the science related teachers of the visually impaired of their training, use during instruction, and levels of comfort or proficiency with different forms of assistive technology reflects their attitudes, perceptions, knowledge, and what they are currently doing about it. As displayed in Table 1, eight respondents informed of their training or lack of training of various forms of accessible technology. At least half of the science related teachers were trained to use a low vision device, hand held magnifier, the Perkins braille writer, slate and stylus, Duxbury or Perky Duck, JAWS, 3-dimensional models, and tactile graphics. The assistive technology used by at least half of the science related instructors was the low vision device, hand held magnifier, Perkins braille writer, Braille embosser, Duxbury or Perky Duck, JAWS, 3-dimensional models, tactile graphics, and tactile and braille labeled science equipment. The data reflects instructors use the assistive technology in instruction more than the frequency of their training, with the acceptation of the slate and stylus, which is not used at all even though all have been trained. The level of comfort or proficiency is rated average or higher by four or more respondents in all forms of assistive technology except the electronic Braille Note or Note Taker, Zoom Text, and Haptic device with computer applications.

Limitations

Limitations included some potential participants who had a Mid-Atlantic state school system email not being able to access the survey. The number of participants was a small amount. More responses could have been gathered had the survey been sent to another Mid-Atlantic state and its teachers of the visually impaired after gaining site approval. The survey also did not submit immediately after the response of not being a teacher of the visually impaired who teaches science but rather remained open enabling those to continue taking the survey. Data from the non-science related teachers responses had to be separated from the science related teachers of the visually impaired.

Conclusions

Overall where the amount of science related teachers of the visually impaired answered yes to having been trained to use assistive technology were low the use of it in instruction was also rated at a lower frequency along with the level of comfort and proficiency. Most every form of assistive technology where the respondents had been trained also used it in instruction and had a higher level of comfort or proficiency, average to mastery or excellent. One exception was a device commonly used when advanced forms of technology are unavailable, the slate and stylus. The science related and non-science related teachers of the visually impaired shared mutual opinions and suggestions during the open ended questions, namely that there needs to be more training of how to use and implement accessible technology and most of what they and their students did know was self-taught. The suggestions given by the respondents of successful methods of teaching visually impaired students mentioned in the open ended comment section of the survey were of different methods and forms of accessible technology than those mentioned in the survey questions. Further research could include those as well.

The theme of more training being needed to skillfully operate assistive technology was expressed, whether in college visual impairment programs or as professional development. This research has given rise to interest in further investigation of the how and what standards colleges are training students in their visual impairment certification programs to be proficient in the use and knowledge of various forms of accessible technology, particularly the electronic braille note or note taker, for teaching science or any other subject at all grade levels to the visually impaired.

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Appendix A
Site Approval Letter

XXXXXXXXX
XXXXXXX
XXXXXX

February 9, 2015

This letter is to document that ***Lydia M. Moreland*** has permission to conduct a research study at ***Marshall University, 100 Angus E. Peyton Dr.***, in ***South Charleston, WV 25303*** once Institutional Review Board (IRB) approval has been obtained. I understand that this study involves ***a survey/questionnaire***. I also understand that this project is part of school requirements for ***CISP 615 Special Education Research 2*** at Marshall University. The instructor for this course is ***Lori Howard, Ph.D.***.

I will act as the on-site supervisor and can be contacted by phone at ***xxx-xxx-xxxx*** or by email at ***xxxxxxxxxxxxxxx.***

Signed,

xxxxxxxxxxxxxx
xxxxxxx

Appendix B

MU Letter of Consent

Anonymous Survey Consent

Marshall University IRB

Approved on:	2/24/15
Expires on:	2/24/16
Study number:	717743

You are invited to participate in a research project entitled “Science and Accessible Technology for the Visually Impaired” designed to analyze the attitudes, perceptions, and knowledge of assistive technology used by science teachers of visually impaired students and how they are incorporated in the classroom. The study is being conducted by Lori Howard, Ph.D. and Lydia M. Moreland from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). This research is being conducted as part of the CISP 615 thesis/dissertation/class requirements for Lydia M. Moreland.

This survey is comprised of Likert scale and open ended questions and will take approximately ten minutes to complete. Your replies will be anonymous, so do not type your name anywhere on the form. There are no known risks involved with this study. Participation is completely voluntary and there will be no penalty or loss of benefits if you choose to not participate in this research study or to withdraw. If you choose not to participate you can leave the survey site. You may choose to not answer any question by simply leaving it blank. Once you complete the survey you can delete your browsing history for added security. Completing the on-line survey indicates your consent for use of the answers you supply. If you have any questions about the study you may contact Lori Howard Ph.D. at (304)746-2076, Lydia M. Moreland at (540)539-1567.

If you have any questions concerning your rights as a research participant you may contact the Marshall University Office of Research Integrity at (304) 696-4303.

By completing this survey you are also confirming that you are **18** years of age or older.

Please print this page for your records.

If you choose to participate in the study you will find the survey at https://docs.google.com/forms.

Appendix C

Survey

Science and Accessible Technology For the Visually Impaired

By taking this survey you understand that all responses will be kept anonymous. *

- agree
- disagree

Do you teach science to visually impaired students?* Please note, if "no" is chosen the survey will be automatically submitted. Thank you for your participation.

- yes
- no

What grade do you teach science to the visually impaired?*

- middle school (grades 6 to 8)
- high school (grades 9 to 12)
- life skills or fundamental academics (grades 6 to 12)
- Other:

Age of the Teacher of the Visually Impaired *

Gender*

- male
- female

Highest level of education*

What science classes do you teach?*

Years of experience teaching the visually impaired*

1a. As a teacher of the visually impaired have you been trained to use a low vision device, such as video magnification (closed-circuit television, Visio-book, Flipper, Merlin or similar as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology in your instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

2a. Have you been trained to use a low vision device such as a hand held magnifier as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology in your instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

3a. Have you been trained to use an electronic braille note or note taker?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

4a. Have you been trained to use a Perkins braille writer?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes

- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

5a. Have you been trained to use a slate and stylus as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

6a. Have you been trained to use a braille embosser as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

7a. Have you been trained to use Duxbury or Perkey Duck as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

1 2 3 4 5

poor ◌ ◌ ◌ ◌ ◌ excellent

8a. Have you been trained to access the curriculum through Zoom Text as a form of assistive technology?*

- ◌ yes
- ◌ no

b. Do you use this form of assistive technology during instruction?*

- ◌ yes
- ◌ no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor	◌	◌	◌	◌	◌	excellent

9a. Have you been trained to access the curriculum through JAWS as a form of assistive technology?*

- ◌ yes
- ◌ no

b. Do you use this form of assistive technology during instruction?*

- ◌ yes
- ◌ no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor	◌	◌	◌	◌	◌	excellent

10a. Have you been trained to access the curriculum through Talking Calculators as a form of assistive technology?*

- ◌ yes
- ◌ no

b. Do you use this form of assistive technology during instruction?*

- ◌ yes
- ◌ no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor	◌	◌	◌	◌	◌	excellent

11a. Have you been trained to use the Haptic Falcon device with computer applications from eTouch Sciences as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

12a. Have you been trained to use 3-dimensional models as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

13a. Have you been trained to use tactile graphics as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes
- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

14a. Have you been trained to use tactile and braille labeled science equipment, such as scales, balances, beakers, and graduates as a form of assistive technology?*

- yes
- no

b. Do you use this form of assistive technology during instruction?*

- yes

- no

c. What is your level of comfort or proficiency in using this form of assistive technology?*

	1	2	3	4	5	
poor						excellent

15. Are there any techniques, modifications or accommodations not mentioned above that you have had success with?

16. Please share any comments you may have below. Thank you for your time in answering this questionnaire and survey. All responses will be kept anonymous.

Add item

Confirmation Page

Show link to submit another response
Publish and show a public link to form results
Allow responders to edit responses after submitting

Send form

Appendix D

Tables 1-4

Table D1: Level of Comfort or Proficiency for Science Related Teachers of Visually Impaired

Form of Assistive Technology	Respondents N	Science Instructors Trained and Percentage	Science Instructors Who Use in Instruction
Low Vision Device such as video magnification	8	Yes-7, 88% No-1, 13%	Yes-6, 75% No-2, 25%
Hand Held Magnifier	8	Yes-4,50% No-4, 50%	Yes-5, 63% No-3, 38%
Electronic Braille Note or Note Taker	8	Yes-3, 38% No-5, 63%	Yes-3, 38% No-5, 63%
Perkins Braille Writer	8	Yes-8, 100% No-0, 0%	Yes-7, 88% No-1, 13%
Slate and Stylus	8	Yes-7, 88% No-1, 13%	Yes-0, 0% No-8, 100%
Braille Embosser	8	Yes-2, 25% No-6, 75%	Yes-4, 50% No-4, 50%
Duxbury or Perky Duck	8	Yes-4, 50% No-4, 50%	Yes-4, 50% No-4, 50%
Zoom Text	8	Yes-2-25% No-6-75%	Yes-3-38% No-5, 63%
JAWS	8	Yes-5, 63% No-3, 38%	Yes-6, 75%, No-2, 25%
Talking Calculator	8	Yes-2-25%, No-6-75%	Yes-3-38%, No-5-63%
Haptic Device with Computer Applications	8	Yes-2-25%, No-6-75%	Yes-1-13%, No-7-88%
3-Dimensional Models	8	Yes-5-63%, No-3-38%,	Yes-5-63%, No-3-38%
Tactile Graphics	8	Yes-5-63%, No-3-38%,	Yes-8-100%, No-0-0%
Tactile and Braille Labeled Science Equipment	8	Yes-2, 25% No-6, 75%	Yes-4-50% No-4, 50%

Table D2: Level of Comfort or Proficiency for Science Related Teachers of Visually Impaired

	Respondents	None		Below Average		Average		Above Average		Master or Excellent	
	N	n	%	n	%	n	%	n	%	n	%
Form of Assistive Technology											
Low Vision Device such as video magnification	8	1	13	1	13	2	25	3	38	1	13
Hand Held Magnifier	8	2	25	0	0	2	25	1	13	3	38
Electronic Braille Note or Note Taker	8	4	50	2	25	2	25	0	0	0	0
Perkins Braille Writer	8	0	0	1	13	0	0	4	50	3	38
Slate and Stylus	8	1	13	0	0	4	50	2	25	1	13
Braille Embosser	8	3	38	1	13	3	38	1	13	0	0
Duxbury or Perky Duck	8	1	13	2	25	1	13	2	25	2	25
Zoom Text	8	3	38	2	25	1	13	1	13	1	13
JAWS	8	2	25	0	0	5	63	1	13	0	0
Talking Calculator	8	4	50	0	0	1	13	2	25	1	13
Haptic Device with Computer Applications	8	6	75	0	0	0	0	1	13	1	13
3-Dimensional Models	8	2	25	0	0	2	25	3	38	1	13
Tactile Graphics	8	1	13	1	13	2	25	4	50	5	0
Tactile and Braille Labeled Science Equipment	8	3	38	1	13	1	13	3	38	0	0

Table D3: Level of Comfort or Proficiency of Non Science Related Teachers of Visually Impaired

Form of Assistive Technology	Respondents N	Amount of Non Science Related Instructors Trained and Percentage	Instruction and Percentage Yes/No
Low Vision Device such as video magnification	4	Yes-0, 0% No-4, 100%	Yes-4, 100% No-0, 0%
Hand Held Magnifier	4	Yes-4, 100% No-0, 0%	Yes-3, 75% No-1, 25%
Electronic Braille Note or Note Taker	4	Yes-4, 100% No-0, 0%	Yes-4, 100% No-0, 0%
Perkins Braille Writer	4	Yes-4, 100% No-0, 0%	Yes-4, 100% No-0, 0%
Slate and Stylus	4	Yes-2, 50% No-2, 50%	Yes-0, 0% No-4, 100%
Braille Embosser	4	Yes-1, 25% No-3, 75%	Yes-3, 75% No-1, 25%
Duxbury or Perky Duck	4	Yes-2, 50% No-2, 50%	Yes-2, 50% No-2, 50%
Zoom Text	2	Yes-2-100% No-0-0%	Yes-1-50% No-1, 50%
JAWS	2	Yes-0, 0% No-2, 100%	Yes-1, 50% No-1, 50%
Talking Calculator	2	Yes-0-0%, No-2-100%	Yes-1-50% No-1-50%
Haptic Device with Computer Applications	2	Yes-0-0%, No-2-100%	Yes-0-0%, No-2-100%
3-Dimensional Models	2	Yes-2-100% No-0-0%	Yes-2-100%, No-0-0%
Tactile Graphics	2	Yes-2-100%, No-0-0%, NR-2-50%	Yes-2-100%, No-0-0%
Tactile and Braille Labeled Science Equipment	2	Yes-0, 0% No-2, 100%	Yes-0-0% No-2, 100%

Table D4: Level of Comfort or Proficiency for Non Science Related Teachers of Visually Impaired

	Respondents	None		Below Average		Average		Above Average		Master or Excellent	
	N	n	%	n	%	n	%	n	%	n	%
Form of Assistive Technology											
Low Vision Device such as video magnification	4	0	0	0	0	2	50	1	25	1	25
Hand Held Magnifier	4	0	0	1	25	0	0	1	25	2	50
Electronic Braille Note or Note Taker	4	0	0	1	25	1	25	1	25	1	25
Perkins Braille Writer	4	0	0	0	0	0	0	1	25	3	75
Slate and Stylus	4	2	50	1	25	0	0	1	25	0	0
Braille Embosser	4	1	25	1	25	0	0	1	25	1	25
Duxbury or Perky Duck	4	2	50	0	0	0	0	1	25	1	25
Zoom Text	2	0	0	1	25	0	0	0	0	1	25
JAWS	2	1	25	0	0	1	25	0	0	0	0
Talking Calculator	2	0	0	1	25	1	25	0	0	0	0
Haptic Device with Computer Applications	2	1	25	1	25	0	0	0	0	0	0
3-Dimensional Models	2	0	0	0	0	2	50	0	0	0	0
Tactile Graphics	2	0	0	0	0	0	0	2	25	0	0
Tactile and Braille Labeled Science Equipment	2	1	25	1	25	0	0	0	0	0	0