A Proposal: Modification for Instruments and Tools used in the Science Laboratory Setting for Students with Disabilities

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Abstract

The purpose of this action research proposal is to create a Modification of Instruments and Tools in Science (MITS) program to address the need for providing Students With Disabilities (SWDs) appropriate access to scientific tools and techniques of scientific inquiry. This proposal contains a review of literature on SWDs, differentiating instruction to meet individual student need, evaluation and survey tools on levels of student accessibility to tools and technology, and science education requirements. In order to appropriately evaluate students, the author developed a Skills Checklist for MITS in addition to combining an already existing Levels of Accessibility Matrix (LAM) system and Student Learning Survey (SLS) recommendations. The Skills Checklist for MITS and LAM/SLS were constructed from modifications to - and hybrids of – similar Evidence-Based Practice tools used by the Assistive Technology Evaluation Unit in District 75, Plourde and Klemm's (2004) Levels of Accessibility Matrix (LAM) system, Boone and Higgins' (2007) *Software √-List*, and Tzu-Chi, Gwo-Jen, and Jen-Hwa's (2013) recommendation for taking into consideration multiple learning criteria, including learning styles, cognitive styles, and knowledge levels, for developing adaptive learning systems. In addition a logic model for the project was developed (see appendix). This proposal supports research on how to provide SWDs with appropriate access to instructional equipment and tools used in science by providing a method for their modification.

Chapter 1 – Identifying a District Level Problem

Introduction to District 75

In the late 19th century New York City was rife with change. Pouring into the city were huge numbers of immigrants from Southern and Eastern Europe, speaking unfamiliar languages, with their different cultures, values and religious customs. Folts (1996) found that to deal with the change in numbers and types of residents, the New York State legislature turned to public schools for assistance, passing the compulsory attendance law of 1894. Shortly after, in 1898, "The Greater New York City" was created by merging all five boroughs into one city. The new public school system quickly learned that there was a major problem: how to provide education to the child who could not be maintained in the regular class?

What were the schools to do with students who did not appear to be learning? Were disruptive? Did not speak English? Did not want to come to school? And were different than their "typical" children? This was the period and the climate in which special education emerged. Duchan (2011) found that in 1906 there were 14 classes in the department of ungraded classes with Elizabeth Farrel as inspector; by 1921 the number had grown to 250 classes. With approximately 70% of NYC public schools' enrollment being immigrant children, many of these children were overly represented in the newly designated "ungraded classes." About the same time, special classes for "crippled" children were established. These emphasized other requirements for buildings with these classes: equipment, architecture, transportation, and food.

The medical model of viewing individuals with disabilities reached into the public schools and children's education. "In an effort to meet the special education needs of a large group of emotionally disturbed and socially maladjusted pre-adolescent and adolescent boys and girls who were unable to adapt to the large classes and settings of the New York City public schools, the Board of Education of the City of New York established the Bureau for the Education of Socially Maladjusted Children" (Cohen, 1966). Intelligence tests, medical evaluations, and psychological testing became determining factors in placing children in programs for special education. There was a separate bureau for every disability: mental retardation, physically handicapped, vision, hearing, and more. Warshavsky (1961) found that The Bureau of Children with Retarded Mental Development (BCRMD) created classes for students classified as Educable Mentally Retarded (EMR) and classes for students classified as Trainable Mentally Retarded (TMR). The Bureau of the Physically Handicapped (BEPH) created classes for students who where non-ambulatory and/or brain-injured. They were called health conservation classes.

Most special classes for handicapped children were in regular school buildings, even though they were separated from the regular classes. According to Cohen (1966) the first experimental "600" school was founded in May 1946. This was a separate special school established to meet the needs of troubled children and youth who were not amenable to instruction within regular school buildings. By 1959 there were 25 of these "600" schools in the city. However, parental pressure and social responsibility to not stigmatize the children and to include them in the community began to grow. In response to this need to include more children, classes were reorganized and renamed. Mild Educable Mentally Retarded (Mild EMR) became Track I, Educable Mentally Retarded (EMR) became Track II, and Trainable Mentally Retarded (TMR) became Track III (District 75 Disability History Exhibit, 2011). Additionally, Cohen (1966) found in February of 1966 the Board of Education passed a resolution changing the name of the "600" schools to Special Schools for the Socially Maladjusted and Emotionally Disturbed.

According to the District 75 Disability History Exhibit (2011), following the Track system another type of special school was initiated in 1961. The Occupational Training Center (OTC) was created to focus on shops and vocational skills to prepare youth with mental retardation, ages 17-21, for competitive sheltered employment. By 1969 there was an OTC in each borough for youth with mental retardation between the ages of 17 and 21. The success of the OTCs encouraged the development of schools for career development for youth with severe learning handicaps and some behavioral difficulties in the 1970s. Each forward step encouraged the growth of a new program for children who had previously been unserved. As a result, a Track IV program for children with severe and profound mental retardation and centers for the multiply handicapped were created. These programs replaced and absorbed the classes at the AHRC (Association for the Help of Retarded Children) and at the developmental disabilities centers.

Legal and social pressures from parents, advocates, disability rights movements, decentralization, rise of unions, lawsuits, and Public Law 94-142 conspired to shake-up special education amidst claims of denial of free appropriate public education and over-representation of minorities in the programs. The law, PL 94-142, called for placement of students in the "least restrictive environment" (Martin, Martin, & Terman, 1996). The bureau system was abolished as a result. The District 75 Disability History Exhibit (2011) states that a new "division of special education" became the new custodian of all children with handicaps in the New York City public schools in the 1980s. Under the new division of special education the old classifications changed names in an early attempt to reduce the 'stigma' or 'otherness' of children with disabilities. The new names were a curious assortment of acronyms designed to describe an instructional environment rather than classify a student. These "objective" acronyms included MIS (Modified

Instructional Services) in which the majority of children in special education classes were assigned to, and SIE (Specialized Instructional Environments), for more severely handicapped students.

Fleischer and Zames (2001) point out that in 1979 a watershed case was decided in New York. Judge Eugene H. Nickerson decided for a plaintiff, a student, named Jose P. Jose was "a deaf child of a non-English speaking welfare mother…a mostly ignored pupil sitting in the back of a Bronx classroom in 1979" (Fleischer and Zames, 2001) which violated the education for all handicapped children act of 1975. By order dated May 16, 1979, the United States District Court for the Eastern District of New York, Eugene H. Nickerson, Judge, certified the class in Jose P. held that by the defendants' own concession they had "Failed to comply with the statutory requirements," and appointed former Judge Marvin Frankel special master under Fed.R.Civ.P. 53 to work out a remedy. The Jose P court case required the school system to find children with disabilities, provide appropriate technology for communication/access, offer programs for English language learners, create a data tracking system, and create evaluation teams. Still ongoing in the 21st century, Jose P launched programs, schools, initiatives, services, facilities, special personnel, special technology, and partly, a separate district to oversee this complex educational juggernaut (District 75 Disability History Exhibit, 2011).

Citywide programs finally achieved equality of status with the city's other local school districts becoming District 75 in 1991 with an official "Superintendent" position and a growing number of schools and school sites in all five boroughs of New York City. New programs were created to try to meet the mandate of the 'least restrictive environment' and to provide placement in the most 'appropriate' environment. As of 1991, District 75 runs programs for the 13 disabilities identified in the IDEA (Individuals with Disabilities Education Act) previously known as PL 94-142. These include autism, deaf-blindness, deafness, emotional disturbance, hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, speech or language impairment, specific learning disability, traumatic brain injury, and visual impairment or blindness.

Special education in New York City has spanned years, cultures, movements, attitudes, chaining language, standards and expectations. From settlement houses to ungraded classes, bureaus, '600' schools, training centers, tracks, special 'environments', court mandated reorganization and more, Special Education in New York City is marked by change; both incremental and sweeping. In trying to find just the right way to teach, and method to learn, District 75 continues to redefine itself. District 75 became part of the Division of Students with Disabilities and English Language Learners and the city began a new journey to answer the call for increased opportunity for equality, both in school and post school. In 2010, 260 schools were chosen to provide students with disabilities the same access to schools as their non-disabled peers, a pre-cursor to the broad rollout of The Special Education Reform in 2012.

As of 2015, the Division of Students with Disabilities and English Language Learners has been renamed to the Division of Specialized Instruction and Student Support and District 75 consists of 58 school organizations, home and hospital instruction and vision and hearing services. District 75's schools and programs are located at more than 350 sites in the Bronx, Brooklyn, Manhattan, Queens, Staten Island, and Syosset, New York.

District Level Issue Statement

The DOE and District 75 are committed to ensuring that programs, services, and activities are accessible to students with disabilities in compliance with the Americans with Disabilities Act (ADA). Functionally accessible schools and programs are located in fully or partially accessible buildings where an individual with mobility impairment may access all relevant programs and services, including the science laboratory, library, cafeteria, and the gymnasium" (Office of Space Planning, 2015).

The Office of Space Planning (2015) is responsible for physical spaces such as classrooms being accessible to students, but who is responsible for student accessibility to learning tools found within a classroom?

A proposed Modification of Instrumentation and Tools used in Science (MITS) program would create a team of individuals for the specific purpose of modifying tools and equipment used in science laboratories for SWDs across the district. This is in response to many SWDs being limited to a standardized laboratory tool kit without any adaptation or modification as well as "specialists in adaptations looking only at physical accessibility and mobility, not the special needs of the disabled student, which may require adaptations for hands-on science investigations" (Norman, 1998). It can be speculated that this program would be even more effective if it takes into consideration student learning styles and cognitive styles. However, Tzu-Chi, Gwo-Jen, and Jen-Hwa (2013) found that few studies have considered multiple learning criteria, including learning styles, cognitive styles, and knowledge levels, for developing adaptive learning systems. MITS team members would include a mounting specialist, fabrication specialist, content specialist, and OT/PT personnel.

Currently, the D75 Assistive Technology Evaluation Unit (2015) serves to evaluate students within D75 programs for use of assistive technology devices. The Assistive Technology Unit was formed in response to "the 1990 amendments to the IDEA, Congress made schools responsible for ensuring that students with disabilities have access to assistive technology" (Martin, Martin, & Terman, 1996). Professionally trained, trans-disciplinary teams are sent to evaluate students in need of assistive and adaptive technology consisting of augmentative and alternative communication devices, computers, and/or software. Students are evaluated for access to these learning devices and to instructional materials through the use of equipment such as a switch, a joystick, head mouse, and/or adapted keyboard among others. MITS would be an expansion of this evaluation unit specifically for the science laboratory setting.

Collection and Analysis of Existing Data

A report by the Council of the Great City Schools (2008) notes, "New York City's Department of Education (DOE) served a total of 180,890 students with disabilities (SWD) in 2006, the most recent year in which comprehensive data were available. Excluding private preschool children and those placed in private schools by their parents, 14.8 percent of students enrolled by the DOE were identified as needing special education services. Including those students, however, the DOE provides special education services to 11.2 percent of the city's resident population. Some 146,700 of all children (81 percent) are school-aged students enrolled in DOE schools. Another 18,149 of these students—or 10 percent of the total—are enrolled in private preschools. And some 9 percent are enrolled in other DOE preschool programs, charter schools, parochial schools, and private and other nonpublic schools."

Number and Percentage of Students with Disabilities by Service Location

Service Location	Number	Percent	Service Location	Number	Percent
DOE Public Schools (school-aged)	146,681	81.0%	**Private Schools**	1,046	0.6%
DOE Public Schools (preschool)	763	0.4%	**Approved Nonpublic Schools**	7,445	4.1%
Charter Schools	749	0.4%	**Private Preschools**	18,149	10.0%
Parochial Schools	6,057	3.3%			
			Totals	180,890	100%

(Council of the Great City Schools, 2008.)

Of the approximately 181,000 students with disabilities being served directly through the Department of Education, about 79.8 percent are served in community schools, approximately 12.7 percent are served in District 75, and the remaining are served in various nonpublic settings.

"The New York City school system differs in its approach to special education in one significant way, however. Within the Department of Education is a unique structure designed to meet the educational and other needs of city students with the most significant disabilities. That structure—District 75—was created more than 30 years ago as a "special" school district with its own superintendent, who serves alongside 32 other district superintendents. The District 75 operation in many ways resembles a New York Board of Cooperative Educational Services, which was devised to serve multiple school systems having too few students with disabilities for any of the individual systems to serve effectively on their own.

Of the total number of students with disabilities, some 22,000—or about 12.7 percent of all students with disabilities and about 2 percent of the Department's total student enrollment—are served in public schools, at home, or in hospitals through District 75. The total number of students served through District 75 includes approximately 2,000 students in homebound o hospital programs. About 1,890 students or 9.3 percent of those served by District 75 are fully included in general education classes on campuses that are co-located with community schools" (Council of the Great City Schools, 2008).

Table 1. Comparison of Schools and Locations by Borough

Areas of Comparison [27]	Staten Island	Manhattan	Queens	Brooklyn	The Bronx	Total
Number Students	5,899	2,680	5,023	1,460	4,611	19,673[28]
Number of Schools	18	9	13	4	12	56
Average Students/School	328	297	386	365	384	351
Total Physical Locations	87	43	86	31	49	296
Average Locations/School	4.7	4.8	6.6	7.8	4.3	5.3
No. Schools w/ Locations > 200 Students	6	3	3	1	6	19
Range	228-463	233-368	257-338	225	231-555	225-555
No. Schools with Locations < 25 Students	14	8	12	4	8	46
No. Locations < 25 Students	33	17	29	16	13	108
Range	0-5	0-4	0-6	0-9	0-2	0-9

(Council of the Great City Schools, 2008.)

Table 3. Distribution of D75 Students by Grade Cluster and Borough

Grades	Type of Data	Brooklyn	Manhattan	Queens	S I	The Bronx	All
K-2	Number SWDs	875	363	846	250	797	3131
	% of All Grades	14.8	13.5	16.8	17.1	17.3	15.9
3rd-5th	Number SWDs	1238	478	1089	301	1009	4115
	% of All Grades	21.0	17.8	21.7	20.6	21.9	20.9
6th-8th	Number SWDs	1241	421	1039	344	1092	4137
	% of All Grades	21.0	15.7	20.7	23.6	23.7	21.0
HS	Number SWDs	2502	1362	1917	492	1885	8158
	% of All Grades	42.2	50.8	38.2	33.7	40.9	41.5

(Council of the Great City Schools, 2008.)

The vast majority (76 percent) of students with autism are served through District 75, which also serves the majority of the city's students with multiple disabilities (63 percent) and those with mental retardation (56 percent).

Table 5. Number and Percentage of Students by Disability Area and Service Type

Disability Areas	Total SWD	Public - NonD75	Non Public	D75	District 75: % of Disability Area	District 75: % of All D75 Students
Learning Disability	64,423	61,900	1,801	717	1.11	3.56
Speech or Language	45,545	41,490	3,684	370	0.81	1.84
Emotional Disabilities	17,410	8,554	2,183	6635	38.19	32.97
Other Health Impairment	8,972	7,571	925	471	5.25	2.34
Mental Retardation	6,496	2,409	438	3593	55.79	17.85
Hearing Impairment	1,733	1,539	78	110	6.37	0.55
Orthopedic Impairment	1,158	945	209	4	0.35	0.02
Multiple Disabilities	3,710	604	728	2315	63.48	11.50
Autism	6,416	447	1,079	4814	75.93	23.92
Visual Impairment	678	380	173	109	16.47	0.54
Traumatic Brain Injury	271	173	32	47	18.65	0.23
Deafness	583	138	396	42	7.29	0.21
No CAP Data	629			629		
Preschool	269			269		
Total	158,294	126,150	11,726	20,125		
% Total Enrollment		11.54	1.11	1.98		
% SWDs		79.84	7.42	12.74		

(Council of the Great City Schools, 2008.)

The data in Table 5 also indicate that four disability groups comprise 87 percent of the 20,125 students enrolled in school-based District 75 programs: those with emotional disabilities (33 percent), autism (24 percent), mental retardation (18 percent), and multiple disabilities (12 percent).

In addition, the Council of the Great City Schools (2008) has found the number of students served in District 75 has increased over time: 2,008 more students were enrolled in FY 2007 than in FY 2003. This increase appears to be due to an increase of 520 students with mental retardation and 1,431 students with autism.

Survey Instrument

Students will be evaluated to see if a MITS program can help them perform skills that they cannot otherwise do because of either physical/developmental delays or deficits. The MITS team will be responsible for all evaluations for students in District 75 school programs. This evaluation can be initiated at anytime during the school year. Oftentimes, it will be necessary to re-evaluate a student due to changing needs or improved developmental skills. These re-evaluations will be handled directly by the MITS program.

The "survey instrument" that will be used is a highly modified skills checklist based on an assistive technology skills checklist for use of a STATIC DISPLAY AAC Device and DYNAMIC DISPLAY AAC Device that was developed by Gorman (2015) in conjunction with a modified Levels of Accessibility Matrix that was developed by Plourde and Klemm (2004) that takes into account student learning styles will be used by the MITS team:

SKILLS CHECKLIST FOR MODIFICATION of INSTRUMENTS and TOOLS in SCIENCE/LABORATORY SETTING

ACCESS SKILLS:
Direct Selection:
__ Has the functional range of motion to access all components of equipment being considered
__ Can cross midline (visually and physically) across body plane
__ Has the functional strength to depress buttons
__ Has the functional strength to turn knobs of various diameters specific to the equipment being considered (e.g. small fine adjustment knob and large coarse adjustment knob on microscope)
__ Has the functional strength to push, spin, or rotate objects or components specific to the equipment being considered
__ Can isolate a body part (e.g. index finger of right hand) to access a button of a particular dimension (e.g. 1 inch x 1 inch) specific to the equipment being considered

Scanning:
__Has the functional range of motion to access a switch, activated by a specific motion (e.g. lateral flexion) of a body part (e.g. head)
__Can consistently use a body part (e.g. hand) without signs of immediate fatigue

LAM/SLS System

Legend for chart:

A- Impairment
B- Visual input accessibility
C- Tactile (sense of touch) input accessibility
D- Sound (audible) input accessibility
E- Motor abilities

A	B	C	D	E
Hearing Impaired/Deaf				
Visually Impaired/Blind				
Speech/Language Impaired				
Orthopedic Impairment				
Other Disability (Identify) Emotional and Behavioral Disorders				
Student Learning Style (circle most appropriate)	Bodily-Kinesthetic Interpersonal Verbal-Linguistic	Logical-Mathematical Naturalistic Visual-Spatial		Musical Intrapersonal

(0) = Not accessible, even with lab modifications and personal assistance
(1) = Might be accessible with lab modifications and personal assistance
(2) = Accessible with lab modifications and personal assistance
(3) = Accessible with lab modifications
(4) = Accessible without need for lab modifications

Chapter 2: Review of Literature

Terms and Definitions

The Nature of Science (NoS) – In general, the nature of science refers to key principles and ideas which provide a description of science as a way of knowing, as well as characteristics of scientific knowledge. Many of these intrinsic ideas are lost in the everyday aspects of a science classroom, resulting in students learning skewed notions about how science is conducted.

Evidence-Based Practices (EBPs) – EBPs are practices and programs shown by high-quality research to have meaningful effects on student outcomes. The logic behind EBPs is simple: Identifying and using the most generally effective practices will increase consumer (e.g., student) outcomes.

Students with Disabilities (SWDs) – As defined by IDEA, the term "child with a disability" means a child: "with mental retardation, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance, orthopedic impairments, autism, traumatic brain injury, other health impairments, or specific learning disabilities; and who, by reason thereof, needs special education and related services."

The National Science Teachers Association (NSTA) – The largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all. Along with Achieve, the National Research Council, and AAAS, the NSTA served as partner in the development of the Next Generation Science Standards (NGSS).

The Next Generation Science Standards (NGSS) – Establish learning expectations for students that integrate three important dimensions–science and engineering practices, disciplinary core ideas, and crosscutting concepts – which will effectively build science concepts from kindergarten through 12th grade and integrate important engineering concepts.

Levels of Accessibility Matrix (LAM) system – A way to evaluate the sensory and motor/manipulative accessibility of hands on activities. LAM consists of a matrix with sensory inputs arrayed horizontally and types of disability impairments, vertically. A rating scale of 0 (completely inaccessible) to 4 (completely accessible) is a means of characterizing hands-on activities.

Competency-Based Learning – Often used in teaching concrete skills rather than abstract learning, learners work on one competency at a time. The students are then evaluated on the individual competency, and only once they have mastered it do they move on to the others.

Review of Literature

The teaching of science in an educational setting has had a turbulent history due to the very nature of science itself. The difficulty comes not from describing the process, but trying to formulate a universal, agreed upon answer to a very simple question, "what is science?" The Nature of Science (NoS) has been the focus of numerous scholars in a variety of disciplines, including history, philosophy, psychology and sociology. Their work, instead of unifying and drawing nearer a single answer, "has generated an even more contested picture of the nature of scientific activity and one that is characterized by 'multiple, competing, often contradictory, views regarding everything from the most desirable unit of scholarly analysis (the laboratory, extended research program, discipline, etc.) to the basis of scientific knowledge claims" (Jenkins, 2013, p.132-133).

Historically, learning science was viewed as the acquisition of factual knowledge while the focus of education was on building character and moral. Factual knowledge was thus not considered essential for students to learn. Science was charged with "failing to meet the criteria deemed essential for inclusion in an academic school curriculum directed towards the liberal education of a gentleman, an education concerned with the development of character, and thus essentially moral" (Jenkins, 2013, p.134). Luckily, the controversy over whether 'natural philosophy' (acquisition of factual knowledge) had any contribution to make to liberal education had lost most of its heat by the time of the Great Exhibition of 1851. Jenkins (2013) states the debate had moved from 'whether' to 'how' science should be accommodated in school curricula.

Jenkins (2013) found that curricula had to be revised or introduced for the first time in order to give greater prominence to scientific literacy and, thereby, to the NoS. So-called Attainment Targets were introduced in some countries. In England and Wales, these were titled AT1 and AT17. "AT1 was firmly focused on work by students in the laboratory and thus had something in common with earlier laboratory-based initiatives intended to promote an insight into the nature of scientific investigation" (Jenkins 2013, p.143). Today, helping students acquire some understanding of the NoS is a feature of school science curricula across the world, although as Jenkins (2013) points out, it is important to note there are differences of interpretation and curriculum practice throughout.

Scruggs, Brigham, and Mastropieri (2013) found that the current culture of high-stakes, standards-linked tests stemmed from concerns about the performance of American schools relative to images of historical efforts and the performance of students in other countries. The response to this perceived deficiency was a federal initiative to improve education, the No Child Left Behind Act (NCLB). However, "the ESA explicitly forbade the establishment of a national curriculum. Therefore, each state created standards and developed assessments to demonstrate accountability to the standards" (Scruggs, Brigham, & Mastropieri, 2013, p.49).

In 2009, the Common Core State Standards Initiative began due to the fact that a national curriculum could not be imposed in the hopes that states would develop a set of standards across the nation. “By 2010, the common core standards for English and Mathematics had been released. These standards contain recommendations for science literacy that are embedded within the English strand” (Scruggs, Brigham, & Mastropieri, 2013, p.49). Scruggs, Brigham, and Mastropieri (2013) point out that these standards also acknowledge their application to students with disabilities, and state that necessary supports and accommodations should be provided to facilitate access to the curriculum. According to Scruggs, Brigham, and Mastropieri (2013) examples of these supports and accommodations include appropriate supports and related services, an Individualized Education Program aligned with grade level academic standards, and appropriately trained teachers and specialized support personnel to facilitate these supports and accommodations.

One needs only to look into the classrooms of a nation to see a mirror of the nation itself. Tomlinson and Alan (2000) point out that students with very advanced learning skills sit next to students who struggle mightily with one or more school subjects. Children with vast reservoirs of background experience share space with peers whose world is circumscribed by the few blocks of their neighborhood. Tomlinson and Alan (2000) also draw on numerous research articles in their conclusions of how applying ‘differentiated instruction’ can help address the needs of academically diverse learners in our increasingly diverse classrooms. This diverse learner group includes SWDs and English learners as well as those who are homeless, migrant, or have been identified as neglected and delinquent.

“In 1985, Peter Fensham published an article that used the phrase *Science for All* in which he proposed that there as a need to provide opportunities for students of varying interests and abilities to be able to achieve success in science” (Villanueva and Hand, 2011, p.233). Turner (2008) found that during this time the science community underscored an abating public respect and understanding of science and, as a consequence, the popularization and accessibility of science became a major focus of curricula reform. Miller (2004) states that the inclusion of socio-scientific domains, such as the nature of science (NOS) and technology and science (STS), to the traditional content-based curriculum was seen as a way to portray a more holistic picture of science, thereby making the subject interesting and accessible to a greater scope of students.

According to Rutherford and Ahlgren (1990) and Patton and Andre (1989) "science has emerged as a critical subject for the 21st century and is considered one of the most valuable subjects that can be taught to students with disabilities" (as cited in Caseau & Norman, 1998, p.55). How large is this group of students? Melber (2008) puts the estimate of children ages six to seventeen at approximately 12% receiving services through special education programs. Melber (2008) notes that the National Science Education Standards clearly state the importance of "inclusion of those who traditionally have not received encouragement and opportunity to pursue science… [including] students with disabilities." These same standards along with the National Science Teachers Association recognize challenges associated with teaching science to students with disabilities, but assert commitments "to developing strategies to overcome these barriers…ensure that all students have the benefit of a good science education and can achieve scientific literacy" (Melber 2008, p.36).

Scruggs, Brigham, and Mastropieri (2013) found that the Common Core Standards contain three explicit references to students with disabilities:

(1) "Diversity should be made visible in the new standards in ways that might, for example, involve…ensuring that students with particular learning disabilities are not excluded from appropriate science learning." (p.308)

(2) "…it is not clear whether these [learning] theories apply equally well to diverse populations of students, including those who have been poorly served in the science and engineering education system…These kinds of natural variations among individuals need to be better understood through empirical study and incorporated into the cognitive models of learning that serve as a basis for assessment design." (p.318)

(3) "How can assessments be developed that are fair, both for different demographic groups and for students with disabilities? Have examples of these kinds of assessments for the practices, concepts, and core ideas in the framework been developed and implemented?" (p.399)

Teaching students with disabilities has long been a challenge to many educators due to the fact that they require an adapted if not altogether modified curriculum. Ravitch (2000) states that to support these students, children need well-educated teachers who are eclectic in their methods and willing to use different strategies depending on what works best for which children. One such strategy includes providing virtual learning (online learning) for SWDs. "For the K-12 teachers and their respective learners, online learning is packaged into two primary formats: blended or fully online" (Greer, 2014, p.79). Greer (2014) differentiates between blended and online learning; describing blended learning as learning that is at least in part through online delivery with some element of student control over time, place, path, and/or pace and online learning as K-12 education that is content and instruction delivered primarily over the Internet.

Virtual learning environments provide SWDs with defined learning modules until they reach competency while working through new content. "Packaged for the learner to log in and begin, online learning provides the student a personalized and independent learning experience dependent solely on the student and the learning management system" (Greer, 2014, p.81). However, this feature of personalized content in a competency-based instructional module "can often ignore the embedded supports and purposeful instructional interventions that are the cornerstone of special education (e.g., learning strategies)" (Greer, 2014, p.81).

Online courses that are designed for the typical student at a specific grade level offer features relevant to that student at that grade level and not the learner with a cognitive or learning disability. Greer (2014) found that these features might be quite rich in offering visuals to construct and support understanding, audio to assist the nonreader or struggling reader, and embedded supports often needed for the early learner. However, for the student who is a sixth grader with an intellectual disability, the features may not match specific needs and the unique challenges often associated with the disability. Thus, the assumed personalization for the learner is often not unique and/or specific to the needs of the student with a disability but instead is for the first grader for whom it was designed and developed.

Another problem often seen when using virtual learning environments to educate students with high-incidence disabilities in traditional science class is task persistence (on-task behaviors), especially during assessment activities. A possible solution to this common problem is incorporating video games into virtual learning. Marino (2014) found that video games are one kind of online learning environment that can be used to increase the cognitive and social accessibility of science curricular materials by presenting students with engaging scientific assessments in an environment where students believe that they can be successful if they persist. Gresalfi and Barab (2011) add that playing leads to content learning because students make decisions and solve problems while receiving continual feedback from the game, their teachers, and their peers.

The application of video games and their design to teaching and learning can help educators answer the ongoing assessment question, develop students' metacognitive skills and empathy, and break down the boundaries between academic subjects. Rappolt-Schlichtmann, Daley, and Rose (2012) state that universal design for learning is a framework for the design and implementation of instructional materials that meet the needs of all students by proactively circumventing curriculum barriers" (as cited in Marino, 2014, p. 29). "For example, whereas the curriculum may present the information using only one modality (e.g., reading the textbook), a video game can provide multiple means of representation" (Marino, 2014, p. 29). Video games also provide the teacher with multiple entry points to assess if a student has met a standard or not, an example being a student completing a level in the game. However, there are other variables that must be considered when planning on using video games or software in general with students with disabilities.

Boone and Higgins' (2007) found that the psychology of user design and instructional focus of educational software is much more complex than many educators imagine, especially when it comes to SWDs. This is due to development of educational software by companies "without consideration of key educational factors that may affect learning for students with disabilities" (Boone and Higgins, 2007, p.2). Because companies develop software for the 'typical' target audience, this can cause problems for the non-typical learner who encounters the same software later at school. In response to this issue, Boone and Higgins' (2007) developed a *Software √-List*. The *Software √-List* is a tool used for evaluating software for students with disabilities. It takes into consideration "the learning characteristics of students in each of the major disability areas (i.e., learning disabilities, intellectual disabilities, emotional disabilities, and physical disabilities)" (Boone and Higgins, 2007, p.3).

However, not all learning can or should be done virtually. According to the General Program Requirements in Science (2003), all students in a Regents science course must complete the laboratory requirement of 1200 minutes of hands-on (not simulated) laboratory experience. The New York State Education Department (1997) states that students should be actively engaged in laboratory work. While computers, library research papers, and worksheets may be a part of the laboratory experience, they should not comprise the sole experience. Teacher demonstrations, followed by student reports are also not considered to be a hands-on experience.

A finding by Bennington (2004) supports the General Program Requirements in Science (2003), showing that many students find when science is taught in a hands-on, inquiry-based manner, it is a preferred subject area. A similar finding by Scruggs, Brigham, and Mastropieri (2013) found when science learning is mediated through hands-on, small-group activities, experimentation, class discussion, adapted practice activities (such as worksheets and reports) and review, there is little reason not to believe that students with learning disabilities can benefit greatly, in many cases approaching the level of learning of general education students.

Unfortunately, Norman (1998) found that general education classroom teachers across grades made few adaptations for students with disabilities. Reasons teachers give for the lack of modifications and adaptations include “the need for more training in the rationale of mainstreaming, instruction and assessment strategies, classroom management, consultation with other professionals, and ways to facilitate student understanding of individual differences” (Norman 1998, p.56). Even in co-teaching settings, Scruggs, Brigham, and Mastropieri (2013) found that special education co-teachers served mostly in a supporting capacity, and rarely employed specialized instructional strategies to assist students with disabilities. This is despite Melber’s (2008) finding that hands-on activities and personally relevant topics are critical for engaging students with disabilities in science learning as these students depend on these experiences to access content.

Melber (2008) found that creating a hands-on experience is not sufficient in reaching students with disabilities. This experience needs to be further modified for uniqueness and specificity to each student. Plourde and Klemm (2004) developed the Levels of Accessibility Matrix (LAM) system, a way to evaluate the sensory and motor/manipulative accessibility of hands-on science activities for students. Using the 0-4 rating scale on the LAM matrix, a level 4 represents the highest level of accessibility or “accessible without need for lab modification” while a level 0 represents the lowest level of accessibility or “not accessible, even with lab modifications and personal assistance.” Bennington (2004) found when hands-on experiences are structured correctly, these activities can stimulate many skill areas, such as fine motor, coordination, and cognitive development for students with disabilities. Melber (2008) goes on to say that true inquiry-based science is not simply a modification of the traditional curriculum but rather the most authentic way for any student to experience science.

The adaptation of tools and instruments in the science laboratory setting can further be refined and fine-tuned by applying an adaptive learning system approach. Papanikolaou, Grigoriadou, Magoulas and Kornilakis (2002) developed an adaptive learning system by taking students’ knowledge levels as the main factor for adapting the learning content; moreover, Tseng, Su, Hwang, Tsai and Tsai (2008) developed an adaptive learning system based on an object-oriented framework that composes personalized learning content by considering individual’s knowledge level and the difficulty level of the learning objects. These approaches to adaptive learning systems can be mirrored when creating modified instruments and tools for students with disabilities based their personal characteristics. Coffield, Moseley, Hall and

Ecclestone (2004) further suggested that teachers and course designers pay attention to students' learning styles and design teaching and learning interventions accordingly.

When designing effective evidence-based programs that not only identify but are based on effective practices in education, Cook and Odom (2013) say that supporting research for evidence-based practices (EBPs) must meet prescribed, rigorous standards. "Typical guidelines require that for a practice to be considered evidence-based it must be supported by multiple, high-quality, experimental or quasi-experimental (often including single-case research) studies demonstrating that the practice has a meaningful impact on consumer (e.g., student) outcomes" (Cook and Odom, 2013, p.136).

Review of Literature Matrix

Author	*Year*	*Impact on Academics*	*Impact on Accessibility*	*Characteristics of Designing a Program*	*Barriers to Program Implementation*
Assistive Technology. *	(2015).		*X*		
Bennington, A.	(2004).	*X*	*X*		
Boon Boone, R., & Higgins, K.	(2007).		*X*		
Chia-Yu, W., Hsin-Kai, W., Wen-Yu Lee, S., Fu-Kwun, H., Hsin-Yi, C., Ying-Tien, W., & ... Chin-Chung, T.	(2014).	*X*		*X*	
Coffield, F., Moseley, D., Hall, E., & Ecclestone, K.	(2004).	*X*	*X*		
Cohen, R. S.	(1966).	*X*	*X*	*X*	
Cook, B. G., & Odom, S. L.	(2013).	*X*		*X*	*X*
Council of the Great City	(2008).	*X*	*X*		*X*

Schools.					
District 75 Disability History Exhibit.	(2011).	*X*			
Duchan, J.	(2011).	*X*			
Fleischer, D., & Zames, F.	(2001).		*X*		
Folts, J.	(1996).	*X*		*X*	
General Program Requirements in Science.	(2003).	*X*			
Gorman, K.	(2015).		*X*		
Greer, D., Rowland, A. L., & Smith, S. J.	(2014).		*X*		
Gresalfi, M., & Barab, S.	(2011).		*X*		
Jenkins, E. W.	(2013).	*X*			
Marino, M. T., Becht, K., Vasquez, E., Gallup, J. L., Basham, J. D., & Gallegos, B.	(2014).		*X*	*X*	*X*
Martin, E. W., Martin, R., & Terman, D. L.	(1996).	*X*	*X*		
Melber, L. M., & Brown, K. D.	(2008).		*X*		
Miller, R.	(2004).	*X*			
Norman, K., Caseau, D., & Stefanich, G.	(1998).		*X*	*X*	*X*
NYS Education Department - Mathematics, Science and Technology Resource Guide - Draft for Review & Comment.	(1997)			*X*	
Office of Space Planning.	(2015).		*X*		*X*
Papanikolaou, K. A., Grigoriadou, M., Magoulas, G.	(2002).		*X*		

D., & Kornilakis, H.					
Plourde, L. A., & Klemm, E. B.	(2004).		*X*		
Preiser, W.	(2001).		*X*		
Ravitch, D.	(2000).	*X*			*X*
Scruggs, T. E., Brigham, F. J., & Mastropieri, M. A.	(2013).	*X*	*X*	*X*	
Spaulding, D., & Falco, J.	(2013).	*X*		*X*	
Tomlinson, C., & Allan, S.	(2000).	*X*	*X*	*X*	
Tseng, S. S., Su, J. M.,Hwang, G. J., Hwang, G. H., Tsai, C. C., & Tsai, C. J.	(2008).	*X*	*X*	*X*	
Turner, S.	(2008).	*X*			*X*
Tzu-Chi, Y., Gwo-Jen, H., & Jen-Hwa Yang, S.	(2013).	*X*	*X*	*X*	
Villanueva, M. G., & Hand, B.	(2011).	*X*	*X*	*X*	
Warshavsky, B.	(1961).		*X*	*X*	

Chapter 3: Action Research Plan

Description of Program or Intervention

The Modification of Instruments and Tools in Science (MITS) program is designed to address the need for providing SWDs with appropriate access to scientific tools and techniques of scientific inquiry. This begins by first evaluating students using a Skills Checklist for MITS and LAM/SLS System upon recommendation from their primary classroom teacher. These evaluation tools were constructed from modifications to - and hybrids of – similar Evidence-Based Practice tools used by the Assistive Technology Evaluation Unit in District 75, Plourde and Klemm's (2004) Levels of Accessibility Matrix (LAM) system, Boone and Higgins' (2007) *Software √-List*, and Tzu-Chi, Gwo-Jen, and Jen-Hwa's (2013) recommendation for taking into consideration multiple learning criteria, including learning styles, cognitive styles, and knowledge levels, for developing adaptive learning systems.

Your Role as a School Leader and the Action Research Team

The Modification of Instruments and Tools in Science (MITS) team is composed of a number of individuals with a specific professional knowledge base. These members include a content specialist, a mounting specialist, a fabrication specialist, and OT/PT personnel. This reflects a finding by Spaulding and Falco (2013), which states most effect action research teams have five to seven members.

The content specialist can be a district-level departmental director, district-level science coach, a school-based science coach, or the lead science teacher in a school. Generally, a teacher who does not hold a professional certificate/advanced degree in science or STEM education or lacks a minimum working experience requirement (2 years) would not be considered a content specialist. The duties of a content specialist can include conferencing with educational committees, focus groups, or other groups, along with developing measurements for the effectiveness of educational content. The content specialist should have first-hand knowledge of educational tools and equipment used in the science classroom and laboratory setting. It is also strongly recommended that the content specialist be up-to-date (attending related professional development, workshops, continuing education experiences, etc.) with current research, safety procedures and science curriculum standards being used in that particular school or district and relay that information to other team members periodically.

The fabrication specialist and the mounting specialist work closely together to design, build, and attach the requested modifications. These roles are usually held by a Shop / Career and Technical Education (CTE) teacher. These professionals "typically have several years of work experience in the occupation that they are certified to teach. This extensive experience allows them to teach their trade specific area and incorporate the latest techniques and skills in their instructional lessons" (CTE, 2015).

Occupational therapists (OT) help students learn skills and participate in activities for successful, independent living. For SWDs, OT focuses on developing specific life skills through specific exercises and task-related activities. Physical therapists (PT) help students who face physical challenges, long-term disabilities or injuries. For SWDs, PT focuses on improving motor skills, balance, coordination, strength, and endurance. "Physical Therapy also promotes function by adapting the environment, providing and maintaining seating, positioning, assistive technology and mobility equipment and by monitoring and managing orthoses and prostheses" (Related Services, 2015). PT and OT personnel work together to create a program that addresses each student's unique needs.

Logic Model

Inputs

The inputs for this project include equipment such as small and large machinery and a budget for its maintenance, various hand tools and fabrication supplies, and consumable items to ensure for the proper care and longevity of them. A professional development (training) budget is also included; attendance at conferences, seminars and/or workshops as well as through informal contexts such as discussions and observations. The purpose of this type of professional development is to enable educators to develop the knowledge and skills participants need to address students' learning challenges. Travel expenses are also necessary to cover the costs of MITS team members as they visit schools throughout the district to support student need.

Program and Activities

Programs and activities include the training of teachers in identifying students in need of a modification of a tool they would use as part of the instructional day in the science laboratory / STEM classroom setting. In addition, training would also be provided to MITS team members on a continuing basis to keep them up to date with changes in subject content and new instructional methods, advances in technology, changed laws and procedures, and student learning needs.

A second round of programs and activities is necessary in order to train teachers in using modified or adapted equipment. This also consists of training students to use the modified tools and identify areas where further improvement or adjustment is necessary via student feedback.

Anticipated Outputs of Activities

Anticipated outputs of activities are an increase in student accessibility to instructional tools in the science laboratory classroom setting and thus in empirical knowledge. The direct result of this is an increase in procedural knowledge and kinesthetic learning.

Anticipated Short-Term Outcomes

Short-term outcomes include the selection and implementation of a pilot MITS program in a few schools within a district. This serve as a small-scale preliminary initiative to improve the program design prior to performance of a full-scale roll out.

Anticipated Medium Term Outcomes

It is expected that over time, all schools will have access to MITS and all SWDs will be able to access the same kinds of scientific tools that are available to the typical student. This will lead to an increase in student engagement; enabling students to satisfy basic human needs of success (need for mastery), curiosity (need for understanding), originality (need for self-expression), and relationships (need for involvement with others). An additional outcome is the creation of a categorized library of resources (photography, videos, blueprints, etc.) based on the modifications that have been created and their results for others to use.

Anticipated Long Term Outcomes

This ongoing program ultimately expects to show increases in student time on task, increases in student overall attendance, and an increase in formative and summative assessment scores.

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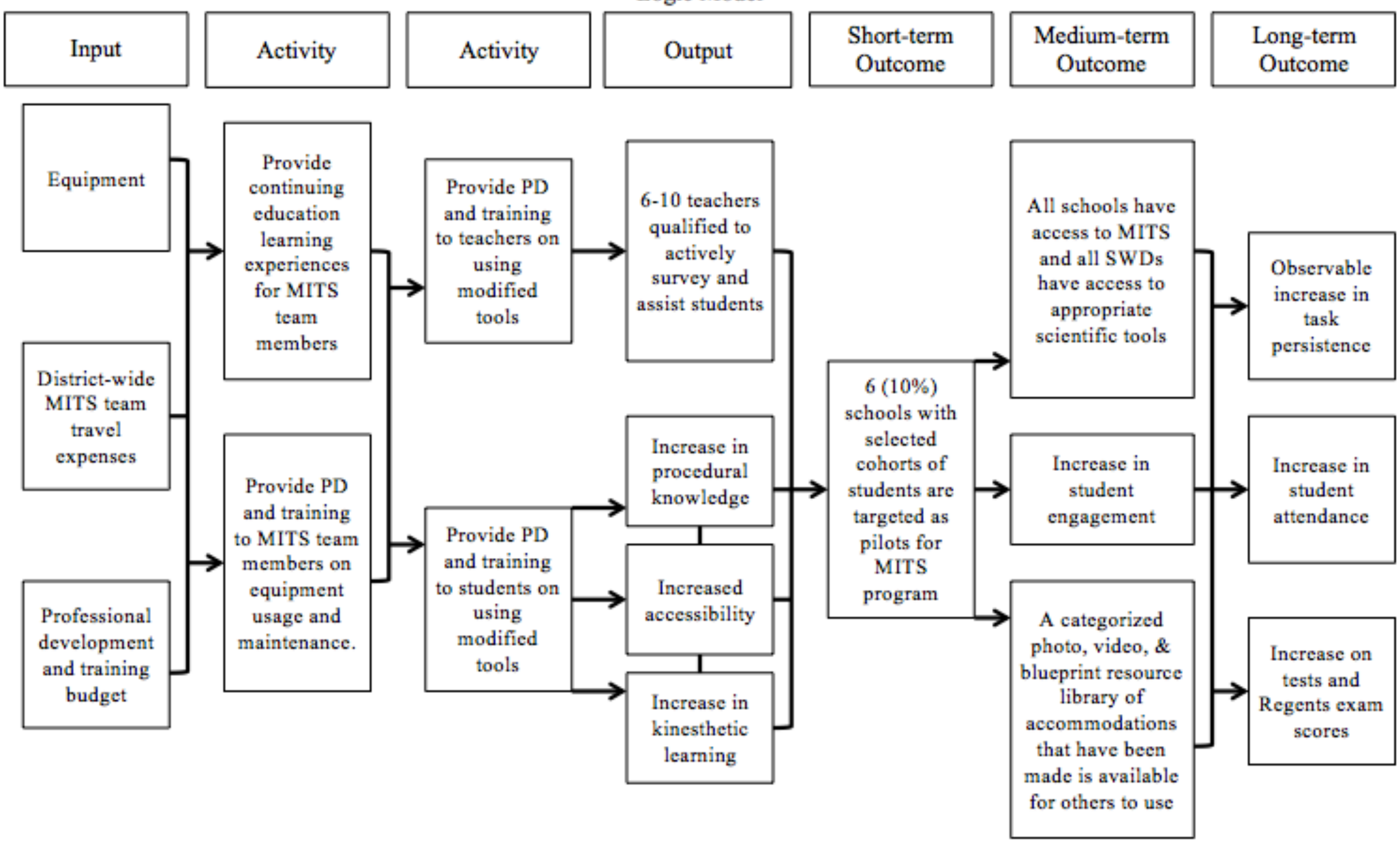
Appendix

Logic Model


Input
Activity
Activity
Output
Short-term Outcome
Medium-term Outcome
Long-term Outcome
Equipment
District-wide MITS team travel expenses
Professional development and training budget
Provide continuing education learning experiences for MITS team members
Provide PD and training to MITS team members on equipment usage and maintenance.
Provide PD and training to teachers on using modified tools
Provide PD and training to students on using modified tools
6-10 teachers qualified to actively survey and assist students
Increase in procedural knowledge
Increased accessibility
Increase in kinesthetic learning
6 (10%) schools with selected cohorts of students are targeted as pilots for MITS program
All schools have access to MITS and all SWDs have access to appropriate scientific tools
Increase in student engagement
A categorized photo, video, & blueprint resource library of accommodations that have been made is available for others to use
Observable increase in task persistence
Increase in student attendance
Increase on tests and Regents exam scores