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Testing the Water: Reflections from a STEM Camp Designed for Learners with Disabilities

Demetria. L. Ennis-Cole
University of North Texas
United States of America

Linda Holloway, Ph.D, CRC
Professor Emerita
Rehabilitation Counseling
University of North Texas
United States of America

Nandika D'Souza
University of North Texas
United States of America

Lucy Gafford
University of North Texas
United States of America

Abstract

Science, Technology, Engineering, and Mathematics (STEM) are very important for the economic growth, stability, and health of the United States. In order to enter STEM fields, students need early and sustained exposure to STEM through camps and formal learning activities which increase their knowledge and interest. Reflections from a pilot project designed to introduce learners with disabilities to STEM are shared.[1] Perspectives from a variety of stakeholders are presented.

Keywords: STEM, disabilities, camp, vocational rehabilitation, informal learning

Introduction

According to the U.S. Bureau of Labor Statistics, STEM occupations had above average growth, 93 out of 100 STEM occupations had wages above the national average, and the mathematical science occupations group is expected to grow the fastest from 2014 – 2024 (Fayer, Lacey & Watson, 2015; Vilorio, 2014). Additionally, computer-related jobs (software developers of applications and systems, computer systems analysts, computer user support specialists, civil engineers, computer programmers, network and computer systems administrators, web developers and others) will result in half a million new employment opportunities (Fayer, et al., 2015). This is remarkable, but there are barriers which prevent people with disabilities from participating: lack of acceptance by peers, lack of instruction, and insufficient access to laboratories and instruments (Sills, 2019).

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Individuals with disabilities (cognitive, developmental, intellectual, mental, physical, sensory, or a combination of these) are often underrepresented in STEM fields. Several things contribute to this situation: limited exposure to prerequisite courses, limited individual support and self-advocacy for accommodations, few role models, a lack of understanding on the part of prospective employers and teachers, a lack of general knowledge about the disability and its impact, and negative societal attitudes and perceptions (Alston, Bell, & Hampton, 2002; Dunn, Rabren, Taylor & Dotson, 2012; Sills, 2019). Federal Legislation mandates the education of individuals with disabilities, but the needs and issues of individuals with disabilities are not being adequately met, and they continue to be underrepresented in STEM (Alston, et al. 2002; Booksh & Madsen, 2018). Individuals with disabilities left the workforce at five times the average rate, and their employment outcomes have not improved since 1990 (Booksh & Madsen 2018).

These results are disparaging. The project described in this article exposed students with disabilities to STEM occupations and activities, and it put students in direct contact with scientists and engineers to increase their access to professionals working in STEM. Following the literature review and theoretical foundation, findings and reflections are shared to create dialogue and inspire others to create similar opportunities for learners with disabilities.

Literature Review

The search terms "Science, Technology, Engineering, & Math (STEM)" & Disabilities were used to locate relevant literature. The search was limited to a five year window (2015 – 2020), and results came from peer reviewed journal articles that focused on adults with disabilities. The following databases in Academic Search Complete | EBSCOhost were used: APA PsycArticles, APA Psycinfo, Computer Source, Education Source, Educational Administration Abstracts, ERIC, Information Science and Technology Abstracts, and Science and Technology Collection. Results returned 141 refereed journal articles. Those were reviewed, and several types of disability categories appeared: Visual Impairment, Learning Differences, Autism Spectrum Disorder, and Deaf & Hard of Hearing. The articles covered a variety of topics: STEM Education & Career Development, Inclusive Practices, STEM Mentoring and Coaching, Design Elements for Online STEM Education, and Postsecondary STEM Learning Environments. There are many topics in the literature, but the most relevant are discussed in the next paragraphs: increasing diversity in STEM through mentoring, encouraging an interest in STEM, preparing faculty to develop inclusive educational opportunities in STEM, the performance of students with disabilities in STEM, and the underrepresentation of students with disabilities in STEM.. These topics provide the context for the STEM Camp described in this article.

Increasing Diversity in STEM through Mentoring. Learners with disabilities are not well represented in STEM (Camp, 2012; Dunn, Shannon, McCullough, Jenda, Qazi, 2018; Gottfried, Bozick, Rose & Moore, 2014); their perspectives are needed to foster innovation and raise the quality of technology embedded in products and services. Many individuals with disabilities perceive the STEM climate as unwelcoming because they experience limited or inconsistent institutional support or issues surface related to their accommodations (Bettencourt, Kimball, Wells, 2018). Often, students at the postsecondary level with disabilities are reluctant to disclose their disability and advocate for themselves; they may only disclose their disability when they experience an academic crisis. Many STEM Occupations require a bachelor's degree, and students with disabilities fall behind their non-disabled peers in the completion of postsecondary degrees. This is unfortunate, because jobs in STEM have a strong employment outlook, and they allow workers to earn decent salaries and enjoy satisfying work experiences (Camp, 2012, Dunn, Shannon, McCullough, Jenda, Qazi, 2018 Yilmaz, Ren, Custer & Coleman, 2010). Ways to increase the participation of students with disabilities in STEM include peer-mentoring (bringing students together across STEM fields and recruiting individuals with disabilities in significant and supportive roles), coaching, and supportive services and programs which individualize support, create a culture of success, increase self-confidence and motivation, and teach needed skills (Bellman, Burgstahler, & Hinke, 2015; Bellman, Burgsthler, & Chudler, 2018; Dunn, Shannon, McCullough, Jenda, Qazi, 2018; Golding, Arreola, Fernandez-Pena, Pitcher, Brozina, Geller, Favela, Stearns, 2018).

Increasing the number of individuals with disabilities in STEM fields will positively impact our nation's global economy, our national security, and our technical competitiveness (Love, Kreiser, Camargo, Grubbs, Kim, Burge & Culver, 2015; White & Massiha, 2015; Yilmaz et al., 2010). Diverse groups bring an assorted set of skills and experiences to their design and development tasks.

There is typically more functionality and there are more features in products created by diverse groups simply because of the varied opinions and experiences they bring to product design and development.

Encouraging an Interest in STEM. There are several ways to encourage students with disabilities to pursue careers in STEM. It is necessary to introduce STEM occupations and concepts at an early age through play, experimentation, and interactive learning projects with peers. Other strategies involve career planning at the primary and secondary levels, having students with disabilities take prerequisite and then advanced courses in STEM, and providing outreach opportunities to bring students to college campuses through summer programs, after school workshops, and field trip experiences. Using technology to explore computer-related fields and employment options, and working on projects with researchers at the collegiate level are also approaches to help students with disabilities become interested in STEM. Investments in extracurricular activities that support collaboration (First Robotics, Computer Science STEM Network, Google Science Fair, Microsoft Imagine Cup, Regeneron Science Talent Search, First Lego League, etc.) are also ways to increase interest in STEM. Additionally, applied STEM coursework may help students with disabilities become interested in STEM because of its “real-world” focus and problem-solving emphasis (Gottfried, et al., 2016).

Preparing faculty to develop inclusive educational opportunities in STEM Courses. Creating positive and inspiring learning opportunities that focus on STEM and create an inclusive culture for students with disabilities requires teacher training, support, and resources. Lucietto, Russell, & Schott (2018) conducted a study to determine how much education or training STEM educators possessed as well as their understanding of the best way to teach students. The authors utilized a three-part survey to gather information on demographics, beliefs about teaching, and thoughts about students in STEM. The authors received 201 responses from survey participants - about 159 participants completed the entire survey. The results indicated that the instructor’s confidence teaching STEM subjects relied on his or her level of knowledge and his or her ability to convey concepts to students using active and hands-on techniques. The STEM Educators focused specifically on supporting interactive communication and sharing their knowledge. The results revealed that some instructors had formal training in teaching pedagogy, some attended a few courses, workshops or seminars to prepare them for teaching, and some had no formal training. Overall, the educators believed they had little to no formal training in education. The duration of formal training was described as eight hours to 23 years, and it was interpreted several different ways - having earned a formal degree or a having attended a few courses or workshops.

Teacher preparation can contribute to the success or failure of a student with a disability in a STEM field. Bettencourt, et al., (2018) collected data from four focus groups across 17 STEM majors to determine what STEM Faculty think about students with disabilities and how they respond to these students. They found well intentioned faculty members who lacked the training and experience needed to support students with disabilities in postsecondary STEM environments. The faculty used on-the-job training, trial-and-error, and their own past experiences to support students with disabilities. Many teachers in STEM report that they are ill-prepared to make the instructional adaptations to meet the needs of students with disabilities (Montgomery & Mirenda, 2014; Stefanich, 2007). Kahn & Lewis (2014) found gaps in science teachers’ education. They also found institutional and attitudinal barriers that limit the success of students with disabilities in science. About 1,088 K-12 Science Teachers were surveyed and asked whether or not they received training to teach students in specific disability categories; overall 91% (995) of the respondents felt they were more prepared to teach students with Learning Disabilities and Other Health Impairments (ADD/ADHD). The science teachers felt least prepared to teach students with Intellectual Disabilities/Mental Retardation, Motor/Orthopedic Impairments, Visual Impairments, Hearing Impairments, Autism Spectrum Disorder, and Speech and Language Impairments. When asked where they received training on specific topics like modifying lessons for students with disabilities, a large number of responses fell into the following categories: professional development from their school district, graduate school, and on-the-job training. When asked about resources for teaching students with disabilities science, a large number of responses fell into the following categories: on-the-job training, I do not know or remember, and graduate school.

Performance of Students with Disabilities in STEM. Williams, Ernst, & Kaui (2015) explain that the increasing national focus on science, technology, engineering, and mathematics should improve the performance of students with disabilities. Unfortunately, students with disabilities tend to struggle with STEM Content (Basham, Israel, Maynard, 2010); they perform lower on assessment measures than their peers without disabilities in math and science (Fisher, 2017; Hwang & Taylor, 2016; Williams, Ernst, & Kaui, 2015), and they become disengaged from STEM as early as middle school. Basham, et al., (2010) indicate that students with disabilities need proactive and flexible instructional support and well prepared teachers in order to be successful in STEM. The authors list the following strategies for supporting students with disabilities: explicit vocabulary instruction, technology support, content area reading strategies, text adaptations, and anchored instruction. Basham, et al., (2010) reported that these strategies met the instructional needs of students with disabilities and resulted in their success; they passed district science exams at the same rate as their non-disabled peers. Plasman & Gottfried (2018) found that students with learning disabilities who took applied STEM courses increased their math test scores and increased their enrollment in postsecondary education.

Williams, Ernst, & Kaui (2015) report that students with Limited English Proficiency (LEP) (21% of public school students) score lower on national assessments of educational progress in science. LEP students and those with disabilities are special populations that qualify for services in public schools through the age of 21 under the Individuals with Disabilities Education Act of 2004.

Students with LEP as well as those with disabilities receive individualized education plans and accommodations to promote their success and matriculation post high school. However, instead of these supports increasing the numbers of students with disabilities and LEP successfully exiting high school, many students with disabilities and LEP do not graduate. According to Williams, et al. (2015), two thirds of students with disabilities do not complete high school. These students will need a GED and/or placement testing, and enrollment in remedial courses in order to successfully enter community college or university courses. Using the Second Staffing Survey by the National Center for Educational Statistics, Williams, et al., (2015) examined data from 2011-2012 to determine the mean service load of STEM Educators working with students with disabilities and LEP. An attempt was made to determine whether or not there was a statistically significant difference between technology, science, and mathematics education teachers' mean service capacity.

Findings indicated that teachers in technology education served a higher number of students with disabilities and LEP than educators in science and mathematics. These differences were statistically significant. Technology instructors had more students-at-risk compared to science education teachers and mathematics education teachers. Students with learning disabilities were placed in non-core (science and mathematics) courses like technology and communication. This situation is a double-edged sword. It can be advantageous, because it may allow students with disabilities and those with LEP to become more technologically literate and learn about a wide range of technologies that can be applied across disciplines. Learning to use technology can allow students to increase their personal productivity and enhance their job-related skills. On the other hand, students with limited exposure and knowledge of science and mathematics will not have the foundation needed to facilitate their success in science, engineering, or math.

Underrepresentation of Students with Disabilities in STEM. Without the necessary foundation, individuals with disabilities will have a difficult time accessing lucrative STEM Careers. Their lack of representation in STEM occurs for many reasons: lack of access to individualized support, lower expectations due to their disability, a lack of prerequisite knowledge, and few role models (Dunn, et al., 2012; Love, et al., 2015). STEM is extremely important, and it impacts many industries. The Bureau of Labor Statistics projects an increase in STEM Occupations, but limited educational preparation, limited encouragement for pursuing STEM Education, inappropriate counseling and guidance, barriers preventing physical access to labs and facilities, lack of participation in math and science courses, limited teacher knowledge relative to accommodations and the inclusion of students with disabilities, and limited access to individualized support are barriers for individuals with disabilities. The next sections discuss the theoretical foundation, methodology and the reflections from the summer camp.

Theoretical Foundation

The design and implementation of the STEM Camp was situated within Constructivism, which is a student-centered approach to learning that has historical roots in the work of Dewey, Vygotsky, Piaget, and others (Bada, 2015). Piaget was a proponent of Cognitive Constructivism where learners build their personal knowledge and representations of the world by discovering, revising, and transforming the information with which they come in contact. Piaget described the cognitive structures that contain student knowledge as schema; they consist of connections, relationships, experiences, etc. According to Talja, Tuominen, & Savolainen (2005), knowledge is produced by creating mental models that are represented by scripts, knowledge structures, and schema.

Piaget also explained assimilation and accommodation in student learning. Students assimilate and accommodate based on the knowledge they have. Learners assimilate similar and congruent ideas, and they adapt their existing schema (accommodation) to reconcile conflicts between new and existing knowledge. In a learning environment that supports Constructivism, students construct new ideas based on their current and previous knowledge; they experiment, practice, compare, form new understanding, and reflect on their learning. Students are active and reactive participants in their learning process, and they collaborate with their peers to pursue meaningful activities that provide them with authentic problems that are relevant and based on real-world experiences. Teachers in a Constructivist Learning Environment take the roles of facilitator, coach, guide, and mediator. They become counselors or consultants who help the learner think through processes, negotiate social structures during collaboration, and reduce barriers to learning by providing visual, auditory, and tactile experiences that provide individual representations of the content material.

In the STEM Camp, participants experienced a Constructivist Learning Environment that supported collaboration in small groups and allowed students to formulate and refine their knowledge of STEM through the engineering curriculum, experiences with peers, camp counselors, and professionals in STEM Disciplines. Students had the opportunity to focus on high level concepts and engage in authentic, real-world activities that scientists, technologists, engineers, and mathematicians experience: creating physical structures, programming rovers and calculators, calculating angles, observing chemical reactions, and others. Students were active participants in the learning environment. They used a variety of manipulatives and shared their written reflections of the activities they most and least preferred each day. They also participated in field trip experiences where they explored labs, viewed equipment, talked with lab attendees, and met undergraduate students who were majoring in STEM.

Research Questions

STEM is very important for our country's economic growth and development. Jobs in computer-related fields and engineering are on the rise, but the U.S. has a shortage of students pursuing degrees in these areas. From the literature reviewed, it is very important to engage students in extracurricular STEM activities and experiences at an early age, and continue to foster these experiences as children matriculate through primary and secondary grades. This is even more important for young adults with disabilities, who often find themselves unable to enter the STEM pipeline due to a lack of science and math courses, institutional and attitudinal barriers, lack of counseling and guidance, few role models, and limited physical access to laboratories and professional experiences in STEM. One way to provide access is through STEM Camps that are designed for learners with disabilities. The following questions guided this descriptive study:

1.) What are campers' preferred activities during the STEM Camp?
2.) How interested are campers' in STEM (as measured by the Stem Semantics Survey)?
3.) What are the student counselor attitudes of the STEM Camp?
4.) What are the planners' attitudes of the STEM Camp?
5.) What are the Vocational Rehabilitation Counselors' opinions of the STEM Camp?

Methodology

The STEM Camp was the first of its kind for students with disabilities, and as a pilot project, camp organizers felt the need to collect data on students' interest in STEM and STEM Careers in order to inform future iterations of the camp and create additional research opportunities. The research design, participants, structure of the camp, adaptations and modifications, and instruments are explained below.

Research Design

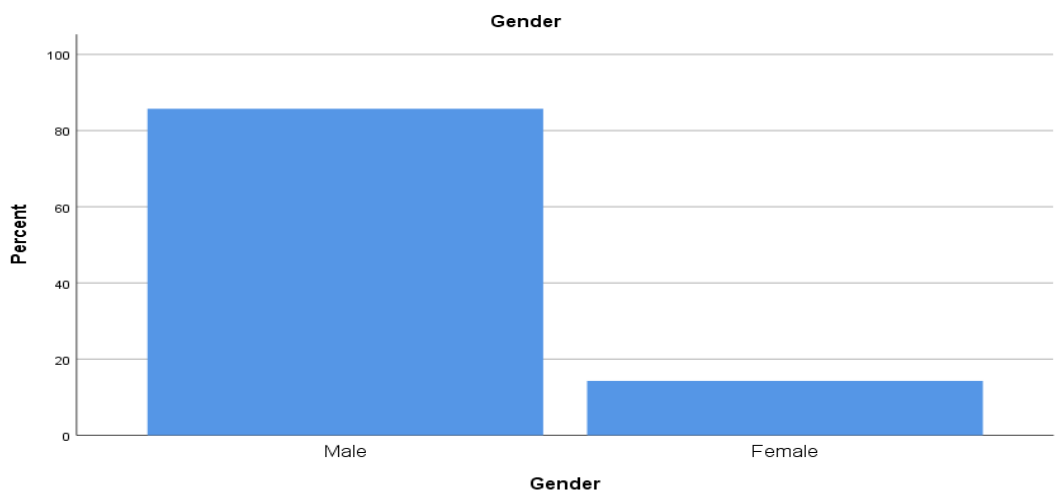
A quantitative research design was selected for this project. The descriptive research paradigm was selected to systematically collect information about the campers and observe them as they participated in camp activities. This method was useful, because it allowed researchers identify characteristics of students with disabilities attending the camp, and it set the stage for further research to determine causal links, make predictions, and generate hypotheses. It was not feasible to randomly assign participants to a treatment or control group due to a small sample size, short duration of the camp (one week), and a desire to expose all participants to the STEM Curriculum developed by the Engineers on the project. Approval to conduct this study was granted by the university's Institutional Review Board; participants and their parents provided informed consent, and all applicable safeguards and policies were followed by the researchers involved in this study to protect the confidentiality and privacy of participants' data.

Participants

A small number of participants (N=21) attended the STEM Camp, and they were between the ages of 14 and 21. They had career plans through the Texas Workforce Commission, and their Vocational Rehabilitation Counselor referred them and approved the funds for enrollment. Women with disabilities were underrepresented in the STEM Camp. See Figure 1 for the percentage of male and female attendees.

Figure 1

Gender Representation in the STEM Camp



The gender gap in STEM is present in learners with disabilities, and it is being addressed by special programs and activities that are designed for females. At the national level, the National Center for Science and Engineering Statistics (NCSES) publishes *Women, Minorities, and Persons with Disabilities in Science and Engineering* every two years to provide statistical data on the numbers women, minorities, and persons with disabilities in science and engineering fields. A 2019 version of the report can be found at the following URL: https://ncses.nsf.gov/pubs/nsf19304/. Young women with disabilities need to be encouraged to participate in extracurricular, formal, and informal STEM learning opportunities to help them develop an interest in STEM.

Ten campers failed to disclose their disability; the eleven who shared that information revealed a variety of disabilities: Autism Spectrum Disorder (ASD), ASD and other co-morbid conditions, Visual Impairments, Amplified Pain Syndrome, Auditory Processing and Sensory Processing, Depression, OCD, Anxiety, and Autoimmune Conditions. See Table 1 below. All graphs and statistical tables were created in IBM SPSS Statistics 25.

Table 1

Disabilities Disclosed by Camp Attendees

Disability	Frequency	Valid Percent	Cumulative Percent
Undisclosed to Researchers	10	47.6	47.6
Autism Spectrum Disorder (ASD)	2	9.5	57.1
ASD & Comorbid Conditions	3	14.3	71.4
Auditory & Sensory Processing	1	4.8	76.2
Visual Impairment	2	9.5	85.7
Depression, OCD & Anxiety	1	4.8	90.5
Autoimmune Condition	1	4.8	95.2
Immune Related Disorder	1	4.8	100.0
Total	21	100.0	

Structure of the Camp

The camp was held for five days. Students attended from 9:00am until 4:00pm. Each day began with an introduction to the topic and ended with an evaluation and wrap-up. There were three 30 minute morning activities, a break, a longer activity, and lunch. The lunch period was one hour, and it was followed by two longer sessions (about 1 hour), a break, and the wrap-up. Most of the topics and activities (tours of laboratory spaces, hands-on building projects, programming, videos, mixing chemicals, and associated safety or prerequisite knowledge) were selected and arranged by the Engineering Department, and the majority of the instruction for the activities was delivered by Professors and Graduate Students in the Department of Engineering.

Adaptations & Modifications

The physical spaces were toured before the camp began to make sure there was adequate space for participants who might be in wheelchairs, those who might require preferential seating, or need adjustments to volume of lighting. Campers had a consistent daily schedule with breaks, and they could request additional breaks as needed from the student counselors who were present from 9:00am – 4:00pm each day. The student counselors provided one-on-one assistance by reiterating steps, gathering material, checking for understanding, and guiding the group through scheduled events. Evaluations were short, repetition was provided for instructions, and learners had the opportunity to support each other by working together. The curriculum involved hands-on activities, and steps and procedures were shortened and made available to students.

Instruments

Participants were observed, and they were asked to supply **written feedback** on their preferred and least-preferred activities. At the end of each day, campers were given time to think about the day's activities and write on a sticky note the activities they most preferred and those they least preferred. The notes had a visual and a word to remind participants of the task.

Campers completed an instrument to determine their interest in STEM. The **STEM Semantics Survey** provided information on students' attitudes toward STEM fields and a career in STEM. The STEM Semantics Survey was created by Knezek & Christensen; they modified it from their Teacher's Attitudes Toward Information Technology Questionnaire, which was created from the Semantic Differential research of Zaichkowsky (Christensen, Knezek & Tyler-Wood, 2014). The STEM Semantics Survey was selected because of its high internal reliability with other test groups. The Cronbach's Alpha ranged from .84 to .93 (Christensen, Knezek & Tyler-Wood, 2014; Tyler-Wood, Knezek, Christensen, 2010); these scores are considered "good" to "excellent" (DeVellis, 1991). Additionally, the instrument has good content, construct, and criterion-related validity. The instrument is a one page assessment that has five sections: science, technology, engineering, math, and a career in these areas. The user responds to five items within each section.

Students attending the camp benefitted from having five student counselors attend the camp with them. The counselors were students in Rehabilitation Counseling or Rehabilitation Studies who had prior experience working with students with disabilities. The counselors attended all activities during each day of the camp and provided assistance with schedule changes, directions, and student support. The **counselors completed a survey** created using a protocol based on the literature, and they were asked to rate the camp and comment on the campers' level of engagement, activities, their training, the overall camp experience, and the things that worked well and those that did not work. Their input is valuable, because they observed all aspects of the camp and worked directly with the campers all day each day of the camp.

The final forms of assessment, the **debriefing meeting** with camp planners and the **written feedback from the Vocational Rehabilitation Counselor** were an opportunity to collect attitudes about the camp from the lens of the camp organizers and referring counselors. This information provides the administrative, recruiting, and planning point of view.

Findings

The assessments provided valuable information for the design of subsequent STEM Camps for learners with disabilities. The next paragraphs cover preferred and least-preferred activities, campers' interest in STEM, student counselor feedback, notes from meetings with camp organizers, and opinions of the camp from the referring Vocational Rehabilitation Counselor.

Preferred and Least-preferred Activities

Campers preferred the mechanical engineering and materials activities (car workshop, computer programming and game design), the hands-on building projects with marshmallows, spaghetti, and wood, the virtual reality demonstration, 3-D printing, SketchUp, and mixing chemicals to make my nylon. Most of the preferred activities involved hands-on or experiential learning. Students appeared to enjoy working on the computer and engaging in activities that resulted in the creation or manipulation of an object. Demonstrations and exploratory events appeared to engage participants and hold their attention.

Campers were also given the opportunity to share the activities they least preferred each day. The least preferred activities involved math (Pythagorean Theorem), lectures, completing paperwork, the augmented reality activity on space, and the chemistry video. It is possible that limited background knowledge, limited exposure and sensory issues may have attributed to their attitudes of these activities. This requires additional investigation. The clarity of instruction, amount of assistance, structure of the activities, and level of feedback could have impacted participants' attitudes.

STEM Semantic Survey Results

Overall, the participants' had a high level of interest in STEM that tended to be higher than those of other groups who had previously completed the STEM Semantic Survey. According to Knezek, the group's beginning scores were "abnormally (unrealistically) high" (G. Knezek, personal communication September 25, 2018). Camp attendees with high interest in and favorable attitudes toward STEM should be identified at the primary grade level, and their curiosity and passion for STEM should be nurtured. These students should have the opportunity to gain a strong foundation in science and mathematics, so that they will be able to be successful in STEM majors. Their passion for STEM should be encouraged at home, at school, and through after school programs and activities that allow them to interact with STEM Professionals and gain real-world exposure and experience. Students should communicate with scientists, mathematicians, engineers, and professionals in technology in their community through local community colleges and universities, neighborhoods, businesses, family members, and friends. This personal contact can fuel students' interest in and knowledge of STEM. Table 2 depicts campers' scores on the Stem Semantics Survey. The means and standard deviation scores are closely clustered, so there is not great variation in the distribution of the scores. Students appear to have a high level of interest in a career in STEM, Science, Technology, Engineering, and Math (though math is a bit lower).

Table 2

Campers' Results on the Stem Semantics Survey

		Science	Math	Engineering	Technology	STEM Career
N	Valid	21	21	21	21	21
	Missing	0	0	0	0	0
Mean		5.6571	4.4571	5.1905	5.3905	5.6190
Std. Error of Mean		.29347	.38450	.29292	.33537	.36040
Std. Deviation		1.34483	1.76198	1.34235	1.53685	1.65155
Variance		1.809	3.105	1.802	2.362	2.728
Minimum		2.60	1.00	2.80	1.40	.80
Maximum		7.00	7.00	7.00	7.00	7.00
Sum		118.80	93.60	109.00	113.20	118.00

Camp Counselor Feedback on the STEM Camp

Surveys completed by five on-site student counselors provided additional insight. The counselors were students who were upper level undergraduates or graduate students majoring in Rehabilitation Counseling or Rehabilitation Studies. The Counselors were asked to provide a rating of the campers' engagement, attitudes toward the camp, counselor training, and the overall camp experience. The counselors' subjective scores in each category of the rating scale were from 1 (lowest) to 5 (highest). Table 3 includes the means and standard deviations of the counselors' ratings.

Counselors were also asked to provide comments and suggestions on the things that worked well in the camp and the things that did not work. Their comments and suggestions were analyzed using thematic analysis: the comments were reviewed several times, coded, and general themes were collected, and defined.

Table 3

Ratings of Campers' Engagement and Attitudes and Counselors' Training

Counselor Ratings					
		Campers' Level of Engagement	Campers' Attitudes	Counselor Training	Overall Rating
N	Valid	5	5	4	4
	Missing	0	0	1	1
Mean		3.4000	3.8000	2.2500	3.5000
Std. Error of Mean		.24495	.37417	.47871	.28868
Std. Deviation		.54772	.83666	.95743	.57735
Variance		.300	.700	.917	.333
Minimum		3.00	3.00	1.00	3.00
Maximum		4.00	5.00	3.00	4.00
Sum		17.00	19.00	9.00	14.00

Camper Engagement. Overall, the student counselors indicated that most campers were engaged and there was more active engagement in the hands-on activities. According to the student counselors, some activities needed to be paced differently to keep some campers from struggling to complete the work.

The following comment reflects this: *"The degree of camper engagement was mild, most of them were engaged, but some were having trouble keeping up."* Engagement is definitely something that camp organizers and planners will emphasize during future iterations of the camp. The engagement of counselors with participants as well as participants' engagement with STEM content activities will be reviewed.

Campers' Attitudes. The majority of comments from student counselors indicated that the campers had positive attitudes toward the camp. One counselor shared *"Overall, the campers had a positive attitude toward the camp." "Either not interested or they are above the topic. Not many in the middle."* The last comment certainly points to the need for understanding the audience and planning activities based on their needs. This is certainly a consideration for the design of future camps. Ability and interest-based activities can provide the motivation that increases the potential for learning.

Counselor Training. The upper level undergraduate counselors stated that they needed more training to better assist the campers, while the graduate level counselors used their decomposition skills to help campers work through tasks and minimize the campers' frustration. *"Autonomy, Motivational Interviewing, and Teamwork"* were the training the graduate level student counselors mentioned. The graduate level counselors appeared to draw from additional experiences and prior knowledge when working with the camp attendees, while the undergraduate counselors expressed a need for more direct instruction on camp activities prior to working with camp participants.

Overall Camp Experience. Overall, the counselors had high regard for the camp, but they expressed the need for training. Their comments are listed below: *"I think it is a great camp. With extra training, it could be better." "We need to know ahead of time what's being taught so we can learn it ourselves. We are all trained to work with the campers, but all they were taught was new to us. As a result, we couldn't help as much as we'd like."*

"We need training in programs and activities ahead of time to help them better. They enjoyed most activities." "I think overall it was good. Executing was an issue, along with preparation. Material and projects were good, need to deliver better and help us with more with training."

What Worked and Did Not Work? Counselors were very candid about the things that went well in the camp. Their answer to the question what worked: *"I especially liked the activities on Wednesday. I feel the VIVE could be longer so campers could have more time." "Most of the campers were very interested in the material and at a learning level where they did not feel bored or lost." "The variety in activities was good for keeping their attention." "The hands-on activities and moving stations [worked]."* The things they said did not work well: *"Lectures and accommodations. Program tailored for this population." "No training for counselors. Some programs were tough for the campers."* The remaining comments involve training. *"We could offer minimal help, because we did not know what they were doing until they did it." "We as counselors were not given the information ahead of time." "Training the counselors about what will happen would be beneficial."*

Feedback from Planners and Organizers

Camp organizers and administrators met to discuss the camp, and notes were recorded from that meeting. Several suggestions were made. One item of discussion was the focus of the camp. Several ideas were mentioned: having a Computer Science or Robotics focus, or just focusing on a few areas. The camp was only one week, and creating an integrative program covering all the areas of STEM was a challenge. As such, the camp needs to be simplified or the duration of the camp needs to be extended. A longer camp would provide additional engagement, greater exposure, and set the stage for exploring causality through a quasi-experimental research design to determine whether or not a causal-comparative relationship exists among camp attendance, interest in STEM, and additional training in STEM.

Transportation was another issue that surfaced in the debriefing meeting. Campers arrived and departed each day, so traveling to other exciting sites for field trips was not an option. As such, an overnight camp was discussed as a possibility to provide more opportunities for engagement, discussion, and interaction. Of primary concern was the need to determine what students prefer. This re-emphasizes the need for ability and interest-based activities, and these can be determined through an audience analysis.

More of a focus on a vocational component and the level of education needed to pursue a career in STEM were also discussed as a future revision of the camp. One suggestion for accomplishing this was partnering with a local community college to support more of a focus on STEM vocations during the camp.

An additional suggestion was having the counselors recap and add a career focus at the beginning of each day. Other comments included assessing the campers' formal and informal prior STEM knowledge and collecting additional demographic data.

Feedback from the Vocational Rehabilitation Counselor

Seven months after the camp, Vocational Rehabilitation (VR) Counselors who referred students to the camp were asked to share feedback on the camp. One respondent who had referred several students replied, and the feedback was positive. When asked whether or not students gained knowledge about STEM and STEM Careers, the respondent replied *"Yes, my students definitely felt they gained additional information about their field of interest."* When asked about the feedback the counselor received from students, the reply was *"they really liked the experience, and wish they had the opportunity to stay on campus with that experience due to transportation issues."* When asked if any of the students had an interest in attending more STEM related activities, the reply was *"Yes! All of my students that attended expressed an interest in more Stem related activities."* The counselor said *"students were considering more STEM related programs"* and suggested *"on campus housing during the program."* The VR Counselor *"did not find feedback from the camp as helpful as it could have been"* and indicated that he or she *"would definitely refer other students in the future."* It may be helpful to survey counselors at additional intervals – two, four and six months after their students' experience to get more feedback to inform the program. It is also necessary to evaluate the information sent from the camp to the counselor; it may need to be packaged or organized differently to better serve the counselor's needs.

Discussion

This camp was the first of its kind, and it exposed students with disabilities to a variety of STEM concepts and activities. Students had the opportunity to meet professionals in STEM as well as other undergraduate students majoring in Biomedical Engineering and Construction Engineering Technology.

Having this direct exposure to both working professionals and student role models is a positive form of mentoring that may help students with disabilities see themselves in STEM fields. This work fits in within the context of increasing participation in STEM through mentoring, direct experiences, and coaching in STEM. It also highlights the necessity for training mentors and instructors, considering accommodations, and creating appealing and interesting activities. Many of the campers did not disclose their disability, and that made it difficult for planners to anticipate all of the needs, but the one-on-one assistance of student counselors provided additional support. The findings on disclosure are in line with the literature – about half of our campers did not disclose their disability. This needs to change so that appropriate support and accommodations can be provided to facilitate their success. Additional training also appeared in the literature for instructors; our student counselors expressed their need for training on activities before the camp to better assist the campers. Further research is needed in each of these areas.

Conclusion

Planning and delivering a STEM Camp takes a great deal of preparation and time, and many things should be considered: student needs and abilities, equipment, physical facilities, logistics and scheduling, curriculum, record keeping, supplies, data collection, IRB Approval, photo releases, dietary and allergy restrictions (menu planning), advertising, marketing, camper support, and much more. The process can take many months, and it should be followed by a structured walkthrough of facilities to ensure that they are accessible and comfortable. Working through all the issues could take from six months to one year.

Having counselors who are able attend the camp with students during each activity is essential, and it provides students with a constant point-of-contact for resolving issues and problems, making students comfortable, and ensuring their safety. The counselors engaged directly with students and provided assistance by answering questions, modeling behaviors and attitudes, and handling unplanned challenges. Counselor training is very important. A STEM Camp should have integrative activities or a single focus and hands-on and interactive projects that stimulate student interest, provide a high degree of student engagement, reduce boredom, and facilitate learning. Students have a wide range of interests and abilities, and those can provide additional ideas for structuring their camp experience. STEM Professionals can be invaluable resources for students, because they can provide the encouragement and knowledge of their fields that helps transform students' knowledge and provide realistic experiences and positive learning opportunities.

References

Alston, R. J., Bell, T. J., & Hampton, J. L. (2002). Learning disability and career entry into the sciences: A critical analysis of attitudinal factors. *Journal of Career Development, 28*(4), 263. Retrieved September 12, 2018 from https://libproxy.library.unt.edu/login?url=https://libproxy.library.unt.edu:2165/docview/220430681?accountid=7113

Bada, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education, 5*(6), 66-70. Retrieved September 2, 2018 from https://pdfs.semanticscholar.org/1c75/083a05630a663371136310a30060a2afe4b1.pdf

Basham, J. D., Israel, M., & Maynard, K. (2010). An ecological model of STEM education: Operationalizing STEM for all. *Journal of Special Education Technology, 25*(3), 9-19. doi:10.1177/016264341002500303

Bellman, S., Burgstahler, S., & Chudler, E. H. (2018). Broadening participation by including more individuals with disabilities in STEM: Promising practices from an engineering research center. American Behavioral Scientist, 62(5), 645–656. https://libproxy.library.unt.edu:2147/10.1177/0002764218768864

Bellman, S., Burgstahler, S., & Hinke, P. (2015). Academic Coaching: Outcomes from a Pilot Group of Postsecondary STEM Students with Disabilities. Journal of Postsecondary Education and Disability, 28(1), 103–108

Bettencourt, G. M., Kimball, E., & Wells, R. S. (2018). Disability in Postsecondary STEM Learning Environments: What Faculty Focus Groups Reveal about Definitions and Obstacles to Effective Support. Journal of Postsecondary Education and Disability, 31(4), 383–396

Booksh, K. S., & Madsen, L. D. (2018). Academic pipeline for scientists with disabilities. *MRS Bulletin, 43*(8), 625–632. http://doi.org/10.1557/mrs.2018.194

Camp, T. (2012, December). Computing, we have a problem. *ACM Inroads*, 3(4), 34-40. doi:10.1145/2381083.2381097

Christensen, R., Knezek, G., Tyler-Wood, T. (2014). Student perceptions of Science, Technology, Engineering and Mathematics (STEM) content and careers. *Computers in Human Behavior, 34*, 173-186. Retrieved October 1, 2018 from http://dx.doi.org/10.1016/j.chb.2014.01.046

DeVellis, R.F. (1991). Scale development: Theory and applications. Newbury Park: Sage Publications, Inc.

Dunn, C., Rabren, K. S., Taylor, S. L., & Dotson, C. K. (2012). Assisting students with high-incidence disabilities to pursue careers in science, technology, engineering, and mathematics. *Intervention in School and Clinic, 48*(1), 47-54. doi:10.1177/1053451212443151

Dunn, C., Shannon, D., McCullough, B., Jenda, O., & Qazi, M. (2018). An Innovative Postsecondary Education Program for Students with Disabilities in STEM (Practice Brief). Journal of Postsecondary Education and Disability, 31(1), 91–101

Fayer, S., Lacey, A., & Watson, A. (2015). STEM occupations: Past, present, and future. Retrieved from https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf

Fisher, K. (2017). The correlation between extracurricular STEM Activities and students with disabilities. Proceedings of the Interdisciplinary STEM Teaching and Learning Conference, 1(6), 55-72. Retrieved August 6, 2018 from https://digitalcommons.georgiasouthern.edu/stem_proceedings/vol1/iss1/6

Gottfried, M. A., Bozick, R., Rose, E., & Moore, R. (2014). Does career and technical education strengthen the STEM pipeline? Comparing students with and without disabilities. *Journal of Disability Policy Studies, 26*(4), 232-244. doi:10.1177/1044207314544369

Hwang, J., & Taylor, J. (2016). Stemming on STEM: A STEM education framework for students with disabilities. *Journal of Science Education for Students with Disabilities, 19*(1), 39-49. Retrieved from https://scholarworks.rit.edu/jsesd/vol19/iss1/4/

Kahn, S., & Lewis, A. R. (2014). Survey on teaching science to K-12 students with disabilities: Teacher preparedness and attitudes. Journal of Science Teacher Education, 25(8), 885-910. doi:10.1007/s10972-014-9406-z

Knezek, G. (2018, September 25). Email.

Love, T. S., Kreiser, N., Camargo, E., Grubbs, M. E., Kim, E. J., Burge, P. L., & Culver, S. M. (2015). STEM faculty experiences with students with disabilities at a land grant institution. *Journal of Education and Training Studies, 3*(1) doi:10.11114/jets.v3i1.573

Lucietto, A., Russell, L. & Schott, E. (2018). STEM Educators, how diverse disciplines teach. *Journal of STEM Education, 19*(3), Laboratory for Innovative Technology in Engineering Education (LITEE). Retrieved October 9, 2018 from https://www.learntechlib.org/p/184621/

Montgomery, A., & Mirenda, P. (2014). Teachers' self-efficacy, sentiments, attitudes, and concerns about the inclusion of students with developmental disabilities. *Exceptional Education International*, 24(1), 18-32. Retrieved October 9, 2018 from https://ir.lib.uwo.ca/cgi/viewcontent.cgi?article=1028&context=eei

Plasman, J., & Gottfried, A. (2018). Applied STEM coursework, high school dropout rates, and students with learning disabilities. *Educational Policy, 32*(5), 664-696

Sills, J. (2019, November 7). Disability inclusion enhances science. *Science*. Retrieved from http://science.sciencemag.org/

Stefanich, G. (2007). *Inclusive science strategies*. Dubuque, IA: Kendall-Hunt Publishing Company

Talja, S., Touminen, K., & Savolainen, R. (2005). "Isms" in information science: constructivism, collectivism and constructionism. *Journal of Documentation, 16*(1), 79-101. Retrieved from https://www.emeraldinsight.com/doi/full/10.1108/00220410510578023

Tyler-Wood, T., Knezek, G. & Christensen, R. (2010). Instruments for assessing interest in STEM content and careers. *Journal of Technology and Teacher Education,* 18(2), 345-368. Retrieved September 8, 2018 from http://libproxy.library.unt.edu:7233/p/32311/

Vilorio, D. (2014). STEM 101: Intro to tomorrow's jobs. *Occupational Outlook Quarterly,* 3-12. Retrieved from https://www.bls.gov/careeroutlook/2014/spring/art01.pdf

White, J. L., & Massiha, G. H. (2015). Strategies to Increase Representation of Students with Disabilities in Science, Technology, Engineering and Mathematics (STEM). International Journal of Evaluation and Research in Education, 4(3), 89–93

Williams, T. Jr, Ernst, J. V., & Kaui, T. M. (2015). Special populations at-risk for dropping out of school: A discipline-based analysis of STEM educators. *Journal of STEM Education: Innovations and Research, 16*(1), 41-45. Retrieved from https://libproxy.library.unt.edu/login?url=https://libproxy.library.unt.edu:2165/docview/1689879113?accountid=7113

Yilmaz, M., Ren, J., Custer, S., & Coleman, J. (2010). Hands-on summer camp to attract k-12 students to Engineering Fields. *IEEE Transactions on Education*, 53(1), 144-151. doi: 10.1109/TE.2009.2026366