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Students with Disabilities' Perspectives of STEM Content and Careers

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Abstract

The current global economy has led to an increase in the need for workers in the fields of science, technology, engineering, and mathematics (STEM). Underrepresented populations, such as students with disabilities, are being considered as one way meet the STEM workforce shortages. In order to increase students' participation in STEM careers, it would be helpful to gauge whether students are interested in STEM content. The current study sought to gauge students with disabilities interest in individual STEM content areas. The research question states: How do middle school students with disabilities perceive science, technology, engineering, and mathematics content as measured by STEM Semantics Survey? In total 43 surveys were collected and analyzed. The overall findings indicate that students have the highest perception of technology and the lowest perception of mathematics. Means were analyzed by gender, race/ethnicity, and grade level. Implications and suggestions for practice are shared.

Students with Disabilities' Perspectives of STEM Content and Careers

The current society is progressive. Advances in science, technology, engineering, and mathematics (STEM) are playing a key role in transforming the current global environment (Dunn, Rabren, Taylor, & Dotson, 2012). The current global economy leads to an increase in the need for workers in STEM fields (Alston & Hampton, 2000; National Science Board, 2006; Tyson, Lee, Borman, & Hanson, 2007), careers typically requiring postsecondary preparation. As a result, STEM education has become a priority for the United States (Burgstahler & Chang, 2009; Tyson et al., 2007).

The increased national emphasis on STEM professions which typically postsecondary education has highlighted the workforce needs of the United States. Solutions being proposed include looking to underrepresented populations, including students with disabilities, to fill these shortages. The number of students with disabilities participating in postsecondary education is increasing (Burgstahler & Chang, 2009; Burgstahler & Doyle, 2005; Henderson, 1999, 2001). Considering most STEM careers require some postsecondary preparation, the increase in the number of students with disabilities attending postsecondary education is encouraging. Unfortunately, when comparing students with disabilities attending postsecondary institutions to their peers without disabilities, fewer students with disabilities graduate from high school and enroll in institutions of higher education. Of the students with disabilities who are able to reach these milestones, fewer earn a degree or certificate (Burgstahler & Doyle, 2005). Consequently, few students with disabilities are pursuing STEM careers and the attrition rate of the students with disabilities who pursue STEM is high (Burgstahler & Doyle, 2005; National Science Foundation, 2000; Office of Disability Employment Policy, 2001). Nonetheless, interest in assisting students with disabilities to pursue STEM careers is increasing (Lam, Doverspike, Zhao, Zhe, & Menzemer, 2008; National Science Foundation, 2000).

Several groups are underrepresented in the STEM areas (Committee on Equal Opportunities in Science and Engineering, 2006; Dunn et al., 2012), including students with disabilities (Alston & Hampton, 2000; Burgstahler & Doyle, 2005; National Science Foundation, 2000). The underrepresentation of people with disabilities in STEM careers is not surprising. Dunn and colleagues (2012) document several barriers to STEM careers for people with disabilities. Barriers include limited educational experiences, limited preparation for STEM careers, and lower participation rates in structured and unstructured STEM-related activities (Dunn et al., 2012).

These challenges begin with early school experiences. As students progress through school and struggle with weak foundations in critical content, their attitudes are affected. Students develop negative attitudes toward STEM subjects as they encounter increasingly complex expository texts and other instructional materials that reduce their ability to access and comprehend scientific information (Basham, Israel, & Maynard, 2010; Lee & Erdogan, 2007; Marino & Beecher, 2010).

Samsonov, Pederson, and Hill (2006) added additional considerations. Students with disabilities require support to manage the extensive information delivered in advanced classes at the secondary level. In addition to the increased cognitive demands, students must manage changing classes or moving from one class period to another within the school day. Secondary settings may also present limited instructional diversity, with many teachers favoring a traditional lecture-type delivery of content. Lastly, secondary teachers may possess inadequate knowledge of effective practices for teaching students with disabilities (Alston & Hampton, 2000; Alston, Hampton, Bell, & Strauss, 1998; Marino & Beecher, 2010; Mastropieri et al., 2006; Robinson, 2002). Commonly utilized text-based instruction at the secondary level provides little support to students who struggle with learning due to limited reading skills or deficits in background knowledge (Basham et al., 2010; Crockett, 2004; Scruggs, Mastropieri, & Okolo, 2008). With the challenging experiences and inadequate preparation it is not surprising that students with disabilities are not prepared for a STEM influenced workforce (Burgstahler & Chang, 2009).

Research suggests that STEM experiences must begin early (Burgstahler & Chang, 2009; Jacobs & Eccles, 1992; Lam et al., 2008; Simpkins, Davis-Kean, & Eccles, 2006). Dunn (2012) emphasizes this need to start early, starting no later than middle school, because early learning experiences play a critical role in career development (Dunn et al., 2012; Lam et al., 2008; Lent, Brown, & Hackett, 1994, 2000; Malian, 2007). Early experiences "shape self-efficacy, beliefs, and outcome expectations, which in turn affect the formation of vocational interest, which subsequently influence occupational goals, choice actions and performance attainments (Lam et al., 2008, p. 22)." Dunn and colleagues (2012) suggest that a foundation for postsecondary education in STEM be made early and include personal development, access to content, experiential development, and postsecondary connecting activities.

Since, students begin career and college preparation at the high school level it is imperative that students with disabilities are exposed to STEM content and careers during early adolescence

(Anderman, 1998). Students are making decisions that will affect the rest of their lives at this juncture. Gauging students' perceptions of STEM at an earlier phase in a students' education will help educators see students are responding positively to STEM content and make conclusions as to whether students may pursue STEM content at higher levels (such as in high school and beyond).

This holds true for all students, including students for disabilities. STEM careers require students begin preparations at the high school level and beyond. To see if students are ready to begin these preparations, students need to begin thinking of STEM in middle school or earlier. The current research study seeks to gauge the perceptions of students with disabilities in regards to STEM content and careers.

Research Question

The research question explored by the current study is: How do middle school students with disabilities perceive science, technology, engineering, and mathematics content as measured by STEM Semantics Survey (Tyler-Wood, Knezek, & Christensen, 2010)?

Method

The research study is a subsection of a bigger study. The study anonymously surveyed middle school students with disabilities enrolled in inclusive classrooms in grades 6, 7, and 8. Students were enrolled in an urban school in a southwest state in the United States.

The researcher first completed IRB process to gain approval for the study. Following the IRB approval, districts were contacted for potential interest in study. As a result two districts were identified. The districts then granted permission to send parent consent forms home with all students enrolled in 6^{th}, 7^{th}, and 8^{th} grade.

At the request of the districts the researcher was not provided direct contact with participants. Instead the researcher worked with either a school or district administrator to ensure anonymity of participants and reduced disruption at the participating schools. The researcher provided the parent consent forms to the administrator. At that point the administrator provided parent consent forms to teachers for distribution to all students.

Students were given approximately two weeks to return parent consent forms. The researcher then collected signed parent consent forms from the administrator to determine how many surveys needed to be provided for each school. After surveys were provided, the administrator distributed the surveys to teachers to administer to students.

Since the researcher was not provided direct access to the teachers or participants, teachers were provided with an optional script for administration. Even though teachers were not required to read the script verbatim, they were encouraged to read the script to ensure necessary instructions were provided to students.

Only students who returned signed parent consent forms were permitted to participate. Prior to administration students were instructed their participation was voluntary and anonymous.

Students were informed that by completing the survey they were giving their consent to participate. Students were informed they may stop or decline participation at any time.

The agreement between the researcher and the districts prevented the researcher from direct contact with students. After surveys were administered, the researcher was contacted to collect completed surveys. The researcher collected the surveys. A graduate assistant assisted with data entry. After the completion of data entry, data were analyzed. The researcher provided each district with a report specific to findings from his or her particular district, in addition to analyzing the data for overall findings.

Instrument

This research study utilized the STEM Semantics Survey (Tyler-Wood et al., 2010). The survey asks students to rank science, technology, engineering, and mathematics individually. Each section begins by asking the participant, "To me, ______ is:" For the different sections a different STEM content area is inserted. Within each section, each item provides two terms that are in contrast with each other and asks the participant to rank each content area on a scale between the two items. To clarify, the first section begins, "To me, SCIENCE is:" following this phrase is 5 pairs of terms that are in contrast with each other with numbers 1-7 listed between the contrasting terms. For example, the first line under science reads: 1. Fascinating 1, 2, 3, 4, 5, 6, 7 mundane. Participants choose how they perceive the individual content areas. The survey has been found to have very good to excellent internal consistency reliability (Alpha=.84 to Alpha=.93), in addition good content, construct, and criterion-related validity (Tyler-Wood et al., 2010).

In addition to the survey, students were instructed to write demographic information in the upper right corner of their survey. Students were asked to list their race/ethnicity, grade level and to include an "X" if they were on an IEP.

For this study surveys from students with disabilities were analyzed. The total number of students with disabilities who participated in this study was 43. Students were not required to disclose his or her specific disability.

Findings

Overall Means

For analysis results from each section was combined into one factor. For example Questions 1, 2, 3, 4, and 5 under the section, "To me, SCIENCE is:" was combined into one factor representing Science. Negatively stated items in the sections were reversed coded for analysis (i.e. #4 and #5 in the Science Section are negatively stated. These items were reverse coded for analysis to reflect the overall positive nature of the section). The range for the group was 1-7. On this scale 1 represents a high perception with 7 representing a low perception. Within the range 4 is located in the middle and can be considered a neutral perspective.

The means were science 2.81, math 3.37, engineering 3.30, and technology 2.31. Overall students ranked technology the highest followed by science. Math was ranked the lowest of the content areas, with engineering following close behind. The mean answer for students for "To me, a CAREER in science, technology, engineering, or mathematics (is):" was 2.83. If "4" is considered neutral all scores were skewed toward positive perspectives. See Table 1 for further overall mean reporting.

Table 1
Overall Means

	N	*M*	*SD*
Science	42	2.81	1.47
Mathematics	42	3.37	1.82
Engineering	41	3.30	1.88
Technology	42	2.31	1.62
Careers	42	2.83	1.97

Means by Gender
The means were further analyzed by gender. There were gender differences evidenced within the data. Based on the data girls' perceptions would rank the content areas from highest to lowest as science, technology, engineering, and mathematics respectively. Boys would rank the content areas as technology, engineering, mathematics, and science. Boys also had a higher perception of a career in science, technology, engineering, and mathematics. Boys ranked technology first, which is reflective of the overall findings; however, boys appear to have a higher perception of engineering than the girls. Also, boys did not rank mathematics the lowest which is different from the overall findings of the study. See Table 2.

Table 2
Means by Gender

Gender		Science	Mathematics	Engineering	Technology	Careers
	M	2.93	2.87	2.60	1.71	2.07
Male	*n*	21	21	20	21	21
	SD	1.65	1.80	1.98	1.46	1.86
	M	2.72	4.01	3.82	2.82	3.66
Female	*n*	20	20	20	20	20
	SD	1.33	1.66	1.41	1.57	1.83
	M	2.83	3.45	3.21	2.25	2.84
Total	*N*	41	41	40	41	41
	SD	1.49	1.80	1.80	1.60	1.99

Means by Race

Another analysis examined race/ethnicity. The following races/ethnicities were identified within the data: Caucasian/White, African-American/Black, Native American, Hispanic/Spanish descent, and Two or more races. There were race differences evidenced within the data. Based on the data White/Caucasian participants mirrored the overall means of the group ranking content areas from highest to lowest as technology, science, engineering, and mathematics. African-American participants ranked the content from highest to lowest: technology, mathematics, science, and engineering. Participants identifying as Asian ranked the content areas from highest to lowest as mathematics, science, technology, and engineering. Native American participants and participants identifying as Hispanic or Spanish descent ranked the content from highest to lowest as technology, science, mathematics, and engineering. Lastly participants ranked the content areas from highest to lowest as science, technology, engineering, and mathematics.

As with the overall group participants identifying as White or Caucasian, Black or African-American, Native American and Hispanic/Spanish descent all ranked technology highest. Similarly, participates identifying as White or Caucasian and those identifying with two or more races held the lowest perception of mathematics, as with the overall group. Students identifying as Asian was the only group to hold the highest perception as mathematics; however, it should be noted this group contained only two participants.

As far as interest in careers the means ranged from *M*=1.45-4.93. Students identifying as "two or more races" perceived careers in STEM the highest, *M*=1.45. Native American students yielded the lowest perception of STEM careers, *M*=4.93, which indicated a negative leaning perception. See Table 3 for further race reporting.

Table 3
Means by Race/Ethnicity

Race/ Ethnicity		Science	Mathematics	Engineering	Technology	Careers
White	*M*	2.68	3.64	2.73	2.23	2.56
	n	24	23	23	23	23
	SD	1.46	1.95	1.68	1.80	1.83
African-American/ Black	*M*	3.97	2.62	4.08	2.30	3.40
	n	6	6	6	6	6
	SD	2.14	1.37	2.35	1.44	2.94
Asian	*M*	2.60	2.30	5.60	4.10	3.20
	n	2	2	2	2	2
	SD	.57	1.84	1.98	.71	1.13
Native American	*M*	2.40	3.93	4.60	1.93	4.93
	n	3	3	3	3	3

	SD	.53	2.12	.60	1.62	1.81
Two or More Races	*M*	1.95	2.35	2.25	2.10	1.45
	n	4	4	4	4	4
	SD	.75	1.58	1.00	1.24	.66
Hispanic or Spanish Descent	*M*	3.27	4.05	4.68	2.40	3.20
	n	3	4	3	4	4
	SD	.92	1.75	1.84	1.62	1.57
Total	*M*	2.81	3.37	3.30	2.31	2.83
	n	42	42	41	42	42
	SD	1.47	1.82	1.88	1.62	1.97

Means by Grade Level

The means were further analyzed by grade level. There were grade level differences evidenced within the data. The perceptions of participant enrolled in 8th grade mirrored the overall perceptions: technology (highest), science, engineering, and mathematics (lowest). Sixth grade participants' perceptions were slightly different ranking content areas from highest to lowest as technology, mathematics, science, and engineering. There were only 4 participants from the 7th grade whose perceptions from highest to lowest were technology, engineering, mathematics, and science. All three grade levels had the highest perceptions of technology; however, 6th and 7th graders did not perceive mathematics the lowest. The perception of mathematics drops at each increasing grade level, ranking 2nd for 6th graders, 3rd for 7th graders and finally last for 8th graders.

Data related to careers varied slightly by grade level as well. The highest perception of careers is presented by 7th graders, *M*=1.73, *SD*=.70 and the lowest perception is presented by 6th graders, *M*=3.27, *SD*=2.39. See Table 4.

Table 4
Means by Grade Level

Grade Level		Science	Mathematics	Engineering	Technology	Careers
6th	*M*	2.78	2.61	3.88	2.38	3.27
	n	17	18	17	18	18
	SD	1.68	1.18	2.02	1.73	2.39
7th	*M*	3.90	3.47	2.40	1.40	1.73
	n	4	3	3	3	3
	SD	2.25	2.37	1.22	.69	.70
8th	*M*	2.64	4.00	2.96	2.38	2.62

	n	21	21	21	21	21
	SD	1.08	2.03	1.76	1.63	1.62
Total	*M*	2.81	3.37	3.30	2.31	2.83
	n	42	42	41	42	42
	SD	1.47	1.82	1.88	1.62	1.97

Considerations

There was consideration of teachers' schedules, effort and time when determining administration of the surveys. With flexibility given to the teachers in administration there was less control over administration. There were no fidelity checks to ensure integrity of treatment. This is evidenced by some portions of the survey being left blank.

This research study is a small study. A total of 43 participants do not provide enough data to generalize results. In addition, students were not required to designate their disability; as a result there may be a wide variety of disabilities represented within the small sample size. However, the data may still provide some insight into how students who are included in inclusive middle school classes perceive STEM content areas.

Discussion

This research study analyzed the STEM perspectives of students with disabilities. Overall 43 surveys were analyzed. This study is a subset of a larger study (author, under review). The larger study included a total of 1873 participants. Of the 1873, 43 self-identified as having a disability, representing just over 2% of the larger study. The researcher expectation was around 10% of the larger study based on the participating districts population of students served by special education.

The first point of discussion is the lack of identification of students with disabilities. The ideal situation would have included having students identified through the school. Unfortunately, that was not the case. Consequently, the study relied on self-identification by students with disabilities. This was a huge limitation for this research study. This lack of self-identification is not surprising. Students may not be comfortable indicating their disability status or may be unaware. However, students in middle school are beginning the transition process; at this grade level transition is starting to be discussed in IEP meetings. Students are getting to an age where they may be involved in their IEP meetings and their interests and desires are being weighed with their needs to determine their futures.

Students are at an age where they are ready to begin self-advocating. Students should feel empowered understanding that they have a disability. Considering only 43 students of the total 1873, an assumption can be formed that this population of students do not know they have a disability or are not comfortable discussing their disability. For students who are being included in general education classrooms STEM careers may be within their grasp, if they understand that they have a disability and know what supports will assist their learning potential. If students do not understand that they need additional supports, what those supports are and how to use them effectively in their content classes, STEM content will continue to be out of their grasp. Self-awareness is difficult to provide to students in a positive manner; however, self-awareness is key to students understanding their learning needs and reaching their academic goals.

Overall students ranked content areas as technology (*M*=2.31), science (*M*=2.81), engineering (*M*=3.30), and mathematics (*M*=3.37, see table 1). Technology was perceived highest, which isn't surprising considering the technological society we live in. However, this should not be mistaken to mean students are effective with technology. The idea of digital natives continues to be debated in the literature and students appear to use mostly social media and commonly established technologies (i.e. messaging). (Bennett & Maton, 2010; Bennett, Maton, & Kervin, 2008; Margaryan, Littlejohn, & Vojt, 2011; Salajan, Schonwetter, & Cleghorn, 2010; Waters, 2011). Seeing how students interest in technology is already high this a great time to expose students to more intricate technologies and demonstrating effective use of various technologies, in addition to increasing technology in the classroom to increase student engagement as many teachers are currently doing in their classrooms.

Overall students ranked mathematics last (*M*=3.37, see table 1). Students perceive mathematics the least positively. Sullivan, Tobias, & McDonough (2006) discusses students' under-participation in mathematics may be determined by the culture students are surrounded by, meaning students may be capable of doing more mathematics, but their disinterest in the subject affects their motivation to participate in the subject area. This study does not investigate how students participate in mathematics; however, if students who have the capacity to achieve in mathematics are disinterested in the subject, logic indicates the likelihood they will enroll in higher level mathematics classes at the secondary level will be low. It is interesting to note that when looking at individual groups mathematics is not always perceived as the lowest content area. In these instances mathematics has the 2nd or 3rd lowest perception. This is the case for boys, specific races/ethnicities (including Black/African American, Hispanic/Spanish descent, Asian, and Native American) 6th and 7th graders.

Implications

Self-awareness

This study and the larger study associated with this study (author, under review) demonstrate the need to encourage self-awareness for students with disabilities. There are curricula available that can assist with students becoming self-aware. These curricula could truly benefit all students. Even though, we know students served by special education need specific supports to be successful academically, it would be helpful for all students to learn about their academic strengths and needs, what supports will assist their academic achievement, and how to respectful advocate for their needs. One resource that is available free is a curriculum called, "ME!" This research based curriculum (Cantley, 2011) focuses on self-awareness and is available from the Zarrow Center: http://www.ou.edu/content/education/centers-and-partnerships/zarrow/trasition-education-materials/me-lessons-for-teaching-self-awareness-and-self-advocacy.html. Other Self-determination packages are available, but may be pricey and may not address self-awareness specifically.

Technology

With the high perception of technology students with disabilities in this study hold (*M*=2.31), teachers should encourage the use of technology. Many teachers are integrating technology into different content areas to engage students. Students can also be introduced to new and more effective technologies, in addition to assistive technology, to increase their awareness of the different ways technology can be used outside of social media and messaging.
Mathematics

Students in this study perceived mathematics the lowest (*M*=3.37). Students may need positive experiences around mathematics. Some students begin to experience difficulties in mathematics at the middle school level due to a weak foundation from prior school experience. This may be the case for the participants as the data demonstrate a decreased interest in mathematics as they progress through middle school, which usually also means in increase in complexity of the content area. Students with foundational weaknesses need to be identified early and provided with supports. Students who are not successful with mathematics at the middle school level or who do not have a solid mathematics foundation will have difficulty with higher level mathematics in high school.

In addition, some students disengage in mathematics due to disinterest in the subject (Sullivan et al., 2006). Students who are not interested in mathematics may not choose to take the higher level mathematics in high school. Without the higher level mathematics in high school post-school STEM opportunities will be limited.
Careers

Students may benefit by being exposed to careers in STEM. Students were overall positive about STEM careers; however, some students may be unaware of what professions fall under the category of STEM fields or may not know or understand the expectations or responsibilities of those professions. In addition, this survey solely asked about science careers. Students should know STEM careers are broader than that.

Conclusion

The present study sought to gauge students with disabilities perception of STEM. Although small in scope, there were some findings worth noting. First, students perceived technology highest. This may be influenced by the prevalence of technology in the current society (i.e. smartphones, tablets). Conversely, mathematics was perceived the lowest. The perception of mathematics drops a rank as students advance through middle school, ranked 2^{nd} for 6^{th} graders, 3^{rd} for 7^{th} graders, and last for 8^{th} graders.

Looking at the findings closer, girls had the highest perception of science. This is different from the overall findings. Girls perceived mathematics lowest, which aligns with the overall findings. Boys had the lowest perception of science and the highest perception of technology.

Gauging students' perceptions of STEM does not guarantee their success in the content areas. However, as Sullivan and colleagues (2006) found, students disinterest in a content area affects their motivation to participate in that subject area. Also, if students do not perceive the content to be important, an assumption can be made that the students will not be motivated to participate.

Even though STEM should ideally be an integrated academic experience, students are still required to take specific content areas at the secondary level. Students with disabilities need to see the relevance of the individual content areas. By determining where students with disabilities interests lie educators can determine where efforts should be focused to encourage all students to seek out STEM content and ultimately STEM careers.

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