IUMPST: The Journal. Vol 2 (Pedagogy), July 2019 [www.k-12prep.math.ttu.edu]
ISSN 2165-7874

Students Tell Us the Best Way to Learn Mathematics in High School

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Abstract

The purpose of this study was to fill a gap in the literature on student learning and use participant feedback to improve the pedagogical effectiveness in mathematics and literacy classrooms. To this end, an anonymous, semi-structured Qualtrics survey was developed and administered to 1,212 recent high school graduates asking about the best way to learn mathematics. Respondents said they preferred printed textbooks, although 30% rarely read them. They found instructional videos helpful and that guided notes kept them engaged. Students wanted practice problems and examples, in an environment where they were unafraid to ask questions. Their learning benefited from both collaboration and independent work. They knew that participation in math clubs improved their learning, but they admitted not participating. Although no survey items focused on teachers, half of those providing open-ended feedback made clear, the necessity of a "good," "patient," "experienced," teacher, "excited to teach math," with whom students could work "face-to-face."

Background

Research on how students think they learn best is limited, yet can be profoundly informative (Bianchi, 2018**;** Groves & Welsh, 2010; Saul, 2005). This information is important because knowledge of learner characteristics allows teachers to provide instruction that supports those characteristics (Bosman & Schulze, 2018; Orhun, 2013). Also, reflection on one's own learning profile allows the individual to develop and use effective strategies (Bosman & Schulze, 2018; Orhun, 2013).

Additionally, scant research has examined the role of the mathematics textbook from the students' perspectives including whether they use textbook features (e.g., visuals, glossary, examples) or even actually read the book (Thomas, 2013). Insights on the use of textbooks are relevant because textbooks have dominated the curriculum of mathematics classrooms in the U.S. from 1977 until last reported in 2012 (Banilower, et al., 2013). Now with the rush to technology-based learning, text use becomes even more expensive and complicated and the perspective of, or benefit to, the learner is still in question (Cheung & Slavin, 2013; Tamin, Bernard, Borokhovski, Abrami, & Schmid, 2011).

Therefore, the purpose of this study was to fill a gap in the literature on student learning and use participant feedback to improve the effectiveness of mathematics and literacy instruction in a Midwest teacher education program. In order to do this, recent secondary graduates were asked to reflect on one high school math course and answer structured and open-ended items such as, "What is the best way to learn mathematics?" Their responses surprised us.

Method

Participants. Individual reflections on learning mathematics were solicited from 1,212 students, the majority of whom (74%) just left high school and were beginning their first month in a midwestern university in the U.S. This was a convenience sample of students enrolled in Intermediate and College Algebra, two large beginning-level undergraduate courses.

To recruit participants, teaching assistants in each section of these courses explained the purpose of the study and described the survey to students. This same information was offered in written format on course Blackboard sites with a link to the survey. A QR code was provided for those who wished to access the survey via their cell phones. Surveys took approximately 15-20 minutes to complete.

The 855 (or 71%) who chose to participate and complete the 38 survey items possessed a range of backgrounds. They came from 34 different states representing the East, West, Midwest and Southern regions of the U.S. as well as from 15 different countries. Demographic information indicated that participants were 69% Caucasian, 9% Asian, 8% Hispanic, 7% African American or African, 1% Native American, 3% Multiracial, and 2% other. Gender representation was 59% female, 41% male, 0.6% other.

Survey Development. Qualtrics, an online, subscription-based survey program, was used to create and distribute the survey. Items were developed to use Likert-scale, yes/no, multiple-choice with multiple answers, and open-ended options. This anonymous, semi-structured survey solicited information on student preferences for mathematics materials, learning practices and school structures.

Likert scale items with ratings “Always,” “Often,” “Sometimes,” “Rarely,” “Never” were developed to ask students about their access to, use and perceived benefits of, instructional materials. Materials included printed (traditional), electronic (digital image) and digital (digital image an interactive) mathematics textbooks and specific features or readers’ aids within those textbooks. Descriptions of each of these textbook formats were taken from published research conducted by Rockinson-Szapkiw, Courduff, Carter, and Bennet (2013). Similar survey items were developed about use of notes, instructional videos, and the Internet.

Another group of Likert items was developed to ask students about their access to, use and perceived benefit of learning practices, including working practice problems (both assigned and self-initiated), learning mathematics vocabulary and reading a textbook.

A final group containing Likert and Yes/No items addressed access to, participation in and preference for school structures, including collaboration, independent work, flipped classes and extracurricular mathematics activities like clubs or competitions.

Two additional open-ended items were included so participants could freely express their opinions about textbooks and “the best way to learn math.” This survey will be referred to as the Mathematics Literacy Survey or MLS because it represented collaboration between the two fields.

Various expert groups were consulted throughout to ensure validity. A literacy professor and doctoral student reviewed high school mathematics textbooks to confirm the textbook features used in the survey (see Table 2). Early on, five mathematics student teachers read items and wrote comments about confusing terms and the feasibility of others being able to answer survey items. Two professors (one mathematics and one literacy) and two doctoral students answered survey items individually and then convened to discuss possible difficulties. The survey was then piloted by 60 staff members--teaching assistants and tutors--who worked with beginning-level college mathematics courses to make sure there were no technical, conceptual or readability problems. An acceptable Cronbach’s alpha reliability statistic of approximately .7 was found for the Likert-scale survey items (Nunnally & Bernstein, 1994).

Theoretical Framework

Theories of constructivism (Piaget, 1971) and metacognition (Flavell, 1976) guided thinking in this research. In order to give voice to an individual's learning in mathematics, the researchers embraced theories that considered how a learner constructs knowledge when engaged in the learning process. Components of this constructivist engagement included schema activation and metacognitive awareness. Metacognition refers to one's knowledge about his/her self as information processor (self-assessment), including knowledge about what one needs to do in order to learn and remember information (regulation). Implemented, these theories allowed participants to reflect on and share how they best learned mathematics.

Analysis

Quantitative reports, categorical data and open-ended responses were retrieved from Qualtrics. Coding systems were used to analyze the extensive open-ended feedback provided by participants. First, Structural Coding was used as a First Cycle coding method. This coding application was appropriate for studies with many participants and standardized or semi-structured data-gathering protocols. Structural Coding is a question-based code, framed and driven by specific research questions, e.g., "What is the best way to learn math?" This coding system "acts as a labeling and indexing device," (Namey, Guest, Thairu & Johnson, 2008, p. 141) that can categorize information for further, more in-depth qualitative analysis.

An additional First Cycle coding technique, In Vivo Coding, was used on open-ended survey items (e.g., why participants preferred a particular type of text.) This 'verbatim coding' method used "a word or short phrase from the actual language found in the qualitative data record" (Saldana, 2013, p. 91). It allowed for the usage of terms given by participants themselves, rather than terms from academic disciplines. Also, In Vivo Codes "can provide a crucial check on whether you have grasped what is significant" to the participant (Charmaz, 2006, p. 57). Focused Coding, a Second Cycle analytic process, followed In Vivo Coding to reorganize, reconfigure, or delete redundant categories in order to develop a more select list of themes and assertions. Inter-rater reliability was calculated on the open-ended feedback about textbooks. Percent agreement on this coding for two raters was 86%; therefore, the coding result was reliable (Statistics How To, 2018).

Findings, Related Research and Discussion

In this section, results are presented about students' preferences for instructional materials, learning practices and school structures when engaged with mathematics. The MLS findings are situated in findings from the research literature in order to contextualize these concepts. Discussion is incorporated.

Instructional Materials

Videos**.** Given the popularity of media and videos, especially those produced by Khan Academy, authors of the MLS asked if participants watched instructional videos in their classes. Almost 22% of the participants indicated that they "Always" or "Often," watched instructional videos in their mathematics classes. However, in another Likert item, 45% of participants said they "Always" or "Often" "*prefer* to watch videos when learning math." This preference may be due to findings like those of Darling-Hammond, Zielezinski, and Goldman (2014); Kahrmann (2016) and Kronholz (2012) who concluded that video tutorials improved student achievement, engagement, and self-efficacy, allowed for differentiated instruction, access to modeling, and information missed when absent. They also provided support for parents. Kahrmann (2016) saw a "high use rate" of the video tutorials by the 55 seventh graders in her experimental study. Her students especially liked that the tutorials sounded like the teacher was talking to them, that word problems were relevant and videos were short (five to seven minutes). Both students and their parents regularly used the tutorials on a mobile device. Even though videos were surprisingly "time consuming" to produce, their teacher concluded that "students actually used the video tutorials for remediation and learning" (Kahrmann, 2016, p. 2).

***Notes*.** In addition to the ubiquitous use of textbooks, notes are often provided in mathematics classrooms. Therefore, a Yes/No item stating, I "received printed notes such as guided notes or Cornell notes that included key facts, concepts or examples" was included in the survey.
Guided notes are teacher-prepared outlines with blank spaces for students to write in concepts and examples (e.g., Haydon, Mancil, Kroeger, McLeskey, & Lin, 2011).

Participants responded that they received notes "Always" or "Often," 50% of the time. Frequent use of guided notes by mathematics teachers may be explained by Konrad, Joseph, and Eveleigh's (2009) meta-analysis on guided notes, which concluded that guided notes were an effective method to increase the accuracy of note taking and improve academic performance. General research on the use of guided notes suggested a likely increase in student engagement during teacher lectures and potential that students have a complete and accurate set of notes to use when studying for assessments (Haydon et al., 2011; Konrad et al, 2009). In the survey's open-ended question, approximately 8% (55/674) of participants indicated that use of "guided notes" was the best way to learn math.

***Text format preferences*.** The Reports of the National Surveys of Science and Mathematics Education over the last several decades (Banilower, et al., 2013; Weiss, 1978; 1987; Weiss, Banilower, McMahon, & Smith, 2001; Weiss, Matti & Smith, 1994) have indicated that 80% to 90% of mathematics teachers used a textbook to substantially guide instruction and they used 75% to 100% of the entire textbook. Therefore, more focus was placed on textbooks in this study beginning with the item, "I prefer to learn math with the following type(s) of textbook(s). Mark all that apply." Responses follow.

Table 1

Type of textbook preferred by students for learning high school math

Text Type	%	Responses
Print Only (traditional)	53%	439/827
Digital Only (digital image; interactive)	11%	91/827
Electronic Only (digital image, *not* interactive)	5%	45/827
Multiple Texts (combination of the above texts)	29%	236/827
None	2%	16
	100%	827

After indicating their text format preference, respondents were asked to provide an explanation as to why they preferred that type of text. Approximately 43% or 491 participants, complied by providing written feedback. Some individuals responded in more than one category. Responses were read and themed.

Preference for printed text. Looking at the fixed-response items in Table 1 it is clear that the majority (53%) chose a printed text format. Most of the open-ended responses given explained why students preferred printed text. The largest group (20%, 100/491), wanted print text because of the problems or *negative aspects of digital* text. Repeatedly, respondents said that being online was too distracting. They knew they would be "tempted to check social media" or "having the Internet makes me want to watch NETFLIX instead of study." Respondents noted eyestrain and difficulties with "internet access," "crashes," "dead batteries," and their own lack of technical expertise. One student summed up the sentiments of others by saying, "I've never had to call tech support for a textbook."

A second theme that emerged was preference for print textbooks because of the *tactile* or physical properties of books (19% or 92/491). Respondents commented: "I like the feeling of the pages." "I want to hold the actual text and problems in my hand." "I feel like I can understand the curriculum more when I'm physically holding it." "I have to be able to trace numbers with my fingers, and also hear what's being explained to memorize things." "Something about being able to touch the book and flip the pages helps me process the information better." Hou, Rashid, and Lee (2017) explained that the tactile interactions with paper may "afford readers richer sensorimotor engagement with the text compared to screen text" (p. 84), which may activate multiple sensory modalities, thus aiding comprehension. This concept has been referred to as "Medium Materiality Mechanism."

Print as a *better learning tool* was a third theme identified by approximately 16% or 79/491. Respondents elaborated: "Print book is easier to read;" "Easier to comprehend;" "More straightforward and easier to follow;" "Better way for me to grasp the concept." Several respondents indicated that the printed text allowed them to have more control over their learning, which allowed them to learn better: "With textbook and paper, I can work the steps the way I like rather than following the steps the computer requires. —I can move at my own pace." "I can reread as many times as I need."

A fourth theme focused on *writing*-- the process of taking notes, labeling, highlighting, or marking in a printed book. Approximately 10% or 50/491 explained that a print book was "easier to take notes from" and that they "Do more writing with [a] print book, which helps learning." Additionally, students felt they could "mark important pages," and "put comments next to the problems." Several students felt strongly about the process of physically writing notes and writing out problems and saw that procedure as a memory aid, e.g., "[Information] Sticks best in my mind when I have to physically take the pen to paper and write." Another said with authority, "Writing problems on paper is statistically proven to help any type of student learn math in a more productive and successful way." Respondents did not view online materials as conducive to note taking.

The fifth theme, described by 8% (41/491) was the ability to *navigate* a printed text more easily than other types. Students said, with print it is "Easier to look back," "Can flip between pages," "[Print is] better to use as a reference" because it is "difficult to scroll online."

This navigational facility is referred to by Li, Chen and Yang (2013) as a "Cognitive Map Mechanism." Just as an individual constructs a mental map of a physical environment this mechanism is thought to allow a reader to construct a mental map of a text. The mental map aids in location and recall of information. "Lack of an effective cognitive map of the text structure," according to Li et al., "could hurt reading comprehension" (p. 92).

A sixth theme was *visualization.* Slightly more than 5% (27/491) of respondents specifically noted what they believed to be the superior visual characteristics of printed text: "Easier to see;" "Can see how it's done;" "Like to see diagrams and problems worked out;" "Like having it close to my face;" "I need to see things being taught or I won't comprehend."

A similarly small number (5% or 27/491) said they preferred print textbooks because "Print is how I've always been taught so it's easier for me" and print is "More comfortable therefore less stressful." *Tradition*, a powerful though small factor, is a seventh and final theme.

Preference for digital text. Only 11% of open-ended responses indicated a preference for digital texts. Unfortunately, this group also provided less explanation for their preferences.

The 7% or 33/491 of respondents who said they preferred using a digital text to learn mathematics did so because it was more *interactive.* They explained, "Interaction allows for more practice and better understanding of material." "I learn by doing instead of watching;" "Allows for more practice;" "More engaging." Another 3% or 15/491 saw the digital text as a surrogate *teacher:* "Helped clear misunderstanding when a teacher was unable to help;" "I like to know how to fix my mistakes and be given an opportunity to correct those mistakes." "Every step is explained and then I do it."

Approximately 2% (12/491) found better *visual* characteristics, embedded in multimodal text: "Video and audio can help explain." A few, (1%, 6/491), saw stronger navigational properties in digital: "Online I can just look up the section and look for the key words that I need" when *navigating* a digital textbook. Others (1% or 6/491) liked its convenience.

Preference for e-book/electronic text. Fewest of those providing open-ended feedback (5%), indicated preference for an electronic format. Participants (3% or 14/491) identified *convenience*, due to ease of portability, as a quality of e-books: "I can access it anywhere." "Print can get annoying to lug around. That's where the electronic textbook comes in handy." As with the other two text types, a small number of participants (1% or 6/491), believed the *visuals* were a strength of e-books. One individual thought it was "*less expensive.*"

Text access. When examining text preferences, a realistic consideration is text access. A majority of students (84%) indicated they "Always" or "Often" had access to a printed mathematics textbook and 61% said they "Always" or "Often" used that printed text. On the other hand, 37% reported "Always" or "Often" having access to an electronic text and 20% "Always" or "Often" using one. Digital text access was lower, with 24% having access "Always" or "Often" and 16% "Always" or "Often" using one. Nevertheless, according to Baron (2015), preference for printed text has been "consistent: When asked, the majority—sometimes the vast majority—say they prefer reading in print" (p. 12).

This aligns with open-ended feedback in the MLS where no student expressed a preference for digital or e-textbooks, even though 86% or 735/855 of total survey respondents indicated that they "Always" had "access to the Internet at home."

When students used a textbook, "Regardless of text type," they were asked to identify "the following textbook features [that] helped me understand concepts better." Of the 826 who responded to this item, the textbook features chosen are listed below in descending order of respondent preference.

The majority of respondents reported using some textbook features. Within these instructional materials, learning the language of mathematics appeared to be useful to respondents. This was seen in Table 2 where 64% marked "Explanations," 58% marked "Definitions," and 48% marked "Highlighted Vocabulary" as helpful aids for understanding concepts. In a separate Likert item 50% of participants marked that learning math vocabulary "Always" or "Often" "helped me understand math better." Nevertheless, one-third reported "Never" or "Rarely" reading their textbooks.

ISSN 2165-7874

Table 2

Textbook features reported by students as helpful for understanding concepts

TEXTBOOK FEATURE	%	Number that chose each text feature
Examples	85%	698/826
Answers/Solutions	76%	626/826
Practice Problems	75%	621/826
Explanations	64%	528/826
Definitions	58%	477/826
Visuals (Diagrams, Tables, Pictures, etc.	57%	467/826
Highlighted Key Information	49%	406/826
Highlighted Vocabulary	48%	396/826
Headings/Subheadings	37%	308/826
Checks for Understanding	37%	303/826
Objectives	31%	257/826
Real-World Applications	31%	254/826
Glossary	30%	246/826
Summaries	28%	235/826
Interactive Functions	21%	176/826
Multimedia	10%	84/826
Extensions/Challenges	8%	70/826
Not Applicable/No Textbook Used	4%	31/826
None of These Used	2%	20/826

The use of “precise mathematical language” has also been emphasized recently in the literature. For example, Star et al. (2015) in conjunction with the Institute of Education Sciences (IES) noted that “using precise mathematical language…is a key component to understanding structure and sets the foundation for the use of reflective questioning, multiple representations and diagrams” (p. 17). Also, IES researchers believed that informal mathematical language could introduce “misconceptions and confusion during standardized assessments when precise language is used” (p. 24).

Learning Practices

Both Likert items and open-ended feedback provided insights into the mathematics learning practices reported by participants. In the item, “What is the best way to learn math?” 79% of those who completed the survey provided written feedback about their personal practices. Four sub-themes within learning practices emerged: the need for a good teacher, use of practice, examples, and questions.

Teacher. In their open-ended feedback nearly half of the respondents (45% or 303/674) reported that first and foremost they needed a “teacher,” “instructor,” or “professor” to help them succeed in mathematics. Further, students stated that they did not want just any teacher, they specified that they needed a “good teacher,” a “patient” one, “excited to teach math,” who is “experienced,” “who knows the material,” with whom they could work “face to face” rather than [through] email. One student made it clear that a setting in which the teaching was removed, was not acceptable: "I don't like having to teach myself. I don't like the flipped classroom setting. That is a waste of tax dollars."

Practice. Indicating that "practice makes perfect," 32% (217/674) of participants admitted that they needed "practice problems "and "practice every day"— "guided practice," "practice in class," "Practice on your own," "practice in silence," "harder practice problems," "practice with all scenarios." Further, they wanted teachers to provide "slow," "step-by-step," "detailed" instruction (7%, 50/674) so they understood the information well enough to continue their practice and be able to move to independent practice. Researchers Star et al. and IES (2015) recommended "worked examples," which combined practice and examples by showing students both the solved problem and each step used to reach a solution to the problem.

In a separate Likert item in the MLS, 39% of respondents noted that they "Always" or "Often" "worked practice problems on my own to understand math better." Another 35% reported engaging in this practice at least "Sometimes" and almost 87% said they "Always" and "Often" "worked practice problems assigned by my teacher." As indicated in Table 2, use of practice problems with the answers was a frequently used feature of their textbooks as well.

Examples. Another instructional practice mentioned by students when describing how they best learned math was a plentiful supply of "examples" (about 16% or 107/674). Based on the language used by respondents, working with examples seemed to connote independence, an affordance that would move students along an instructional continuum. When they described working on examples, respondents used such descriptions as "working myself on examples," "alone with examples," "working examples at my own pace," "examples that I can apply later," "examples and application." Once again, as noted by respondents in Table 2, one regular source for examples and the most frequently used text features were examples from their mathematics textbooks.

Questions. In addition to the teacher, participants also indicated that they learned from others, especially by asking questions. Repeatedly, students wrote that they wanted to work "one-on-one" so they could "ask questions." They wanted to ask "questions about concepts, not just examples." Understandably, many "don't want to feel dumb for asking questions" and remind themselves to "Always ask questions no matter how nervous you are." Another confessed, "There's nothing as awful as being confused and then afraid of asking for help in fear of judgement." Establishing an atmosphere in which one could make mistakes and where questions were welcome was emphasized by 8% or 55/674 of the open-ended responses.

Incorporating questions and self-questioning strategies have also been recommended by researchers discipline-wide. In their 2015-practice guide, "Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students," Star, et al. advised incorporating "reflective questioning" or "thinking aloud while solving a problem" (p. 19). This metacognitive questioning strategy suggested that teachers write down the questions they ask themselves to demonstrate their thinking processes; then have students work in pairs, writing down their own reflective questions while solving a new problem. The goal was for students to use think aloud/ reflective questioning independently as they moved through the process of problem solving.

School Structures

In the survey's Likert and multiple-choice items students were asked about participating in such arrangements as collaborative groups, flipped classrooms, clubs and competitions. Once again there was some overlap between fixed-response items and open-ended responses. When information was gathered from both of these sources four sub-themes emerged: mixed structures, collaboration, flipped classrooms, clubs and competitions.

Mixed Organizational Structures. Similar to Buehl's (2011) "Gradual Release of Responsibility Model," in which learners move from "teacher regulation," to "supported practice (scaffolding)," to "student regulated learning," (p. 27) or Star et al.'s (2015) whole-class, small-group, independent practice, respondents discussed the value of a combination of organizational structures when learning mathematics. Many participants suggested the process should start with the teacher providing step-by-step instruction, then students working in groups in class, doing homework independently, then coming back with questions for discussion. Along this line, when asked in the multiple-choice item to indicate when they "learn math best," 25% marked, "When working with others" and a smaller percentage (18%) indicated they "learn math best… When working alone." However, the largest percentage (56%) indicated they "learn math best" when given opportunities to participate in classrooms using "both" collaborative and independent work opportunities.

Collaboration. Almost one fourth (23% or 157/674) of those who narrated their best way to learn mathematics noted the importance of collaboration or "working with others in an interactive way." "Talking things through with teachers and peers" was described as important for learning mathematics. Some preferred "small groups," some "Build[ing] a study group outside of class," others "together as a class," with "peers," as a "team," "teaching it to others," or having "a classmate explain how to do it." One participant mentioned "lik[ing] groups because it can help me understand things from a different perspective." Respondents made it clear that these were not social groups; these were "helping groups." Need for interaction with others, was explicit. Further, on the Likert items, 59% marked that "Always" or "Often" "In math classes, I worked with others." Expecting students to collaborate is in line with practices called for by those trying to achieve the "rigor" (i.e., thinking, reasoning and depth of knowledge) called for in the Common Core State Standards for mathematics. For example, Hull, Balka, and Miles (2013) urged school principals to see that students collaborate as a method for incorporating rigor. Additionally, Star et al. in conjunction with IES (2015) suggested the use of a wide range of cooperative learning strategies including "think, write, pair, share;" "jigsaw;" "directions for a friend" and "numbered heads together" (p. 25).

Flipped Classroom. A classroom structure increasing in popularity with each passing year (Project Tomorrow, 2015) is the "flipped classroom." The goal is to encourage active student engagement and ownership of learning via reading, use of supplemental videos, or problems worked outside of the class. Then, in class teachers can observe students, assess, provide feedback, or explore topics in greater depth (Flipped Learning Network, 2014). To learn more about participants' experience with this class structure, survey authors asked students the degree to which they participated in flipped classrooms. Responses indicated that 41% "Rarely" or "Never" participated in flipped classrooms, 33% "Always" or "Often" did and 26% did so "Sometimes."

According to those represented in the *Speak Up 2014 National Research Project Findings*, 'flipped learning' is showing 'positive results.' However, one problem with interpreting responses in the MLS without additional follow up is that there have been nation-wide inconsistencies in defining a flipped classroom (Abeysekera & Dawson, 2015).

Clubs and Competitions. Finally, 86% of respondents indicated in a yes/no survey item that when they participated in "extracurricular" structures like "math clubs" or "math competitions," it helped them "learn math better." Supportive of these kinds of activities, Gottfried and Williams (2013) also found that "math club participation was related to higher cumulative high school math GPAs" (p. 18). Additionally, their longitudinal data showed that "students who participated in math or science clubs would select STEM majors in college" (p.18). This research aligned with earlier studies (e.g., Lipscomb, 2007), which found that secondary students who participated in extracurricular clubs demonstrated increased math and science test scores. Reasons for the positive effects of clubs were thought to be the development of positive social networks, leadership skills, self- efficacy and interests in mathematics and science. Despite the fact that MLS survey students said they recognized the value of math clubs, etc., when asked if they participated in those extracurricular activities, 90% of respondents said, “No.”

A very small number of the hundreds who responded (approximately 1% or 10/674) admitted, “I have no idea how to learn math. I have always done fairly poorly,” and seemed resigned to their difficulties stating, “Failure is OK. Nobody is perfect.”

Conclusion

In order to fill a gap in the literature on student learning and improve the pedagogical effectiveness of mathematics and literacy faculty in a Midwest teacher education program, recent high school grads were surveyed. Both structured and open-ended items were developed. Responses were received from 855 students who used individual reflection (metacognitive awareness) to identify the instructional materials, practices and school organizations that helped them best learn mathematics. Their responses frequently aligned with good practices found in the research literature.

Instructional materials noted by students as beneficial were printed textbooks that included examples, answers with solutions, practice problems, explanations, definitions and visuals. Students found printed texts preferable to digital or electronic texts because print was more dependable, tactile, lacked distractions, and was easier to navigate and notate. A majority in this study also had access to printed text. Researchers like Mizrachi (2015) have concluded that print seems to be preferred when reading longer, more difficult text that required deeper learning and an electronic format was preferred for reading shorter material like email, or for scanning for facts or definitions. Mathematics is often perceived as difficult. Since one-third in this survey reported not reading their textbook, teacher guidance was likely needed.

This issue may come into conflict with the current practice of many schools to move all of their instructional materials online and provide students with laptops or iPads, thus eradicating a “digital divide.” However, if students view print as the preferred medium, they may want to print out electronic materials in order to annotate or highlight, or they may want to purchase a print copy of a textbook. Unfortunately, these approaches can be expensive and individuals with more money are advantaged, thus creating a ‘print divide’ (Mizrachi, 2015).

Baron (2015) noted that the decades of studies that have compared reading on screens to reading in print are “reporting essentially no differences” in factors like “comprehension” or “reading speed.” Therefore, perhaps options in text choice or multiple texts could be made available. Students may have suggested that approach when 29% indicated a preference for multiple or a combination of texts. This survey should be redone in a few years to reassess student learning preferences.

Students also preferred to watch instructional videos when learning mathematics. Notes, and “guided notes” in particular, were other materials that helped keep them less distracted and more engaged. Along with these materials was the expressed need for practice and use of practice problems, “with all scenarios.” Students also requested lots of examples and the opportunity to be taught in an environment where they could ask all questions needed.

Respondents believed they learned mathematics best in structures that allowed them to collaborate with peer “helping groups” but also work independently. They acknowledged that they learned math better when they participated in extracurricular structures like math clubs, or math competitions but admitted that they did not do so. Perhaps, again, teacher encouragement and guidance were needed.

Quality materials, sound practices, and supportive structures are not enough to learn mathematics. A good teacher provides a critical piece of the equation. MLS authors are embarrassed to admit that they did not include a survey item about teachers. However, almost half of the students who replied to the open-ended questions, made clear the importance of a "good teacher." Comparing this number (45%), to the few (4%) who said a textbook best helped them learn mathematics, should indicate a needed shift in nationwide spending, from textbooks to teachers. Unfortunately, finding a highly qualified teacher of mathematics has become more difficult recently as "states across the country are experiencing subject area teacher shortages. In fact, in the 2015-2016 school year…42 states plus DC [reported shortages] in mathematics" (Sutcher, Darling-Hammond & Carver-Thomas, 2016). Calls to attract thousands of "America's brightest students to the teaching profession" in the area of mathematics have been heard for a decade (National Academy of Sciences, 2007). The importance of recruiting mathematics teachers cannot be underestimated because students' performance on standardized tests is usually associated with teachers' qualifications—the more highly qualified the teacher, the higher the student performance (e.g., Darling -Hammond, Holtzman, Gatlin, & Heilig, 2005). The effects of test performance may be seen in the form of jobs and in the U.S. economy.

Participants in the present study were individuals who did well enough to gain admittance to a Research I university. However, when asked "When do you like to do math?" only 23% marked "Always" or "Often" and almost twice that number (41%) indicated "Rarely" or "Never." Perhaps if student voices are heard and addressed, motivation for learning mathematics would increase. Such practices, in addition to giving students a voice, align with the research of Cannata, Haynes and Smith (2013,) in "Reaching for Rigor: Identifying Practices of Effective High Schools" that concluded, "increasing student ownership…emerged as a distinguishing feature of schools with higher…student achievement" (p. 6).

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