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A. Susan Gay, Arlene L. Barry, Katrina S. Rothrock, Melissa M. Pelkey
University of Kansas, Department of Curriculum & Teaching, Lawrence, KS USA

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Abstract

A survey of 80 United States middle and high school mathematics student teachers gathered data on availability and use of textbooks and traditional and technology-supported instructional strategies. Findings about textbooks include (1) most classrooms had one or more textbook formats (print, digital or e-textbook) available but did not necessarily expect students to use the textbook; (2) some differences were noted when comparisons were made based on school location, size, and grade level; and (3) student teachers preferred the digital textbook format but there was also support for the print format. Analysis of student teachers' self-reported use of instructional strategies, including a principal component analysis, revealed use of traditional teaching strategies and student-centered teaching. Student teachers' views about how best to teach mathematics centered on themes of active learning and ways to meet students' needs.

Introduction

Anecdotes and research studies are documenting changes in mathematics classrooms. Teachers who are given the opportunity to choose instructional resources may choose new materials or familiar materials in new formats. Other teachers experience pressure to change their resources, technology, or instructional approaches, whether or not they are inclined to do so. Some teachers have no access to traditional resources such as textbooks, or they prefer to use something other than a textbook, and choose to search the internet for worksheets, activity sheets, and lesson plans. The 2012 National Survey of Science and Mathematics Education (NSSME) report (Banilower et al., 2013) gathered information from a sample of teachers across the United States about the availability and use of instructional resources, including textbooks. The data showed that more than 80% of middle and high school mathematics classrooms used published textbooks/programs, and of those, more than 50% used only one commercially published textbook or program most of the time.

A noticeable change is occurring in the format and methods of access to textbooks (Choppin, Carson, Borys, Cerosaletti & Gillis, 2014; Rockinson-Szapkiw, Courduff, Carter, & Bennett, 2013; Usiskin, 2013). Publishers are increasing production of digitally-accessed textbooks for students (Usiskin, 2013), a venture that has been supported by the U.S. government, which set a goal of providing a digital textbook for every child by 2017 (e.g., Toppo, 2012). Many school districts across the United States are adopting digitally-accessed textbooks in an effort to both save money (Hui, 2013) and stay current (McCarty, 2015). The increased availability of electronic and online resources is having an effect on teachers' usage of instructional strategies and non-technology resources (Roberts, 2017). While the NSSME report documented frequent use of longstanding instructional strategies such as explaining mathematical ideas to the whole class and resources such as manipulatives (Banilower et al., 2013), other instructional strategies such as a flipped classroom and regular use of video are increasingly present in mathematics classrooms (Lo & Hew, 2017; Project Tomorrow, 2015). A 2014 survey of school leaders at all grade levels by Project Tomorrow and the Flipped Learning Network (Project Tomorrow, 2015) reported an increase over a three-year period in teachers using videos they found online (23% to 32%) and an increase in teachers creating their own videos (19% to 29%).

In 2015, our student teachers placed in local schools were participating in changes to how teachers and students accessed materials because local districts were limiting access to physical textbooks and encouraging more electronic access. Conversations with teacher education colleagues in other states generated interest in knowing more about whether school districts across the United States were making similar changes. A survey was developed about the resources and strategies used to teach mathematics, and student teachers in middle and high school classrooms across the United States were invited to share information about their views and experiences. The research questions guiding this study were:

- What formats of textbooks are available to and preferred by mathematics student teachers for use by their students and are there differences when school characteristics (size, location, middle or high school level) are considered?
- What instructional materials and strategies are student teachers using to teach mathematics?
- What teaching profiles are suggested by student teachers' use of instructional strategies?
- What do student teachers say is the *best way* to teach mathematics?

Background

Mathematics Textbook Formats

As schools invest in 1-to-1 and Bring Your Own Device initiatives (Avery, 2016), students and teachers have more digital access to textbooks (Choppin et al., 2014; Usiskin, 2013). Textbook companies consistently offer electronic versions of textbooks to replace or supplement traditional mathematics print textbooks (Choppin et al., 2014; Usiskin, 2013). Some versions have interactive components and multimedia content like video clips and animation while others are simply an image of a print text such as a pdf file viewable on a digital device (Choppin et al., 2014; Rockinson-Szapkiw et al., 2013). Still others are more elaborate versions that act as assessment systems, generating student data and controlling access to content, and have features that encourage student interaction and communication (Choppin et al., 2014; Usiskin, 2013). Although there are a growing number of digitally-accessed mathematics textbook offerings, Usiskin (2013) predicted that electronic and print mathematics textbooks will coexist, with teachers and students utilizing both in some yet to be defined combination.

Open Educational Resources

Open educational resources (OER) have been described as "materials that can be used and replicated free of charge because their copyright exists in the public domain" (McShane, 2017, p. 2). Included as OER are lessons shared by classroom teachers, videos, assessment items, and even complete online courses and digital textbooks (McShane, 2017; U.S. Department of Education [USDE], 2017). The use of OER in addition to, or instead of published textbooks, is increasing (Cavanagh, 2015; McShane, 2017; USDE, 2017) due to the opportunity to maintain up-to-date content that meets current state standards (Kaufman et al., 2017; Webel, Krupa, & McManus, 2015); the opportunity for teachers to collaborate to best serve their students' needs (McShane, 2017; Webel et al., 2015); and the savings in textbook costs at a time when district budgets are being cut (Cavanagh, 2015).

As mathematics teachers began implementing the Common Core State Standards for Mathematics, a national survey of middle school teachers found that many teachers were not following a textbook but were regularly using electronic and/or digital resources (McDuffie et al., 2017). In 2015, the U.S. federal government began to promote the creation and adoption of OER with the initiation of the #GoOpen campaign, including the development of the Learning Registry repository of open resources (McShane, 2017). The 2017 National Education Technology Plan encouraged the adoption of high-quality openly licensed educational materials for use in K-12 classrooms (USDE, 2017).

Digital Divide

By the 1990s, personal computers and the internet had become common in many households, and policymakers and researchers recognized the existence of a digital divide, a phenomenon of increasing disparities in computer access and use across populations (Strover, 2014). Prensky (2001) coined the term *digital native* to describe a person who has grown up in this digital era, generally considered those born since 1980.

By the turn of the millennium, users were accessing digital tools differently, and for a variety of purposes (Strover, 2014). National surveys found that the varying use of technology had much to do with demographic characteristics like age, gender, level of income, and level of education (Strover, 2014). One of the impediments to some communities was an inadequate infrastructure for broadband, making it difficult for community members to use the internet effectively (Stern, Adams, & Elsasser, 2009). This heavily impacted rural communities that have been more likely to use slower forms of internet technologies (Stern et al., 2009; Strover, 2014) and experience poor connection quality (Strover, 2014) both associated with less technological proficiency (Stern et al., 2009). In urban areas, where a broadband infrastructure already existed, districts have received funding to expand student access to technology in order to address noticeable interurban digital inequities (Hess & Leal, 2001). Growing implementation of one-to-one initiatives has increased the frequency and breadth of student technology use at all grade levels (Zheng, Warschauer, Lin, & Chang, 2016).

Instructional Strategies and Resources

Mathematics teachers use a variety of instructional strategies and resources. The 2012 NSSME documented the frequency of use of some strategies in middle and high school mathematics classrooms (Banilower et al., 2013). In all or almost all lessons, teachers explained mathematical ideas to the whole class (71%/72% (middle/high)) and engaged the whole class in discussions (59%/48%). Less frequently but at least once a week, teachers had students work in small groups (70%/63%); asked students to read from a mathematics textbook or other mathematics-related material in class (34%/25%); and provided manipulatives for students to use (33%/18%).

Note-taking is a frequent classroom activity. Guided notes, an alternative to traditional note-taking (Konrad, Joseph, & Itoi, 2011), are teacher-prepared handouts that provide an outline of a teacher's presentation with blank spaces where important concepts and examples will be written by the student during the classroom presentation (Haydon, Mancil, Kroeger, McLeskey, & Lin, 2011). Teachers use guided notes to increase the accuracy of note-taking (Konrad, Joseph, & Eveleigh, 2009) and increase student engagement during lectures (Haydon et al., 2011; Konrad et al., 2009).

Teachers commonly use textbooks as an instructional resource. Even though textbooks are meant to be read by students, and textbook authors often include messages to students about how to read the text (Weinberg & Wiesner, 2011), teachers lack a confidence and willingness to teach students how to read texts (Carter & Dean, 2006; Metsisto, 2005). However, teachers are willing to engage in vocabulary instruction to support students' understanding of mathematical concepts and procedures (Carter & Dean, 2006). Researchers at TeachingWorks (2017) focused their attention on beginning teachers and developed a list of routine practices that have been shown to be particularly important to advance learning about content. Among those high-leverage teaching practices relevant to the present study are explaining content, leading a group discussion, setting up and managing small group work, and providing oral and written feedback to students.

Among the newer technology-supported instructional approaches are flipped classroom and blended learning. A flipped classroom exists when instructional time is organized to reverse the activities traditionally occurring during and outside of classtime (Project Tomorrow, 2015). In one common type of flipped classroom, students are expected to watch instructional videos or online lectures before arriving in class so that classtime can be spent doing learning activities, often in small groups. Teachers flip because they hope that their students will experience mathematics differently, be more engaged, develop deeper understanding, and gain more positive attitudes toward their mathematical studies (de Araujo, Otten, & Birisci, 2017). Blended learning is a phrase used to describe a variety of classroom environments or instructional programs that utilize a blend of technology and face-to-face learning (Christensen, Horn, & Staker, 2013). In particular, a "student learns at least in part through online learning with some element of student control over time, place, path, and/or pace *and* at least in part at a supervised brick-and-mortar location away from home" (Christensen et al., 2013, p. 7). Advocates choose blended learning models in order to improve student engagement, personalize learning, and place the student at the center of the learning process (Christensen et al., 2013).

Method

Procedures and Participants

Mathematics teacher educators in 16 states were contacted and 29 of them forwarded the information letter and an online survey to university student teachers in either Spring or Fall 2016. Survey items requested information about the school where the student teacher was working and gender and ethnicity of the student teacher. Other items asked about the materials, including three different textbook formats, and instructional strategies used by the mathematics student teacher. Some survey items about instructional strategies were related to items used in the 2012 NSSME (Banilower et al., 2013) and/or on the list of TeachingWorks' (2017) high-leverage practices.

Feedback from a field test and a focus group informed the survey development. In Fall 2015, a first draft of the survey was field tested with five mathematics student teachers at one university. In addition to answering the items on the survey, they wrote comments about the feasibility of a student teacher being able to answer the items and noted where wording seemed to be confusing. This feedback was used to develop a second version of the survey. In February 2016, a focus group of six middle and high school mathematics teachers in one district completed the revised survey individually and supplied written feedback, then as a group they provided oral feedback. Subsequent changes to the survey involved eliminating some items and changing wording in item statements and responses. The final version of the 32-item survey included items about demographic information, items with Likert-scale responses, items asking for rank order, and items that requested open-ended responses.

The field test and use of a focus group of content experts helped establish content validity of the survey. Descriptions of possibly unfamiliar phrases were included in survey items to increase the likelihood that each respondent understood the statements. Descriptions of a digital textbook as a text with interactive components and multimedia content and an e-textbook as an image of a print text such as a pdf file were taken from Rockinson-Szapkiw et al. (2013). Reliability for the Likert-scale survey items was established using Cronbach's alpha; the value was 0.727.

Eighty student teachers located in 16 different states across the East (7), Central (6), and Mountain/Pacific (3) timezones of the United States participated by responding to all or most of the survey items. Participants taught a wide range of mathematics courses in grades 5-12 in middle schools (36%), high schools (62%) and other (2%). They taught in urban (30%), suburban (53%), and rural (17%) public schools and in schools with less than 750 students (43%) or schools with more than 750 students (57%). Respondents identified themselves as primarily female (76%) and White (89%); 4% self-described themselves as Asian, 4% as Hispanic, 2% as Black and 1% as Other.

Results

Results about Textbook Formats

Availability and Use

Student teachers were asked which format(s) of textbooks were available to students and which format(s) students were expected to use. Respondents were allowed to select all that applied to their classroom. Results are provided in Table 1. Six student teachers noted that they had all three formats of textbook available. There were 17 who only had access to a print format of their textbook, whereas 27 student teachers did not have any access to a print format. Of those without a print textbook, 11 noted that their students did not have access to any of the three listed textbook formats, answering that only other resources were available.

Table 1. Textbook Format Availability and Expected Use

Textbook Format	Format is Available to Students (n = 78)	Students Expected to Use this Format (n = 77 [a])
Print Textbook	51 (65%)	36 (47%)
e-textbook	29 (37%)	23 (30%)
Digital Textbook	24 (31%)	20 (26%)
Other Resources	22 (28%)	28 [b] (36%)

Note. Percents total more than 100% since responses allowed more than one choice.
[a] One participant did not respond about expected use.
[b] Due to response error or misunderstanding, more student teachers said that other resources were used than said other resources were available.

Even when a textbook format was available for student use, the student teacher did not necessarily expect students to use it; 29 of the student teachers (38%) did not expect students to use all of the textbook formats that were available to them. Table 2 disaggregates the expected use of textbook formats that were available to students. Even when one or more of the three listed textbook formats were available, at least a quarter of respondents did not expect their students to use one or more of those formats.

Some student teachers used other resources, no matter which textbook formats were available for student use. Twenty-two student teachers (29%) expected students to exclusively use other resources, even though 12 of those had access to a textbook in some format.

Table 2. Expected Student Use of Available Textbook Formats

	Print available (n = 51)	e-textbook available (n = 29)	Digital available (n = 24)	Other available (n = 22)
Expected use of available format	36 (71%)	20 (69%)	18 (75%)	18 (82%)

Table 3 displays information about textbook format availability and use disaggregated by school location. Student teachers in rural schools had minimal access to a digital textbook or an e-textbook. Fewer print textbooks were available in urban school settings compared to suburban or rural schools.

Table 3. Textbook Format Availability and Use by School Location

	Rural (n = 13)		Suburban (n = 40)		Urban (n = 24)	
	Available	Used	Available	Used	Available	Used
Print	11 (85%)	8 (62%)	28 (70%)	20 (50%)	12 (50%)	8 (33%)
e-textbook	3 (23%)	2 (15%)	18 (45%)	14 (35%)	8 (33%)	7 (29%)
Digital	1 (8%)	0 (0%)	14 (35%)	12 (30%)	9 (38%)	8 (33%)
Other	4 (31%)	4 (31%)	11 (28%)	13 [a] (33%)	7 (29%)	11[a] (46%)

Note. Percents total more than 100% since responses allowed more than one choice.
[a] Due to response error or misunderstanding, more student teachers said that other resources were used than said other resources were available.

Smaller schools did not differ much from larger schools with regard to textbook format availability, except that fewer student teachers in smaller schools expected their students to use an e-textbook or digital format, even if it was available to their students. Table 4 shows the data regarding textbook format availability and use disaggregated by school population size.

Table 4. Textbook Format Availability and Use by School Population

	Less than 750 Students (n = 34)		Greater than 750 Students (n = 43)	
	Available	Expected Use	Available	Expected Use
Print	23 (68%)	16 (47%)	28 (65%)	20 (47%)
e-textbook	13 (38%)	9 (26%)	16 (37%)	14 (33%)
Digital	11 (32%)	5 (15%)	13 (30%)	15 [a] (35%)
Other	10 (29%)	12 [b] (35%)	12 (28%)	16 [b] (37%)

Note. Percents total more than 100% since responses allowed more than one choice.
[a] Due to response error or misunderstanding, two student teachers expected their students to use a digital textbook format even when they did not indicate that a digital format was available.
[b] Due to response error or misunderstanding, more student teachers said that other resources were used than said other resources were available.

Although middle school and high school students had relatively similar access to print, e-textbook, and digital textbook formats, student teachers in high schools expected their students to use a print textbook more often (53%) than those teaching in middle schools (32%). With the exception of the print textbook, middle school student teachers anticipated that their students would use the textbook format available to them. High school student teachers anticipated lower rates of use for a digital textbook format, and an increased use of other resources. The results about textbook format availability and use are disaggregated by grade level (Table 5).

Table 5. Textbook Format Availability and Use by Grade Level

	Middle School (n = 28)		High School (n = 47)	
	Available	Used	Available	Used
Print	17 (61%)	9 (32%)	32 (68%)	25 (53%)
e-textbook	10 (36%)	10 (36%)	18 (38%)	15 (32%)
Digital	10 (36%)	10 (36%)	14 (30%)	10 (21%)
Other	10 (36%)	10 (36%)	12 (26%)	15 [a] (32%)

Note. Percents total more than 100% since responses allowed more than one choice. Two respondents identified their student teaching placement grade level as "other," and were not included in this table.
[a] Due to response error or misunderstanding, more student teachers said that other resources were used than said other resources were available.

Student Teacher Choice

Student teachers were asked to rank the type of text they would choose to have their students use and 67 respondents made a first choice. The survey offered the following choices: Print Textbook, E-textbook, Digital Textbook, No Textbook, Other. A digital textbook was the first choice for 35 (52%) and a print textbook was the first choice for 24 (36%). Another 4 (6%) ranked *no textbook* as first choice, 2 (3%) chose e-textbook and 2 (3%) chose Other. When considering their top two choices combined, 89% selected a digital textbook format; 63% selected print; 32% selected an e-textbook; and 21% selected *no textbook*.

Student teacher textbook format choice did not necessarily align with the textbook format that their students currently had available. Of the 24 who chose a print format, only 17 (71%) had access to a print format for their students. Of the 35 who chose a digital format, only 14 (40%) had access to a digital format for their students. Although there were 22 student teachers who had expected their students to use other resources, only 2 of the 67 respondents chose other resources as a first choice. Student teachers were asked to share the reason for their textbook format preference. For the 24 who chose print as their top choice, 45% identified access to technology as a primary concern, 26% identified a perceived importance of physically holding a textbook, 13% felt that print textbooks caused the least amount of classroom management issues, 7% described the importance of teaching students how to use a print resource, and the remaining felt that it was either the preferred format for their students or it fit best with their instructional notes.

Of the 35 student teachers who selected a digital format as their top choice, 81% felt that the interactive features possible with a digital format would benefit their students, pointing to increased access to videos, tutorials, definitions, and graphics, as well as the opportunity for immediate feedback and monitoring of student progress, increased content support through differentiation opportunities, increased engagement, and the opportunity to see more real-life applications of the material they were learning. Another 8% felt a digital resource was more appropriate for students preparing for a technologically advanced world. Accessibility, ease of use, and organizational structure were identified by 9%, and 2% felt that students lacked interest in reading print books in general, so a digital format was preferable.

Data about first choice of text format disaggregated by school location are provided (Table 6). Student teachers in suburban schools were more likely (38%) to select a print format as first choice, compared to those in rural schools (31%) or urban schools (21%). However, a digital format was preferred by more student teachers, no matter where they were teaching.

Table 6. Textbook Format Availability and Choice by School Location

	Rural (n = 13)		Suburban (n = 40)		Urban (n = 24)	
	Available	First Choice	Available	First Choice	Available	First Choice
Print	11 (85%)	4 (31%)	28 (70%)	15 (38%)	12 (50%)	5 (21%)
e-textbook	3 (23%)	0 (0%)	18 (45%)	2 (5%)	8 (33%)	0 (0%)
Digital	1 (8%)	7 (54%)	14 (35%)	19 (48%)	9 (38%)	13 (54%)
Other	4 (31%)	0 (0%)	11 (28%)	1 (3%)	7 (29%)	1 (4%)
None [a]	n/a	1 (8%)	n/a	3 (8%)	n/a	0 (0%)

Note. Not all participants responded with a first choice for a textbook.
[a] "None" was not an option when indicating textbook format available to students, but was an option when selecting a first choice

When student teachers were separated into two groups according to school population, less than or greater than 750 students, first choices for text format were similar with about one-third choosing print, about one-half choosing digital, and few making other choices. Student teachers in middle or high school settings made similar first choices for textbook format. About 50% at each school level preferred digital, about 30% preferred print, about 5% preferred no textbook, and few chose e-textbook or other resources.

Results about Instructional Strategies and Resources

The student teachers were asked about the frequency of their use of selected classroom materials and instructional strategies. These survey items were Likert-scale items that began with "I teach…" and had five response options that were *Always*, *Most of the time*, *About half of the time*, *Sometimes*, and *Never*.

Responses to six statements revealed high levels of use. Student teachers taught using explanations (88% always or most of the time), demonstrations (90%), and student and teacher dialogue or discourse (71%); mathematics vocabulary (82%); and by providing feedback (92%) and having students collaborate (68%). Student teachers were asked about three sources for instructional videos and, for all three, their responses indicated infrequent use. More than 40% never used any of the types of videos. A few (17%) sometimes or more often used videos they created themselves. More respondents sometimes (52%) or more often (7%) used instructional videos available from organizations such as National Council of Teachers of Mathematics (NCTM), Public Broadcasting Service, Khan Academy, or publishing companies and about half sometimes (39%) or more often (6%) taught mathematics using instructional videos made by other mathematics teachers.

Responses to five statements revealed diverse levels of use. Student teachers had students use writing to explain their thinking process and answers; 20% did this most of the time, 33% did this about half of the time, and 37% did this sometimes. Only about 17% of the student teachers required their students to read from the text or other math-related materials half or more of the time. Manipulatives were used by 10% of student teachers always or most of the time, 30% about half the time, and 56% sometimes. Guided notes or Cornell notes were used by 50% of respondents about half the time or most of the time and 37% used them sometimes or never. Worksheets (bound as a workbook or as single sheets) were used by 54% about half the time or most of the time.

Unanimous or 99% use was noted on several statements. Respondents taught mathematics using explanations; used student and teacher dialogue or discourse; provided feedback; used worksheets; had students collaborate; used demonstrations; and taught vocabulary. The flipped classroom was rare among the student teachers; only 4% always taught using a flipped classroom while 61% never did.

Exploring the Presence of Teaching Profiles Using Principal Component Analysis

Responses to the 15 Likert-scale items were subjected to a principal component analysis (PCA) using ones as prior communality estimates. The principal components method was used to extract the components, and this was followed by a Varimax (orthogonal) rotation. The KMO Measure of Sampling Adequacy was a 0.639, and the Bartlett's Test of Sphericity was significant at $p < 0.001$; therefore, the data were considered suitable for component analysis. The first five components displayed eigenvalues greater than 1, and a scree test confirmed that the first five components were likely to be meaningful, so those were retained for rotation.

Even though the first analysis was conducted on 15 statements and resulted in the identification of five components, adjustments were made. The flipped classroom statement was removed from component loadings because it loaded onto two components at just above 0.40. The fifth component was also removed from consideration; this component included two statements and one of them, the discourse statement, loaded above 0.40 onto the fifth component as well as another component. The four remaining components accounted for 57.4% of the total variance in the responses (see appendix).

Component 1 was labeled Traditional Teaching, since the retained component loadings were from survey items regarding student teachers' use of explanations, vocabulary, demonstrations, and feedback as instructional strategies. Although all four survey items strongly contributed to the component, the correlation of .85 between the use of explanations and the principal component suggests that this principal component is primarily a measure of using explanations as an instructional strategy. Component 2 is strongly correlated with five of the Likert-scale items. Because the second component was a measure of the use of student collaboration, writing, reading, manipulatives, and student-teacher discourse, it was labeled Student-centered Teaching. Teachers who scored high on this component were likely to view their role in the classroom as a facilitator and guide for students.

Component 3 is predominantly a measure of the use of videos made by others for mathematics instruction. The two items that strongly correlated with this component were the use of videos made by other teachers and videos made by organizations as a mathematics teaching resource. This component was labeled Offloading, relating to the work of Brown (2009). "Curricular offloads are instances where teachers rely significantly on the curriculum materials to support instruction, contributing little of their own pedagogical design" (p. 6). Using videos created by others as a teaching strategy can be viewed as offloading the delivery of instruction. Component 4 is strongly correlated with a teacher's use of worksheets and notes as an instructional strategy. The component was labeled Worksheets because of a high correlation of .83 between this component and the use of worksheets. Without more information, it is unclear how those worksheets and notes were being used in classrooms; they may be used in conjunction with a textbook, during a project-based activity, as mastery practice, or in another capacity.

All of the student teachers identified strongly with a Traditional Teaching profile, as all of them received a component score above the mean possible, and a quarter of the teachers responded with *Always* for each of the four items that load onto this component (Table 7). About a third (many of the same participants) identified strongly with a Student-Centered Teaching profile. However, very few of the student teachers identified with an Offloading profile.

Table 7. Statistics for Participant Scores for each Component

	Possible Score Range (min, max)	Mean Possible Score	Participant scores above mean possible (n = 75)	Participants at Maximum Score	Participants at Minimum Score
Component 1 Traditional Teaching	(1.15, 5.77)	3.46	75 (100%)	19 (25%)	0 (0%)
Component 2 Student-Centered Teaching	(1.55, 7.75)	4.65	24 (32%)	0 (0%)	0 (0%)
Component 3 Offloading	(1.06, 5.28)	3.17	2 (3%)	1 (1%)	24 (32%)
Component 4 Worksheets	(1.00, 5.02)	3.01	46 (61%)	3 (4%)	1 (1%)

Student Teachers' Views about How Best to Teach Mathematics

Among student teachers' comments about the best way to teach mathematics, one theme was active learning with a focus on discovering mathematical ideas, collaboration, and hands-on experiences. One or more of these aspects of mathematics teaching were included in 49 (75%) of the 65 responses to this survey item. One student teacher wrote about these ideas saying "I believe the best way is to teach using cooperative learning and hands-on activities. When the students get to learn things for themselves and discover math concepts on their own, they are more apt to remember the concepts."

Another theme in the responses reflected a focus on determining what works for the teacher's students, which included developing a relationship with students to learn about their interests and needs and/or providing relevant real-world uses of mathematical ideas. One or more ideas in this theme were included in 16 (25%) responses. A sample response suggested "getting to know the students and their interests is one way to teach math effectively so they can apply it to their lives."

An emphasis on variety in instructional strategies, students' learning styles, and/or multiple ways to solve a problem was present in responses from 15 (23%) student teachers. One student teacher wrote "I think it is important to show students a variety of ways to solve a problem. I think that mixing up lecture style notes, peer conversation, individual practice, and interactive activities accommodate a variety of learning styles."

Other ideas about the best way to teach mathematics, each mentioned by two or three student teachers, included stressing critical thinking skills, emphasizing the importance of knowing concepts rather than just procedures, taking notes, and doing homework. The use of technology was part of six responses; other than a SmartBoard mentioned by one student teacher, no other specific descriptions were provided. In addition to meeting students' needs and addressing content, a few other aspects of teaching were mentioned. One student teacher wrote "We must teach them that mistakes are okay and we learn from our mistakes." Another's response began with "The best way to teach math is with a smile on your face and a whole ton of patience."

Discussion

Our findings from some United States mathematics classrooms confirmed that textbook formats are changing. We also learned what resources and instructional strategies student teachers used and did not use in their classrooms and what they thought would be most useful for their future students when they have their own classrooms. We discuss the findings and this study's contributions first about textbook formats and then about instructional strategies.

Textbook Format

While three textbook formats (print, e-textbook, and digital) were present in the classrooms where the participating student teachers taught, of particular note were the expectations for use. Even when one or more textbook formats were available, at least 25% did not expect their students to use any of those formats. Especially for the print textbook, only about one-half of the student teachers in high schools and only about one-third of the student teachers in middle schools expected their students to use the text. Prior research studies have documented disparities with regard to how teachers choose to use mathematics textbooks (e.g., Fan, Zhu, & Miao, 2013; Remillard, 2005) and the present study supports that conclusion noting that the disparity is there for all three textbook formats included in this study.

Other resources are being used no matter what is available as a textbook. For 29% of our respondents, their students exclusively used other resources even when about half of the classrooms had access to a textbook. Since no information was gathered about the age of available textbooks, it is possible teachers were seeking materials produced more recently and aligned with Common Core State Mathematics Standards (Common Core State Standards Initiative [CCSSI], 2010). No information was gathered in the survey responses about the nature of these resources and the places where they were found, though our own experience is that teachers are using internet-based resources. NCTM (2016) expressed a concern about risks associated with the use of OER including the broad variance in resources that are inevitable between teachers and schools which can exacerbate inequities, and the loss of transparency that otherwise exists when a school community agrees to the adoption of particular curricular resources.

The percent of rural school respondents who had digital or e-textbook formats was smaller than for respondents in suburban or urban schools, which could be indicative of the urban-rural digital divide. However, there was not a particularly strong correspondence between textbook format availability or use and school population size or grade level. Overall, these findings indicate that districts across the United States have invested in more than printed textbooks.

Student teachers had a clear preference for a digital textbook, but print was valued, too. More than one-half preferred digital when naming a first choice and almost 90% listed digital as first or second choice for their future classrooms. The print textbook was the first choice for about one-third of respondents and was either first or second choice by about two-thirds. However, the student teachers' textbook format preference did not necessarily align with the textbook format that their students had available. Perhaps the student teachers had identified problems with the format they utilized and assumed another format would be better, such as those who utilized digital textbooks during student teaching but expressed a preference for print. Our respondents' support for digital and print aligns with Usiskin's (2013) prediction that print and electronic formats of textbooks are likely to coexist.

Since 60% of the student teachers that expressed a preference for a digital textbook did not have access to one during student teaching, we wondered why and drew on our own student teachers' experiences to offer a possible explanation. Perhaps student teachers had positive personal experiences with a digital textbook in high school or university classes, in mathematics or in other content areas, and wanted to bring this resource into their own classroom. Open-ended responses suggested an expectation that students would benefit from access to interactive experiences and support systems built into digital textbooks.

Instruction

The data about instructional strategies were analyzed in three ways. Together they provide a look into a variety of classrooms and the goals of the student teachers in this study. Among the instructional strategies addressed in our survey, there were some with near unanimous regular use by the student teachers: using explanations, demonstrations, worksheets, and student and teacher dialogue or discourse; providing feedback; teaching mathematics vocabulary; and having students collaborate. With the exceptions of using worksheets and specifically teaching mathematics vocabulary, all of those are high-leverage practices listed by TeachingWorks (2017) as important capabilities, especially for beginning teachers. Strategies that utilize student and teacher dialogue and collaboration among students have long been supported in national standards (e.g., NCTM 1989, 2000). While it is impossible to know how successfully the student teachers used any of these instructional strategies, we view their experience with these important strategies as likely positive steps in their professional development.

The principal component analysis also connects our survey results with the high-leverage practices (TeachingWorks, 2017), the findings in the 2012 NSSME report (Banilower et al., 2013), and reform and standards-based practices (CCSSI, 2010; NCTM, 1989, 2000). The component labeled Traditional Teaching is a measure of the use of explanations and demonstrations which are mentioned in the NSSME report (Banilower et al., 2013) as frequently used in mathematics classrooms. The Student-centered Teaching component is composed of instructional practices that place the teacher in a facilitator role which aligns with recommendations in standards (CCSSI, 2010; NCTM, 1989, 2000). These are important connections between the survey results and long-standing and standards-based strategies.

Few student teachers responded that they used the flipped classroom. We were surprised because of the attention this approach has received nationally for several years (Project Tomorrow, 2015) and what we have witnessed in local school districts. Student teachers were using videos from other teachers and professional organizations, but few details were provided to know if the videos were substituting for teacher in-class presentations or are used in other ways. When student teachers described how best to teach mathematics, almost all of them conveyed ideas that painted a picture of a classroom where students were actively engaged with mathematical ideas and discovering concepts through collaboration with peers; where teachers were genuinely interested in learning about their students' interests and needs; and where teachers used a variety of instructional strategies and encouraged more than one approach to mathematics problems. All of these classroom characteristics align with the goals described by others (e.g., CCSSI, 2010; NCTM, 1989, 2000).

Conclusion

We chose to survey student teachers across the United States to provide a broader view than a focus on one district, state, or region. We acknowledge that decisions about instructional strategies and resources, especially textbook formats, were not the purview of the student teacher alone. For example, if the student teacher was placed with a cooperating teacher who had a flipped classroom or a classroom where guided notes were provided every day, the student teacher was likely to continue that approach. Even though student teachers were answering the survey items and some of their responses were the result of their interactions with a mentor teacher(s), there is powerful insight in the commonalities and differences exposed in the data from 80 new members of the mathematics teaching profession. We note that our survey results suggest that teacher education programs are promoting the teaching skills recommended by leading authorities in mathematics education. Student teachers' opinions can be valuable guidance to decision-makers who will make choices about textbook formats and other resources for use in mathematics classrooms.

In their report of existing mathematics textbook research, Fan et al. (2013) mentioned that only a few studies on electronic textbook use in secondary schools were available at the time of their review. Citing the rapid growth in electronic textbooks, they noted the need for more research on this format of textbook. While our study does not describe how textbooks are used, we do provide information on the access teachers and students have to digital textbooks, print textbooks, and e-textbooks.

Fan et al. (2013) mentioned inadequate research about how mathematics textbooks were used by teachers and students, asking for larger scale studies, confirmatory research, and more studies on students' use of textbooks. While our study did not respond directly, our findings do indicate that while teachers have access to textbooks, they are not necessarily asking students to use the textbooks available to them. Future research, building on our results, should inquire about why teachers are not using the textbooks they have and what differences and similarities exist among the reasons given about the three formats.

Other studies could explore the future of some instructional strategies and resources in relation to our results. In a few years, will there be more classrooms using instructional videos with or without the flipped classroom and will more classrooms be using other resources and not textbooks? More broadly, research could explore the consequences of the choices teachers are now making on the ideas students and others hold about teaching and learning mathematics.

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Author Information

A. Susan Gay
University of Kansas
Department of Curriculum & Teaching
Lawrence, KS 66045
USA
Contact email: *sgay@ku.edu*

Arlene L. Barry
University of Kansas
Department of Curriculum & Teaching
Lawrence, KS 66045
USA

Katrina S. Rothrock
University of Kansas
Lawrence, KS 66045
USA

Melissa M. Pelkey
University of Kansas
Lawrence, KS 66045
USA

Appendix. PCA Rotated Component Loadings for the Four Components

Variable	**Comp 1: Traditional Teaching**	**Comp 2: Student-Centered Teaching**	**Comp 3: Offloading**	**Comp 4: Worksheets**
use explanations	**0.85**	0.01	0.09	-0.02
teach math vocabulary	**0.71**	0.20	0.13	-0.21
use demonstrations	**0.68**	0.04	0.13	0.21
provide feedback	**0.53**	0.25	0.07	0.16
use student collaboration	0.07	**0.71**	0.12	-0.08
have students use writing to explain thinking	0.30	**0.71**	0.19	0.15
require reading from the text	0.32	**0.69**	-0.21	-0.16
use manipulatives	-0.25	**0.63**	0.18	0.31
use student/teacher discourse	0.05	**0.45**	0.32	-0.05
use videos made by other teachers	0.18	0.03	**0.86**	-0.17
use videos from organizations	0.14	0.21	**0.82**	0.18
create own videos	-0.10	0.00	0.12	0.05
use worksheets	-0.2	0.11	-0.6	**0.83**
use guided notes	0.35	-0.15	.09	**0.67**
% of Total Variance	25.0	12.6	10.3	9.5
Total Variance				**57.4%**