Elementary Pre-service Teachers and the Internet: Perceptions and Concerns

Ji-Won Son
jiwonson@buffalo.edu
University at Buffalo-SUNY
New York, USA

Qingtong Hu
qhu@utk.edu
University of Tennessee
Tennessee, USA

Abstract

Preservice teachers are encouraged to use the many available web resources for lesson planning and teaching, but little research exists on their conceptions of the resources' quality and potential for application. As part of a larger effort to find a better way to prepare preservice teachers through teacher education programs, this study investigated the evaluations of online math teaching resources made by seventy-six preservice elementary teachers. This study also explored the challenges preservice teachers perceive integrating internet-based resources. Analysis of preservice teachers' responses revealed quality determinants of websites in seven aspects. This study also revealed that preservice teachers intended to use websites as learning tools for teachers and as communication tools. Four themes of challenges were identified from preservice teachers' statements regarding the integration of web-resources into mathematics instruction. Implications for teacher educators and future research are discussed in accordance with the findings

1. Introduction

Integrating technology into mathematics instruction is highlighted as one of the central tasks for reform-minded mathematics teachers. The *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 2000), for instance, states that "[t]echnology is essential in the teaching and learning of mathematics; effective teachers maximize the potential of technology to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics" (p. 25)[32]. Yet, creating a learning environment that takes advantage of what technology can do efficiently and effectively is not an easy task for teachers. Research has documented teachers' use of technology is far from providing the deep and engaging learning experiences that are intended [7], [13], [34], [39], [45]. Kaput (1992) notes that it is the teachers' use of technology, and not the technology itself, brings reform in mathematics teaching [24]. In the same vein, the U.S. Department of Education (2000) claimed that "teachers' preparation and training to use education technology is a key factor to consider when examining their use of computers and the Internet for instructional purposes" (p. iii) [33]. It is therefore important to examine how to empower preservice teachers (PTs) to integrate technology in instruction.

The technology investigated in this study is the use of the internet (i.e., World Wide Web) to research and access freely available instructional and learning materials. We set out to

investigate elementary PSTs' conceptions of website quality and its potential usage for planning and teaching mathematics. Although a growing body of research has been carried out in preservice teacher education programs in connection with the use of technology, most of these studies focused on investigating technology competency of specific hardware such as graphing calculators, or software or software, such as the Computer Algebra System [33], [35]. Limited attention has been given to the use of freely available teaching resources over the internet.

The World Wide Web is a place to find a wealth of instructional resources, including professional information, curriculum resources (e.g., activities, games, lessons), digital tools, and open-source software. Numerous mathematics-specific websites have been developed to support teachers by ensuring high quality mathematics learning for all students (e.g., NCTM *Illuminations*). Research identifies internet technology as a valuable and necessary resource for preservice teacher education [23], [27], [9]. Charland (1998) specifically notes that PTs consider the internet as a valuable asset in their future teaching assignments [14]. However, little research exists on what aspects PTs value in website and context selection or in implementation plans. As Adler (2000) claims, "in mathematics teacher education, resources in practice in context need to become a focus of attention" (p.221) [2].

The purpose of this study was to investigate PTs' conception of website quality and the potential usage of internet-based resources in planning and teaching mathematics. This study also explored the challenges PTs perceive when integrating such internet-based resources. The research questions that guided this study were:

1. What aspects of the websites do PTs value when determining the quality of selected websites?
2. How do PTs plan to use the web-resources for mathematics instruction?
3. What challenges, if any, do PTs report on the integration of the web-resources into mathematics instruction?

2. Related Research

2.1 Research on technology related to preservice teachers

Studies indicate that new teachers feel unprepared to teach with technology [17], [33]. Though PTs are equipped with technical skills, they are not being adequately prepared to integrate technology into the curriculum in effective and meaningful ways [9]. Research studies have investigated various aspects in preservice teacher training programs designed to prepare student teachers in the use of technology, including a methods course redesigned with multimedia and modeling tools [3], the ways PTs construct websites [16], [29] and factors such as constraints or affordances that enhance PTs' use of multimedia and modeling tools [21]. Doering, Hughes, and Huffman (2003), for example, explored how PTs learn how to use and integrate technology into the curriculum in the content-based courses [14]. They found that PTs who learned technology within a content-based framework were more likely to use technology in the K-12 classroom. Mitchell (1995) also focused on building internet-based repositories containing collections of quality learning resources [29]. She asked PTs to develop a curriculum web page with significant online resources links that students should visit to learn. She found that these PTs felt more comfortable with technology and accumulated resources for curriculum ideas. Although the aforementioned studies help us understand better how to help PTs become more proficient at integrating technology into their curricula through teacher education programs, there is still limited attention on the use of the internet (i.e., World Wide Web) with PTs in research studies. We did not find any study on PTs' conception of website quality and their potential usage of the

internet-based resources. In the next section, we summarize the main findings from previous studies regarding inservice teachers' use of internet-based resources.

2.2 Research on teachers' use of Internet-based resources

With the introduction of the Internet into the classroom, teachers were able to incorporate activities that tapped the World Wide Web. Research has reported various functions of internet technology on students' learning and teachers' professional development, including the ways in which technology has an influence on student learning [8], [22], [24], the range of ways in which inservice teachers use websites [6], [7], [12], [31], [37] and factors such as constraints or affordances that enhance inservice teachers' use of internet-based resources [17], [42]. For examples, several researchers have reported the importance of Internet technology for teachers as a *curriculum resource* [6], [7], [12], [29], [31], [36]. These research studies focused on teachers finding and using online resources. Recognizing instructional use as a separate from use outside of the classroom, the National Center for Educational Statistics (NCES) (2000), reported that 53% of all public school teachers who have a computer at school are using it for instruction during regular class time [31]. NCES articulated several facets of teacher technology usage such as creating instructional materials, keeping administrative records, communicating with colleagues, gathering information for planning lessons, presenting multimedia classroom presentations, accessing research and best practices for teaching, communicating with parents or students, and accessing model lesson plans. They found the most frequent uses of technology across all subject areas was not instructional use but *professional uses* of technology, related to teachers' day-to-day needs [9]. One of the most frequent uses of technology reported by teachers was producing hand-outs for class with 66% of all teachers making handouts at least once a week. In addition, almost half of the teachers reported using a computer for record keeping and student grading, two-thirds reported using the internet for lesson planning, and 68% reported using e-mail for communication. These findings indicated that the majority of teachers were using internet technology to support their teaching, but much of this use occurred outside of class time. This finding was echoed by Cuban (2001) and Bebell, Russell, and O'Dwyer (2004) who argued that computers are underused as instructional tool [26], [6]. While the aforementioned study relied on teachers' self report on the use of internet technology, Recker, Dorward, and Nelson (2004) conducted a case study involving eight in-service middle and high school science and mathematics teachers to discover how these teachers find, access, and use digital learning resources [37]. They reported that the teachers tended to use materials with little adaptation when planning instructional activities.

Although previous studies provided valuable information including the possible categories of PTs' internet technology use, they do not answer how PTs determine the website quality and plan for their use in the classroom, which should be a first step of understanding to empower PTs to integrate technology in their instruction.

2.3 Research on barriers or challenge of teachers' use of Internet resources

Research has reported that teachers' use of the internet is far from providing the deep and engaging learning experiences to students as intended [6], [13], [34], [39], [45]. The difficulties in implementation are attributed to a variety of causes, including lack of teacher training or commitment, inadequate technology or technical support, structural barriers in school schedules and policies, and lack of administrative support [28], [34], [42]. Hall and Hord (1987; 2001) identified three types of concerns which teachers face when incorporating new technologies in

their mathematics teaching—personal (i.e., concerns about how the technology affected the teachers personally), management (i.e., concerns about having control of and managing technology-enabled classroom environments), and technology (i.e., concerns related to a level of comfort and familiarity with the technology), [20]. In accordance with Hall and Hord, Beaudin and Bowers (1997) developed the PURIA (Play, Use, Recommendation, Incorporate, Assess) stages, describing the developmental process teachers undergo as they learn to teach mathematics with technology (see Table 1) [5]. According to Beaudin and Bowers, teachers use technology first as a personal learning tool, then as a communication tool by recommending it to others, and finally as an instructional tool, including as an assessment tool.

Table 1: *extended PURIA model* (adopted from *Zbiek & Hollebrands, 2008,* [44])

PURIA MODE	Nature of Activity during the Mode	Function
1. *Play*	Use technology without clear mathematical purpose.	Tool for teachers doing mathematics
2. *Use* as personal tool	Use technology in doing mathematics of one's own design. Maybe uses it as a learner of mathematics but not in a classroom setting or with students.	
3. *Recommends* to others	Recommends use to a student, a peer, or a small group of students or peers. This likely is not in a formal classroom setting or as an integrated part of instruction.	Transition between personal & pedagogical tool
4. *Incorporates* into instruction	Integrates—by varying degrees—the technology into classroom instruction.	Pedagogical tool for instructional use
5. *Assesses* students' use	Examines how students use the technology and what they learn from using it.	

Although the findings from previous studies provide important information on the different ways in which PTs may use technology for instruction, they were developed in response to inservice teachers' integration of the Computer Algebra System. Mathematics websites for teachers have different affordances and varying purposes (i.e., instructional technology), and we hypothesize that PTs might undergo a different developmental process from the PURIA model as they learn to teach mathematics with this particular resource technology. Accordingly, PTs may have different challenges or concerns reported from Hall and Hord [20] and other research studies. This study investigated whether the extent to which the tendencies and challenges were similar in the integration of the *internet-based resources* into math instruction.

3. Method

3.1 Participants

Seventy-six PTs participated in the study at a large southeast university in the US. Of the 76 participants, only nine were male. All participants had completed a required mathematics course equivalent to a 3 credit pre-algebra course either in their freshman or sophomore years. They also took a 3 credit technology course as requirement, *Integrating Technology into the Curriculum*, designed to enable PTs from all grade levels to integrate productivity tools, digital imaging, digital tools, virtual environments, and web authoring tools into their curriculum. Participants

were recruited from four mathematics methods courses in which the first author was an instructor.

3.2 Task and Data Collection

Data were collected as part of course assignments in the mathematics methods course, designed to support PTs' understanding of approaches, strategies, and issues relevant to the teaching and learning of mathematics, particularly in the elementary grades. After spending the six class sessions discussing current trends in the teaching and learning of mathematics (e.g., NCTM ideas), effective ways for creating mathematics lessons, and fundamental ideas of whole numbers and whole number operations, PTs were initially asked to locate and review five web-based resources for mathematics education in an annotated bibliography as a first assignment. At least four of the sites were to contain activities or lesson plans that teachers could use in planning and teaching mathematics. The instructor suggested the PTs use internet search-engines to find websites relevant to student-selected math topics and lesson activities. In the bibliography, the list of websites was to be accompanied by brief descriptive and evaluative paragraphs regarding the relevance, accuracy, and quality of the cited sources. Participants were subsequently asked to share their websites with partners in class discussing the relevance and/or quality of the sources and how such web-resources could be used. Finally, they were asked to reflect on the assignment in written responses to the following questions: (1) What did you learn by completing the assignment?; (2) How do you plan to use these web resources in your future teaching and why?; (3) What types and forms of activities do you plan to use from the selected websites?; and (4) What challenges do you think you might face when you integrate the web-resources into your mathematics instruction? In the data collection process, the instructor minimized intervention or guidance to gather more accurate information on the nature of PTs' preconception of website quality and their intended usage. Only data of the PTs who signed the study's consent form was reported.

3.3 Data Analysis

The annotated bibliographies were analyzed in order to understand how PTs gauge the relevance, accuracy, and quality of the cited sources. PTs' reflection papers were analyzed in order to explore their potential use of the internet-based resources and challenges regarding the integration of technology. In a later assignment, the PTs were asked to create a lesson using web-resources they found in the first assignment and conduct microteaching in class as components of the second assignment; however, findings from the second assignment were not included in this study.

Descriptive statistics were used to analyze the collected data. First, all of the websites selected by the participants were recorded and counted to ascertain the frequency of website selection. Next, the annotated bibliographies were analyzed through three processes: (1) an initial reading of each PT's response, (2) determination of emerging and recurring themes and categories that describe quality features of websites, and (3) codification of categories and subcategories [8]. The same procedure was utilized for the analyses of both the PTs' potential integration of the websites in their teaching and in the curriculum as well as possible challenges. The researchers coded the data individually according to the frameworks developed and then compared the coding for reliability. The inter-rater agreement was 98 %. In the next section, we present the findings in detail.

4. Results

4.1 PTs' selection of math-related websites

In total, 94 websites were reviewed by 76 participants. Table 2 shows a list of websites cited by at least 10 PTs. The most frequently cited website is *Cool Math 4 Kids* (http://coolmath4kids.com); *Illuminations* by NCTM (http://illuminations.nctm.org/) was ranked the fourth by the PTs.

Table 2: *a list of websites commonly cited by PTs*

Title (Address)	Frequency
1. Cool Math 4 Kids (http://coolmath4kids.com/	29
2. Math Playground (http://mathplayground.com/games.html)	19
3. The Math Forum: Teachers' Place (http://mathforum.org/teachers/)	19
4. Illuminations: Resources for Teaching Math (http://illuminations.nctm.org/)	16
5. AAA Math (http://aaamath.com/index.html)	16
6. The Lesson Plans Page (http://www.lessonplanpage.com/Math.html)	14
7. Fun Brain (http://www.funbrain.com)	13
8. A Plus Math (http://aplusmath.com/)	13
9. Cool Math (http://coolmath.com/index.html)	11
10. Free Elementary and Preschool Math Activities Educational and Interactive Online Kids Math Games and Lessons (http://www.apples4theteacher.com/math.html)	11
11. PBS Teachers Math Resources (http://www.pbs.org/teachers)	11

4.2 PTs' quality determinants of on-line resources

When the PTs were asked to describe the rationale for their website choices (in terms of relevance and quality), seven aspects emerged: (1) format of the website, (2) resourcefulness of materials for lesson planning, (3) availability/resourcefulness of learning tools for students which teachers use in instruction, (4) opportunities for teachers to learn, (5) professional development opportunities, (6) existence of communication tools, and (7) availability/resourcefulness of instructional tools/materials for parents. At the outset, the participants seem to focus on the format of the websites, such as how easily the websites could be accessed and how the materials are organized to facilitate potential usage. Table 3 presents the sub-categories that comprised each category, a brief description of each sub-category quoted from the PTs' annotated bibliographies, and the corresponding frequency of each subcategory.

Table 3: *web-resource quality determinants and corresponding frequencies*

Category	**Example**	**Freq.**
A. Format of the website (191, in total)		
1. Content organization by grade	1. [Has] a link for each grade level.	89
2. Accessibility	2. Is well organized and easy to access.	56
3. Free use	3. [Is] a free math resource.	33
4. Language friendly	4. There is a Spanish version as well.	8
5. Content organization by topic	5. Sections are divided focusing on topics.	4
6. Free of advertisements	6. [The website] is free of advertisements.	1

B. Resourcefulness of materials for lesson planning (486, in total)		
1. Lesson plan/lesson plan guide	1. Includes teacher-developed lesson plans.	202
2. Classroom activity/game	2. Includes many resources for math activities	158
3. Other related useful links	3. Numerous other websites are suggested.	41
4. Materials for other subjects	4. Provides information in all areas.	30
5. Real world problem	5. Includes a wider variety of real world math.	13
6. Software/technology	6. Provides software/ways to integrate tech.	12
7. Printable hand-out	7. Provides printable handouts to supplement.	11
8. Math literature/book	8. Provides math *books* to help teach.	8
9. Assessment rubrics	9. Includes contests/assessment options.	5
10. Homework	10. Includes the web-based homework.	4
11. Online textbook/curriculum	11. Contains online textbooks/curriculum.	2
C. Availability/resourcefulness of learning tools for students (422, in total)		
1. Engaging /interacting activities	1. Contains activities (e.g., games/puzzles).	158
2. Work sheet/Practice problems	2. Includes worksheets to practice math skills.	153
3. Online-feedback	3. Gives immediate feedback to students	34
4. Lesson to follow/Explanation	4. Provides lesson, explanation and formula.	27
5. Tutorial videos/Movie clips	5. Includes videos explaining specific skills.	18
6. Virtual manipulatives	6. Includes virtual manipulatives.	16
7. Math term dictionary/library	7. Includes a math dictionary and library.	16
D. Opportunities for teachers to learn (OTL) (142, in total)		
1. Alignment to standards	2. [Is] correlated with the standards.	54
2. Professional materials to read	3. Include[s] journals and books.	31
3. Teaching strategies/tips/advice	4. Include[s] detailed teaching instructions.	26
4. Tutorial videos	5. [Contains] video tutorials for topics.	20
5. Teacher's guide/note	6. Has a section for teacher's notes.	11
E. Professional development (PD) opportunities (55, in total)		
1. Continuing education	1. [Has] a section for continuing PD.	38
2. Professional workshop info.	2. Includes educational workshops.	13
3. Job information	3. Include[s] links to teaching jobs	3
4. News in education world	4. Provides news in education world.	1
F. Tools for communication (51, in total)		
1. With other peer teachers	1. There are discussions on teaching fractions.	39
2. With and to student(s)	2. Ha[s] students email their results.	6
3. With parents	3. [It] can be used to keep parents up to date.	4
G. Availability/resourcefulness of materials for parents (35, in total)		
1. For parents	1. Helps parents brush up on math skills	19
2. For extra help at home	2. Has sections that students and their parents can do together at home.	12
3. For advanced learners	3. Has material for an accelerated learner	2
4. For implemented curriculum	4. Has a report section for what is being implemented in a given math grade.	

Among the seven aspects of quality determinants, *availability (or resourcefulness) of materials to lesson planning* is referred most frequently (486, in total), followed by the *availability of instructional materials for students* (422, in total). The most popular category typically describes a printed version of activities or lesson plans, and the second most popular category highlights more engaging and interactive activities for students to work on online (or which teachers can use during instruction). Similarly, the availability of engaging/interacting activities was the most frequently evaluated feature in *availability of instructional materials for students,* followed by the availability of work sheet/practice problems.

Interestingly, however, our PTs seem to pay more attention to the *quantity* of materials than the quality or relevance. Rather than pointing out the relationship between the materials and national or state standards, PTs tended to evaluate it by amount, saying, for example, "there are lots of/many/ tons of materials to use". While the first and second quality determinants are directly related to mathematics instruction, the third popular website feature was the format, emphasizing ease of access, content organization by grade level, organization by topic, and non-commercial character. Unsurprisingly, content organization and ease of access, practical considerations were prominent. The appreciation of free resources was another critical aspect, and probably practical, since some of the online materials require membership.

The results referencing opportunities for teachers to learn (OTL) and professional development (PD) indicate that PTs in this study also evaluated the quality of the websites with respect to personal development, particularly in regard to learning new ideas and teaching skills directly related to the mathematics curriculum. The finding of this study showed that, as the developers of the websites intended, PTs determined the quality of the website not only from the resourcefulness of curriculum and instructional materials but also from the availability of learning opportunities for teachers, and information for career-related subjects and professional organizations. Although the remaining two quality determinants are not directly related to mathematics instruction, the existence of communication tools for teachers and students and the availability or resourcefulness of materials for parents were critical as well. Indeed, websites are convenient tools for teachers to communicate with peers to learn numerous teaching and learning strategies, to give immediate feedback to students, and to keep in touch with the parents. These findings suggest that PTs expect math-related websites to provide instructional assistance and materials that transcend the immediate mathematical curriculum to the general teaching context.

4.3 PTs' potential usage of the websites and resources

When PTs were asked to describe the ways in which they would use a selected website for planning and teaching mathematics, five categories emerged: (1) *planning tools for teachers,* (2) *instructional tools for students,* (3) *assessment tools for students,* (4) *learning tools for teachers,* and (5) *communication tools*. Each sub-category was drawn from the PTs' responses (see Table 4).

As might be expected, the usage of websites as *planning tools for curriculum supplement* is most frequently mentioned by the participants. A similar tendency appeared as in the PTs' determinants of website quality. The PTs commented that by using the materials available from the websites in their planning (e.g., lesson plans, games, and activities, etc.). This tendency is consistent with the findings from previous studies on inservice teachers' use of internet technology reporting that the extent of technology use is highest for class preparation by making hand-outs for class [5], [13], [31].

Table 4: *PTs' intended usage of the websites in planning and teaching*

Category	Frequency
A. Planning tools for teachers (128, in total)	
1. To find good lesson plan	48
2. To find classroom activity/game	44
3. To find extra practice materials/worksheet/homework	14
4. To check alignment between teaching and suggested standards	11
5. To find materials available for other subjects	5
6. To find videos and other useful web links	5
B. Instructional tools for students (67, in total)	
1. To make math fun and interesting	22
2. To provide practice and free time in a more engaged way	13
3. To keep students interested and involved during class	11
4. To help students grasp math concepts	7
5. To give students various ways to learn	4
6. To supplement students' free time	4
7. To give students effective explanation	4
8. To help students with special needs	4
9. To use virtual manipulatives for students	2
C. Assessment tools for students (3, in total)	
1. To assess students' progress	3
D. Learning tools for teachers (25, in total)	
1. To find a better way to teach mathematics	22
2. To enhance own lesson plans	2
3. To enhance own education for teaching math	1
E. Communication tools (27, total)	
1. To communicate with students and parents	15
2. To discuss with other teachers	12

Note: each frequency is out of 76 participants.

Intending to use the websites as *instructional tools for students* in math instruction was the next most common usage. A large portion of the PTs intended to use the websites as a tool to improve student motivation, intensify engagement, and/or increase participation in mathematics instruction rather than a functioning as a learning tool itself. Only a small number of the PTs intended to use the websites to assist students in developing ideas by using virtual manipulatives or by presenting mathematics with effective explanation in multiple ways. This tendency is more apparent when PTs were further asked to choose the types and forms of activity they intended to use from the on-line resources (see Table 5).

A large portion of the PTs preferred to use web-resources as practice or review, in particular in the form of groupwork. This tendency is consistent with the findings from previous studies (e.g., [15], [17]). Drier (2001), for example, reported that preservice middle school and high school mathematics teachers tended to view technology as useful only after students had learned mathematical concepts in a by-hand setting [15]. This finding implies that although PTs in this study intended to treat the web-based resources as instructional tools, their use is limited to reviewing the concepts or practicing procedures rather than exploring mathematical concepts.

Table 5: Frequency of types and forms of web-resources for classroom instruction

Category	Frequency
A. Activity types	
1. Practice	45
2. Main class activity	18
3. Review	15
4. Homework	12
5. Game	9
B. Forms of activity	
1. Group work or math center	43
2. Whole class work	16
3. Individual work	17

The website usages of *learning tools for teachers* and *communication tools* mirror findings from the PTs' quality determinants. The PTs wanted to use web-based resources as *a learning tool* to improve their own understanding of planning and teaching mathematics. Similarly, they intended to use these web-resources for exchanges with students, parents, and teachers, (e.g., to communicate with students and parents through web-links, perhaps suggesting how parents use the web to help their children; to discuss math lessons/activities with other teachers etc.).

4.4 PTs' perceived challenges for web-resource integration

PTs were also asked to report any challenges in regard to incorporating the web-resources in mathematics instruction. Four major themes emerged from the responses as shown in Table 6: (1) challenges resulting from PTs' knowledge and abilities, (2) challenges resulting from management problems that may occur during instruction of their students and during interaction with students when incorporating the web-resources in mathematics instruction, (3) challenges resulting from lack of technology accessibility or availability of internet, and (4) challenges resulting from the difficulty of assessment while students participate in web-based activities.

The most prominent challenge is related to PTs' knowledge and abilities, encompassing finding quality resources, modifying the tasks, and aligning the tasks with standards. PTs also expressed a great concern of the accessibility or availability of technology (e.g., computer and internet). While the first and second commonly perceived challenges are less directly related to mathematics instruction (meaning that this work needs to be done before carrying out instruction), the remaining perceived challenges are directly relate to what and how students learn. Although the PTs intended to use the web-resources with a variety of purposes and forms (see Table 4), they expressed difficulty managing the learning process and learning product (i.e., assessment). Indeed, in any interaction with students, on or off the internet, a teacher can find herself dealing with unexpected or unfamiliar content. According to Wallace (2004), teaching with the internet makes special demands in at least two ways: First, such teaching is still relatively new and unfamiliar [41]. Knowing what to expect from students is in part a function of having seen it before, but with the internet, both the medium and the content can be novel to teachers and students alike. Second, it is difficult to anticipate students' responses to content that is changing. With both the context and content in flux, it may be hard for PTs to develop knowledge of what students know and can do with subject matter on the internet. Furthermore, our PTs identified assessing student work as a specific challenge when using the internet.

Knowing what each student is doing and what he or she has done can be difficult in any kind of small group or individualized work. In particular, the problem is compounded on the internet where the environment is virtual, allowing the teacher access to students' work only one screen at a time. Although a teacher wants her students to learn mathematics from their internet work, she may have no routines or tools in place either to hold students accountable for their work on the internet or to evaluate what they actually had learned. The web-based resources have little or no support for solving assessment problems, and it makes it difficult for the PTs to apply their usual routines for tracking student work.

Table 6: *PTs' perceived challenges in integrating web-resources*

Category	Example	Frequency
A. Challenges related to PTs' knowledge and skills (45, in total)		
1. Modifying tasks	1. Modifying the activities to fit student needs.	18
2. Finding resources	2. Finding quality resources is challenging.	12
3. Teacher knowledge	3. Knowing the different rules/materials to use.	9
4. Aligning with standards	4. [Putting] activities with standards.	3
5. Modifying teaching	5. [Modifying] the lessons to fit your way of teaching.	3
B. Challenges related to management issues (18, in total)		
1. Keeping on task	2. Keeping students on task makes it difficult.	9
2. Limited time	1. [Taking] more time to instruct students.	6
3. Instructional control	4. Not let[ting the] internet be the only source.	3
C. Challenges related to Assessment (21, in total)		
1. Type of assessment	1. Assessing students can be challenging	15
2. Individual work	2. Making sure students do assessment	6
D. Challenges resulting form Technology conditions (39, in total)		
1. Availability	1. Schools [possibly not having] computer access.	24
2. Technology issue	2. Technology [not always working] all the time.	15

Note: Each frequency is out of 76 participants.

5. Discussion and Implications

The goal of this study is to inform the design of teacher education in order to find a better way of incorporating technology into mathematics instruction. This study showed that PTs evaluated website quality by considering the following seven aspects in descending order: (1) availability of materials for planning lessons, (2) availability/resourcefulness of instructional tools for teacher use, (3) format of the website, (4) opportunities for teachers to learn, (5) professional development opportunities, (6) existence of communication tools, and (7) instructional tools/materials for parents. These aspects were also apparent when PTs expressed their intended usage of the websites for math instruction, indicating that PTs consider websites not only as tools for curriculum and instruction but also as learning and communication tools. Five intended usages are similar to the PURIA (Play, Use, Recommendation, Incorporate, Assess) model of Beaudin and Bowers (1997) [5]. However, we found that our PTs did not use them to assess very

much, nor play with them like they would with virtual manipulatives or formal practice softwares.

Figure 1 shows the frequencies of the websites used by PTs in describing their selection (Table 3) and intended usage (Table 4) of websites, respectively, with respect to the five roles (functions) of the websites. The frequencies of teachers' opportunities to learn and PD opportunity in Table 3 were combined for the frequency for learning tool for teachers; frequencies of communication tools and materials for teachers were also combined for the frequency for the communication tool in the website selection criteria. The same trends appeared in the website selection criteria and the intended website usage with respect to the functions of the websites. In both cases, PTs considered the websites as a planning tool most frequently followed by an instruction tool for students, a learning tool for teachers, and a communication tool. This indicates that how teachers view technology may be an indicator of how they *plan* to use the technology.

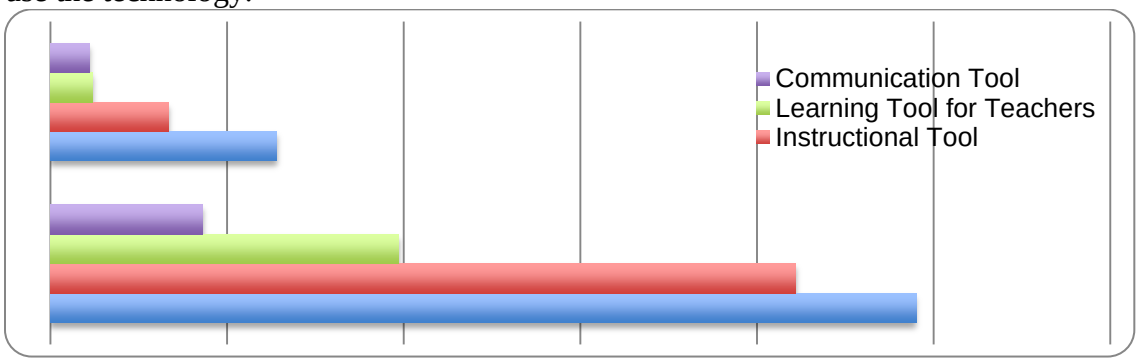

Figure 1: *comparison between selection criteria and intended usage with respect to four functions*

However, an important point to note is that PTs pay more attention to the quantity of materials available than to the quality. Most of the PTs pointed out the resourcefulness of mathematics by saying "there are lots of/many/ tons of materials to use on the websites," which suggests that teacher educators should help PTs understand the quality versus quantity distinction. However, interestingly, this concern is moderated by the participants' clear awareness of quality-related issues in regard to implementation. When asked to express the challenges of using web-based resources in mathematics instruction, PTs expressed more quality-related challenges, such as selecting appropriate tasks from the available website, checking the alignment of the web-tasks with the standards, and modifying the tasks selected from the web according to the students and their school environment. In particular, consistent with the findings from previous studies [20], [42], personal challenges related to PTs' knowledge and skills in determining website and task quality preceded other types of challenges.

Another concerning finding of this study is that a large portion of PTs intended to use web-based resources for review or practice as a form of group work rather than for developing and/or exploring mathematical ideas. This tendency is similar to the findings from previous studies [1], [2], [22]. Manoucherhri (1999) examined middle school and high school teachers' use of computers and reported that teachers rarely used the computers for purposes other than drill and practice [25]. We found a similar pattern with most of the PTs intending to use the web-resources only as a game for the purpose of practice. This finding suggests that teacher educators need to provide opportunities for PTs to use web-based resources with a variety of purposes, including development of mathematical concepts, practice, review, assessment, and homework

assignments, including lessons via microteaching experience to help them foster the knowledge needed to use technology.

This study has implications for teacher educators and future studies. First, adequate preparation of PTs in terms of content knowledge and critical thinking skills is necessary to foster deep appreciation for its use in mathematics [18], [19]. The most prominent challenge is related to PTs' knowledge and abilities, encompassing finding quality resources, modifying the tasks, and aligning the tasks with standards. Teachers' knowledge of their subject matter is always an important factor in teaching and learning [43]. When teachers use the internet, most content is neither designed nor selected for teaching purposes. The teacher does this work herself, relying on her own mathematics knowledge, curriculum knowledge, knowledge of her students, and of resources on the internet. The internet resources do not support teachers who are lacking in any these knowledge domains. In order address the most frequent concern the prevailing concern of teachers' limited or lack of understanding towards applying instructional technology, PTs need to develop their technology knowledge in concert with sound content knowledge, pedagogical knowledge, and curriculum knowledge. Teacher educators need to pay attention to helping the PTs develop the full range of requisite knowledge and skills in order to better prepare PTs to integrate web-based resources in the future instruction.

Second, teacher educators need to help PTs learn how to determine what "appropriate or relevant" means in the selection of quality websites and web-based resources. The findings of the study showed a predominant interest in the quantity of web-resources over the quality. Teacher educators need to help them be aware of the quality of mathematical tasks/ activities presented in web-based resources. Considering that PTs are just starting their teaching journeys, they are likely to be more interested in finding lots of materials from websites to broaden their repertoires; teachers educators must raise PTs' awareness of the importance of task quality in mathematics instruction and help them use such criteria in the selection of the tasks and then modify selected tasks depending on the instructional purpose and students' needs. Stein, Grover, and Henningsen's (1996) framework could be utilized, which is categorizing mathematical problems/activities with respect to cognitive demand on students: (1) problems that require low cognitive demand ("procedures without connections" and "memorization") and (2) problems that require high cognitive demand ("doing mathematics" and "procedures with connections") [40]. Once PTs found classroom activities from websites, they could analyze them according to the Stein, Grover, and Henningsen's framework, subsequently using or altering them. Such opportunities to develop their knowledge and skills would also help address the challenges PTs experience in regard to the integration of the internet-based resources. Another way to help PTs is to introduce well-known websites (e.g., *Illuminations*: http://illuminations.nctm.org/) designed for enhancing teachers' mathematics instruction in alignment with NCTM's ideas.

Furthermore, teacher educators need to help PTs be aware of the different functions of web-resources in the teaching of mathematics. This study showed that a large portion of PTs intended to use web-based resources mainly for review or practice as a form of group work rather than for developing and/or exploring mathematical ideas. Therefore, teacher educators should incorporate the materials in their own classrooms for a variety of purpose in order to model to the PTs that this is possible/effective.

The findings from this study are based on an assignment asking PTs to find five websites for math education with at least four including lesson plans or activities. The participants' responses are limited by the assignment requirement (e.g., preference of planning tool over other website functions). Such limitations require future studies using different methods. Future studies might

employ interviews or more open-ended tasks to collect data. Since teachers' previous knowledge about and beliefs regarding technology greatly affect their decisions about applying technology in classroom instruction, further research could investigate the potential influence of these factors on PTs' web resource usage. Furthermore, future studies might explore how PTs and in-service teachers actually use web-resources in curriculum construction and instruction in conjunction with challenges they face in the integration of technology. Such collective efforts from teacher educators and researchers will help enrich a dialogue among reformers, teacher educators, and professional developers about ways to help PTs learn to use technology in order to promote students' understanding.

Appendix

An appendix to the paper describing the used resources can be found at: https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxpY21lMTJ0c2cxOHxneDo2NmM2MWQwZGU4ODQwNTM

References

[1] Abbott, J. A., & Faris, S. E. (2000). Integrating technology into pre-service literacy instruction: A survey of elementary education students' attitudes toward computers. *Journal of Research on Computing in Education, 33*(2), 149-161.

[2] Adler, J. (2000). Conceptualising resources as a theme for teacher education. *Journal of Mathematics Teacher Education, 3*, 205–224. doi:10.1023/A:1009903206236.

[3] Angeli, C. (2005). Transforming a teacher education method course through technology: efforts on preservice teachers' technology competency. *Computers &Education, 45*(2005), 383-398.

[4] Barnes, A. & Loong, E. Y.-K. (2003). Teaching Mathematics and the Web: A Task-Object Approach. Paper presented at the 19th Biennial Conference of the Australian Association of Mathematics Teachers 2003, Brisbane.

[5] Beaudin, M. & Bowers, D. (1997). Logistics for facilitating CAS instruction. In J. Berry, J. Monaghan, M. Kronfellner & B. Kutzler (Eds.), *The State of Computer Algebra in Mathematics Education*, p. 126-135. Sweden: Chartwell-Bratt.

[6] Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education, 37*(1), 45-63.

[7] Becker, H. J. (1999). Internet use by teachers: Conditions of professional use and teacher-directed student use. Teaching, Learning and Computing: 1998 National Survey, Report #1.

[8] Berg, S., Benz, C.R., Lasley II, T. J., & Raisch, C. D. (1998). Exemplary technology use in elementary classrooms. *Journal of Research on Computing in Education, 31*, 111-122.

[9] Charland, T. S. (1998). Classroom homepage connections. *Technological Horizons in Education*, April, 62-64.

[10] Chen, R.J. (2010). Investigating models for Preservice teachers' use of technology to support student-centered learning. *Computers & Education, 55*, 32–42.

[11] Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.

[12] Cuban, L. (2001). *Oversold & underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.

[13] Davidson, A.L., Schofield, J., & Stocks, J. (2001). Professional cultures and collaborative efforts: A case study of technologists and educators working for change. *The Information Society, 17*(1), 21-32.

[14] Doering, A., Hughes, J., & Huffman, D. (2003). Preservice teachers: are we thinking with technology? *Journal of Research on Technology in Education, 35*(3),342-361.
[15] Drier, H.S. (2001). Beliefs, experiences, and reflections that affect the development of techno-mathematical knowledge. In J. Price, D. Willis,N. Davis, & J. Willis (Eds.), *Proceedings from the Twelfth International Meeting of the Society for Informational Technology and TeacherEducation* (pp. 1353-1358). Charlottesville, VA: Association for the Advancement of Computing in Education.
[16] Ferrucci, B. J & Carter, J.A. (2003). Using a cognitive taxonomy to enhance prospective teachers' mathematical website constructions. *The Mathematics Educator, 7*(2), 25-36.
[17] Fine, A.E., & Fleener, M.J. (1994). Calculators as instructional tools: Perceptions of three preservice teachers. *Journal of Computers in Mathematics and Science Teaching, 14(4),* 481-498.
[18] Garofalo, J., Drier, H., Harper, S., Timmerman, M.A., & Shockey, T. (2000). Promoting appropriate uses of technology in mathematics teacher preparation. *Contemporary Issues in Technology and Teacher Education* [Online serial], *1* (1).
[19] Gerber, S. & Shuell, T. J. (1998). Using the Internet to learn mathematics. *Journal of Computers in Mathematics and Science teaching*, 17(2/3), 113-132.
[20] Hall, G.E. & Hord, S.M. (2001). Implementing change: Patterns, principles, and potholes. Needham Heights, MA: Allyn & Bacon.
[21] Handler, M. G. (1993). Preparing new teachers to use computer technology: perceptions and suggestions for teacher educators. *Computer Education, 20*(2), 147-156.
[22] Hershkowitz, R., Dreyfus, T., Ben-Zvi, D., Friedlander, A., Hadas, N., Resnick, T., et al.. (2002). Mathematics curriculum development for computerized environments: A designer-researcher-teacher-learner activity. In L. D. English (Ed.), *Handbook of international research in mathematics education* (pp. 656–694). Mahwah, NJ: Erlbaum.
[23] Jervis, A., & Steeg, T. (1999). Internet-based resources -- Really useful? *Teaching Mathematics and its Applications, 18(*3), 106-114.
[24] Kaput, J. (1992). Technology and mathematics education. In D. Grouws (Ed.), *A handbook of research on mathematics teaching and learning* (pp. 515-556). New York: Macmillan.
[25] Manoucherhri, A. (1999). Computers and school mathematics reform: Implications for teacher education. *Journal of Computers in Mathematics and Science Teaching, 18*, 31-48.
[26] Maring, G., Wiseman, B., & Myers, K. (1997). Using the World Wide Web to build learning communities: writing for genuine purposes. *Journal of Adolescent & Adult Literacy, 41*(3), 196-207.
[27] Means, B. (2001). Technology use in tomorrow's schools. *Educational Leadership, 58*(4), 57-61.
[28] Means, B., Penuel, W.R., & Padilla, C. (2001). *The connected school: Technology and learning in high school*. San Francisco: Jossey-Bass.
[29] Mitchell, W. J. (1995). *City of bits*. Cambridge, MA: MIT Press.
[30] Moor, J. & Zazkis, R. (2000). Learning Mathematics in a virtual classroom: Reflection on Experiment. *Journal of Computers in Mathematics and Science Teaching, 19*(2), 89-113.
[31] National Center for Education Statistics, U.S. Department of Education. (2000).Teachers' tools for the 21st Century. A report on teachers' use of technology. Washington, DC: Author. Retrieved May 10, 2013, from http://nces.ed.gov/spider/webspider/2000102.shtml. (Eric Document Reproduction Service No. ED 444500).
[32] National Council of Teachers of Mathematics. (2000) ***Principles and Standards for School Mathematics*** Reston, VA: Author.
[33] Ozgun-Koca, S.A. (2010). Preservice teachers' views on the use of calculators with Computer Algebra System in algebra instruction. Jou*rnal of Mathematics Teacher Education.13*, 49-71.
[34] Peck, C., Cuban, L., & Kirkpartick, H. (2002). Techo-promoter dreams, student realities, *Phi Delta Kappan* (February), 472-480.
[35] Pope, M., Hare, R. D., & Howard, E. (2002). Technology integration: Closing the gap between what teacher candidates are taught to do and what they can do. *Journal of* Technology *and Teacher Education, 10*(2), 191-203.

[36] Pope, M., Hare, R. D., & Howard, E. (2005). Enhancing technology use in student teaching: A case study. *Journal of Technology and Teacher Education, 13*(4), 573-617.

[37] Recker, M. M., Dorward, J., & Nelson, L.M. (2004). Discovery and Use of Online Learning Resources: Case Study Findings. *Educational Technology & Society, 7* (2), 93-104.

[38] Ruthven, K., & Hennessy, S. (2002). A practitioner model of the use of computer-based tools and resources to support mathematics teaching and learning. *Educational Studies in Mathematics, 49,* 47-88.

[39] Songer, N.B., Lee, H.S., & Kam, R. (2001). Techology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching, 39*(2), 128-150.

[40] Stein, M. K., Grover, B. W., & Henningsen, M. A. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, *33*(2), 455-488.

[41] U.S. Department of Education, National Center for Education Statistics. (2000). *Teachers' tools for the 21st century. A report on teachers' use of technology*. Washington, DC: Author.

[42] Wallace, R.M. (2004). A framework for understanding teaching with the Internet, *American Educational Research Journal*, 41(2), 447-488.

[43] Wilson, S.M., Shulman, L.S., & Richert, A.E.(1987). "150 different ways" of knowing: representations of knowledge in teaching. In J. Calderhead (Ed.), *Exploring teachers' thinking* (pp. 104-124). London: Cassell Education.

[44] Zbiek, R. M., & Hollebrands, K. (2008). A research-informed view of the process of incorporating mathematics technology into classroom practice by inservice and preservice teachers. In M. K. Heid and G. W. Blume (Eds.), *Research on technology and the teaching and learning of mathematics: Volume 1* (pp. 287-344). Charlotte, NC: Information Age.

[45] Zhao, Y., Pugh, K., Sheldon, S., & Byers, J.L. (2002). Conditions for classroom technology innovations, *Teachers College Record, 104*(3), 482-515.