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Examining Mathematical Task and Pedagogical Usability of Web Contents Authored by Prospective Mathematics Teachers

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Abstract

The study was designed to engage prospective mathematics teachers in creating web learning modules. The aim was to examine the mathematical task and perceived pedagogical usability of the modules for mathematics instructions in Ghana. The study took place at University of Education, Winneba. Classes of 172 prospective mathematics teachers working in design groups were involved in the study. Data were collected using Mathematical Task Usability Scale and Pedagogical Usability Rubrics. The result indicated 77.8% of the task contents examined contained worthwhile mathematical tasks. Descriptive analysis of data reflected three distinct categories of perceived pedagogical usability. Approximately 6%, 58% and 36% of the modules contained low, moderate and high pedagogical usability attributes. The study concluded that majority of the modules developed by the prospective teachers have considerable instructional value. Implications for involvement of prospective mathematics teachers in authoring web resources were discussed against the backdrop of policy initiatives for integrating emerging technologies.

Key words: Web contents; Web modules; Mathematical task; Pedagogical usability

Introduction

In the past one decade, there have been wide-reaching moves in mathematics education in which mathematics teachers are required to integrate emerging technologies in their mathematics instructions. These moves are based on the supposition that when teachers teach with these technologies, students will develop substantial mathematical knowledge and lifelong learning skills (Buabeng-Andoh, 2012; MOESS, 2007). While the supposition holds a significant level of acceptance in literature (Guzeller & Akin, 2012; Beki & Guveli, 2008; Kong & Kwok, 2005), recent studies (Agyei & Voogt, 2012; Agyei & Voogt, 2011) have noted that most mathematics teachers have not had adequate preparation in terms of pedagogical knowledge, technical skills and readiness for such technology integration. It is thus imperative to question how teacher educators can prepare prospective teachers towards technology integration in Ghana.

Literature review on teacher education processes and technology integration worldwide suggests a gradual shift towards learning technology-by-design and lesson enactment approaches (Akayuure, Nabie & Sofo, 2013; Agyei & Voogt, 2012; Koehler, Mishra & Yahya, 2007). Agyei and Voogt (2012), for example, established that the use of collaborative design in which pre-service teachers work with peers to design and enact lessons using specific technology promotes teacher competencies for technology integration. Studies in this area are very rare or perhaps still new in Ghana.

The present study sought to investigate how a Ghanaian mathematics teacher preparation program could be tailored to bridge mathematics teachers' knowledge gap to integrate web technologies in their practice. An earlier study (Akayuure, Nabie & Sofo, 2013) investigated prospective mathematics teachers' self-efficacy levels towards web pedagogical content knowledge and the impact of a web technology methods course on their self-efficacy. The present study examined the mathematical task and pedagogical usability of the web contents created by prospective mathematics teachers during a web technology methods course. It is anticipated that the level of usability of participants' web contents should highlight their mathematical task knowledge, design skills and readiness to use web resources in their future classroom practice. The study might also generate discussions on the relevance of engaging prospective teachers in design-based activities and in development of virtual learning resources during teacher training programs.

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Web-based Learning Resources

With the advent of the internet, the creation of learning resources for mathematics instructions is currently influenced by web technologies. On daily basis, several virtual environments are being gradually developed and digital learning materials frequently posted onto the internet to support the learning of mathematics and other disciplines. These digital materials are described in literature as web-based learning resources, web contents or learning objects. Kay, Knaack and Patrarca (2009) describe Web-Based Learning Resources (WBLRs) as web-based tools that support, enhance, amplify and guide the cognitive processes of learners towards a specific learning objective associated with the curriculum. These WBLRs may include websites, podcasts, video modules, blogs and wikis. The main characteristics of WBLRs are that they are shareable, customizable, repurpose-able and re-usable in the learner-centred context.

WBLRs are very useful in promoting learning effectiveness. Majority of WBLRs studies on user mathematical performance, self-efficacy, attitudes and acceptance have mainly reported of positive benefits of WBLRs with some few contextual constraints (Guzeller & Akin, 2012; Beki & Guveli, 2008; Kong & Kwok, 2005). As compared with the traditional resources, Hadjerrouit (2010b) indicates that WBLR serves as an added value because the resources promote a new, exciting, active, self-reflected and collaborative learning environment. Following a structured observations of two groups of students who were learning fractions, Kong and Kwok (2005) concluded that the group who used the web material performed better than their colleagues in the control group. A study by Beki and Guveli (2008) indicated that not only did web-based mathematics instruction material improved students' attitude towards mathematics instruction but also ensured students learnt the content of the mathematical function successfully. Combes and Valli (2007) also acknowledged the potential value of WBLRs in promoting constructivist learning environment.

Kay, Knaack and Patrarca (2009) also found that a large proportion of the teachers in their study reported that the use of WBLRs stimulated students' knowledge acquisition. They argued that, among the emerging technology resources, most teachers perceive WBLRs to be easy to learn and more flexible to use in their teaching practices. According to Guzeller and Akin (2012), one of the best examples of integration of emerging technologies in mathematics education is web technology. As illustrated above, these growing evidence of instructional benefits of WBLRs in contemporary literature has implications for mathematics instruction.

Web Pedagogies

A review of emerging literature on technologies in mathematics instruction has revealed a global advocacy for the adoption of web pedagogies to improve the way Mathematics is taught and learnt (Akayuure, Nabie & Sofo, 2013; Hadjerrouit, 2010b; Kay, Knaack & Patrarca, 2009 Beki & Guveli, 2008; Nam & Smith-Jackson, 2007). The emergence of these new pedagogies which range from new instructional approaches on virtual environments to those that incorporate merely simple web-based resources is influenced by several factors. Among these factors, the influence of new theories of learning, changes in societal prospects for learning and the potential of emerging technologies to meet learners' expectations appear overriding (Agyei & Voogt, 2011). Since the teacher is the driving force in any instructional process, the emergence of these pedagogies has implication for mathematics teacher education. As a mandate, teacher education institutions, in Ghana for instance, have to provide not only professional knowledge but also instructional design capacities to prospective teachers to enable them implement web pedagogies (Akayuure, Nabie & Sofo, 2013). The aim of this provision is to afford prospective teachers with what is required to teach effectively with technology.

Teaching is a design activity (Brown & Edelson, 2003) and teachers are expected to be professionally creative in their lessons design and delivery. This explains why professional knowledge and instructional design capacities are very crucial in the mathematics teacher education. However, research suggests that the mathematics teacher education processes have often focused on the knowledge component of prospective teachers to the neglect of their instructional design capacities. In particular, teacher training process that emphasize the professional capacity of prospective mathematics teachers to introduce their own innovative strategies, make professional decisions and design web instructional materials that will meet learning needs is currently limited (Buabeng-Andoh, 2012; Combes & Valli, 2007; Castro, 2006). As we attempt to exemplify in this study, we argue that prospective teachers must be provided with the needed opportunities to develop appropriate instructional design capacities during their teacher education programs.

One way of ensuring that prospective mathematics teachers develop instructional design capacities is to engage them in design activities as in creating instructional materials (Agyei & Voogt, 2012). Constructing instructional materials enables prospective teachers to think deeply about the kind of mathematical task and pedagogical approaches that affect students' learning processes. As WBLRs have become evident in mathematics education, developing prospective teachers' ability to design these resources with suitable mathematical tasks is very imperative.

Usability of Mathematical Task in WBLRs

Chapman (2013) describes mathematical tasks as tasks intended to promote students' thinking about mathematical concepts and procedures including their connections and applications to real world situations. According to Yeo (2007), mathematical tasks range from problem-solving tasks, investigative tasks, guided-discovery tasks, project work, real-life tasks, problem-posing tasks, open tasks to ill-structured tasks. Mathematical tasks may also be classified into mathematically-rich and non-mathematically-rich tasks. Yeo (2007) explained mathematically-rich tasks as analytical tasks which "provide students with opportunities to learn new mathematics and to develop mathematical processes such as problem-solving strategies, analytical thinking, metacognition and creativity" (p.2) Non-mathematically-rich tasks on the other hand include procedural tasks which only provide students with practice of procedures.

Mathematical task is central to the learning of mathematics. This is because according to Furner and Gonzalez-DeHass (2011), the mathematics content is typically embedded in the series of tasks assigned to the learner. In view of this, the kind of tasks incorporated into a given WBLR significantly affects its usability and worth. For instance, Chapman (2013) and Furner and Gonzalez-DeHass (2011) indicated that mathematical task which stresses on students' relational understanding and opportunity to explore the mathematics content and draws on students' intrinsic value of learning relative to real-world significance, encourages active learning of mathematics. Distinguishing between worthwhile and non-worthwhile forms of tasks, Chapman (2013) indicates that worthwhile mathematical task has "…significant mathematical content; … multiple ways …multiple representations …and requires …students to justify, interpret, conjecture…" (p.1).

The choice of any type of tasks depends on the curriculum and instructional goals and the learning outcome or the nature of support anticipated for students to promote knowledge transfer. Literature has however shown that the choice of these tasks is often difficult for practicing teachers and more especially for prospective teachers. Thus, as we engage prospective mathematics in designing mathematical tasks for web instructions, it is imperative to examine the kind of mathematical tasks embedded in their modules.

Pedagogical Usability of WBLRs

To ensure that students can benefit from WBLRs, Kay, Knaack and Patrarca (2009) and Nokelainen (2006) specified two main usability features. The first one is technical usability which measures the extent to which a WBLR is convenient, practicable, and usable. The second is pedagogical usability which ensures that the WBLR is tailored more closely to meet the curriculum requirements as well as teachers and learners' needs. Hadjerrouit (2010b) indicated that the pedagogical value of WBLR lies in its instinctive characteristics which help learners to explore knowledge by themselves through interactive, flexible, differentiated and motivated activities. This study will focus more on pedagogical usability as it significantly relates to the teacher knowledge domains.

In recent times, researchers (Akpinar & Simsek, 2007; Hadjerrouit, 2010b) have found a mismatch between existing WBLRs and what teachers, educators and learners need for effective teaching and learning. While the majority of WBLRs are posted online, Hadjerrouit (2010b) emphasized that they do not conform to the instructional goals, philosophical beliefs and intentions of many mathematics teachers. According to him, a large proportion of WBLRs are created by software experts for classroom teachers to solve instructional problems. As these experts know little about the contextual needs of users and the pedagogies aligned to specific mathematics task in the curriculum, their WBLRs are often deficient in pedagogy, learner control and users' social domain (Akpinar & Simsek, 2007).

To address this mismatch, professional teachers and prospective mathematics teachers need to be provided with the right knowledge which can enable them design their own WBLRs that will meet their own instructional needs, their learners' dispositions and the mathematics curriculum requirement. Unfortunately, a literature search suggests little is known about how teacher training program, particularly in Ghana, develops mathematics teachers' capacities to create usable WBLRs for instructions. The knowledge constraint appears to limit the mathematics teachers' self-efficacy, acceptance and efforts to use WBLRs for instruction. This limitation has the tendency to undermine policy initiatives towards the integration of web resources in mathematics instructions in Ghana.

The present study reports on the heuristics evaluation of mathematical tasks and pedagogical usability attributes of prospective mathematics teachers self-authored web modules. Specifically, the first objective is to examine evidence of worthwhile mathematical tasks embedded in web modules designed by prospective mathematics teachers. The second objective is to examine the pedagogical usability levels of web modules created by prospective mathematics teachers for use during their oncoming teaching practice at senior high schools in Ghana. Web module is operationalized here as a type of WBLR comprised of web pages of video/audio lessons, presentations, assignments/quizzes, etc on a topic in the Ghana mathematics syllabus. Perceived pedagogical usability level is also conceptualized as the extent to which a web module possesses characteristics that can support learners to achieve a given instructional objective in the mathematics curriculum.

Methodology

The study employed descriptive research methods to examine perceived usability of web modules created by prospective mathematics teachers in Web Technologies Methods course. In relation to this design, the study seeks to categorize and describe the mathematical tasks and pedagogical usability attributes of participants' self-authored web modules.

Participants

The participants were 157 males and 15 females who were pursuing a 4-year bachelor degree in mathematics education at the University of Education, Winneba (UEW). Sixteen were enrolled as post-diploma students with an average of two years teaching experiences and 156 were admitted directly from the senior high schools in Ghana without any experience in teaching.

The students were enrolled in a one semester Web Technologies Methods Course titled, "Web Technologies for Mathematics Teacher". The course was the last of six courses designed to develop prospective mathematics teachers' knowledge and skills to design web teaching modules and integrate web resources in their future teaching practice. The study examined the impact of the course on the prospective teachers' ability to select and create WBLRs in line with the mathematics curriculum and learning needs in Ghana.

The Web Technologies Methods Course

The present study followed instructional procedures used by Akayuure, Nabie and Sofo (2013). However, for ease of access, we have restated the objectives and procedures adopted as follows:
The course was designed to provide participants the opportunity to locate and evaluate the suitability of WBLRs in terms of mathematical tasks and pedagogies for mathematics instruction. It was also intended for the prospective teachers to create suitable web modules for teaching and learning mathematics (Department of Mathematics Education, 2010).

The participants were guided to examine various WBLRs for mathematics instruction using characteristics of good websites. They also learnt how to create web pages involving Hypertext MarkUp Language (HTML), Cascading Style Sheets (CSS) and Javascripts. The course was developed on Moodle platform and delivered by the first researcher. Instructions were done in hybrid mode involving face-to-face demonstrations and online interactions. Sample demonstrations and practical activities - including the use of HTML and CSS using Notepad, FrontPage and Dreamweaver - took place in the institution's Math Laboratory. With the aid of the Moodle Resources and Activity tools, all online reading materials, quizzes, assignments, forums and tasks were presented developmentally for 12 weeks. Series of projects were developed by participants to teach mathematical concepts.

In the final project, design groups, of four or five students, were requested to: (i) identify a mathematics topic that they could adequately teach using web resources, (ii) develop web contents and compose them into web modules for a targeted class in the Ghanaian senior high school curriculum using (iii) the constructivist approaches that will enable learners to explore the mathematical knowledge. They were first required to do needs analysis of potential users and design a project layout to show the structure of the web modules to be created. At the end of the semester, each group (36 in all) was guided to host their final piece of project-based web resources onto free webhosting site.

Research Instruments

A Mathematical Task Usability Scale and Pedagogical Usability Rubrics were employed in rating the usability of the mathematical tasks and pedagogical attributes of the web modules.

Mathematical Task Usability Scale (MTUS)

The items were adapted from a set of prompts derived from the Professional Standards for Teaching Mathematics, Standard 1, for evaluating the worth of tasks in mathematics lessons (NCTM, 1991). There were 11 items designed to rate evidence of worthwhile mathematical tasks in the web contents. Examples of the items include: "Task in the web content was based on sound and significant mathematics", "Task in the web content entails problem solving and mathematical reasoning", "Task in the web content is sensitive to varying background experiences and dispositions of users", etc. Each item was rated from 1 to 4, where 1 indicates no evidence of usability of mathematical task and 4 indicates explicit evidence of usability of mathematical task.

Pedagogical Usability Rubrics (PUR)

In order to design a set of rubrics for the data collection, we conducted a literature search on various criteria employed to evaluate the worth of WBLRs. This was followed by a meeting and discussion on the appropriateness of the rubrics. Finally, the rubrics were derived after modifying rating criteria used by Nokelainen (2006) and Hadjerrouit (2010a) to assess pedagogical usability of digital learning tools. Ten attributes were deemed to reflect instructional value of web contents for the study. The attributes (scales are in parentheses) include: understandability (0-3), added value (0-2), goal-orientation (0-4), interactivity (0-3), multimedia (0-4), motivation (0-3), flexibility (0-3), autonomy (0-3), variation (0-2) and collaboration (0-3). With this rating scale, cumulative score of 30 represents the highest pedagogical usability level.

Data Collection

Three faculty members, at the Department of Mathematics Education of the University of Education, Winneba (UEW), Ghana, where the study took place, examined and rated the web modules using the MTUS and PUR. The selection of the three faculty members were based on Sicilia and Garcia (2003) assertion that three to five experts may be appropriate for heuristic evaluation of the usability of learning objects.

Two of the faculty members hold Master Degrees in Mathematics Education and have been teaching multimedia and web technology courses in mathematics education for 4 years. They are pioneers of course writers and instructors on Moodle platform at the UEW. The third faculty member holds a PhD in Mathematics Education and has taught Psychology of Learning Mathematics at UEW for over 16 years. During his PhD program in Canada, he experienced the use of web resources and had instructions on the selection and evaluation of suitable web resources for mathematics instruction.

A pilot rating session was initially conducted where the three faculty members rated two previously designed web modules to resolve variability and non-uniformity on scoring. An intra-rater agreement of 92% and 80% were reached for MTUS and PUR respectively. After the pilot, all 36 web modules were examined and rated independently by the three faculty members. This was followed by a meeting to cross-check and addresses few inconsistencies in scores. This procedure was adopted to uphold consistency, track intra-rater reliability and to arrive at average scores for analysis.

Data Analysis

The scores were keyed into SPSS software for analysis. Reliability tests were performed to check internal consistencies of scores. Alpha reliability estimates for the mathematics task items ranged from 0.868 to 0.895 and the overall reliability coefficient computed for worthwhile mathematical task construct (r_α=.891, n=11) indicate high consistency of scores. The overall reliability coefficient for perceived pedagogical usability construct (r_α= .577, n=10), were also found to be moderately satisfactory.

To address the first research objective, cumulative mathematical task scores were computed, re-coded and categorized into little/no evidence of worthwhile tasks (0-20) and explicit evidence of worthwhile tasks (21-40) (Figure 2). The evidence of the worthwhile tasks was then examined with regards to mathematics curriculum requirement and learning needs (Table 1). Simultaneous 95% confidence intervals of means for within clusters for the three mathematics content areas were also analyzed. To address the second research objective, pedagogical usability scores were computed and categorized into three distinct levels based on commonalities. These categories include low score (0-18), moderate score (19-23) and high score (24-30). Table 2 displays these categories based on the range of scores, frequency and percentage distributions of pedagogical usability levels.

Results

Usability Ratings of Web Contents by Evidence of Mathematical Task Attributes

One aspect of the usability of web learning content is the extent to which the mathematical tasks embedded in them address curriculum goals and learning needs of target learners. Designing mathematics tasks to address such usability aspects can be difficult especially for prospective teachers. The first objective in the study was to examine the ratings of perceived usability of participants' web contents in terms of the mathematical tasks embedded in these contents. Table 1 shows the descriptive statistics of ratings of mathematical tasks.

Table 1. Ratings of evidence of usability of mathematics tasks

Mathematical Task Attributes	N	Min	Max	Mean	Std. Dev.
Curriculum Requirement Attributes	36	1	4	2.46	.589
Sound and significant math content		1	4	2.36	.723
Students' intellectual development		1	4	2.56	.939
Students' math understanding/skills		1	4	2.58	.841
Students' math connection/ coherence learning		1	4	2.36	.833
Students' problem solving/math reasoning		2	4	2.44	.652
Learning Needs Attributes	36	1	4	2.47	.597
Knowledge of students' interest/experiences		2	4	3.03	.559
Knowledge of diverse ways students learn math		1	4	2.39	.764
Promotes communication of math		1	4	2.03	1.108
Represents math as ongoing human activity		1	4	2.67	.926
Draws on students' diverse background experiences		1	4	2.58	.649
Promotes students' dispositions to do math		1	4	2.14	.899
Cumulative Task Usability Rating	36	1	4	2.47	.583

An analysis of the results in Table 1 indicated high mean rating ($mean = 2.47$, $SD = .583, max = 4.00$) of mathematics curriculum requirement attributes. In particular, the high mean ratings of curriculum requirement attributes, as shown in Table 1, indicate that the participants' web contents have high evidence of significant mathematics content tasks (2.36), students' intellectual development tasks (2.56), mathematical skill development tasks (2.58), mathematical connections tasks (2.36) and problem solving/mathematical reasoning tasks (2.44). The result suggests that the mathematical tasks selected by prospective teachers to develop their web contents largely related to the Ghanaian mathematics curriculum goals.

The results also indicate high mean ratings (2.47) of learning needs attributes. Further analysis of the individual attributes as shown in Table 1 indicated the participants incorporated students' interest, background experiences and dispositions in their choice and creation of the mathematical tasks. The cumulative rating of evidence of task usability (2.47) indicates that participants' web contents relate to the learning needs of their target students.

Worthwhile and Non-worthwhile Mathematical Tasks in Participants' Web Modules

Further descriptive analysis of all 11 items evaluating evidence of worthwhile mathematical tasks in the web contents revealed two categories as shown in *Figure 1*.

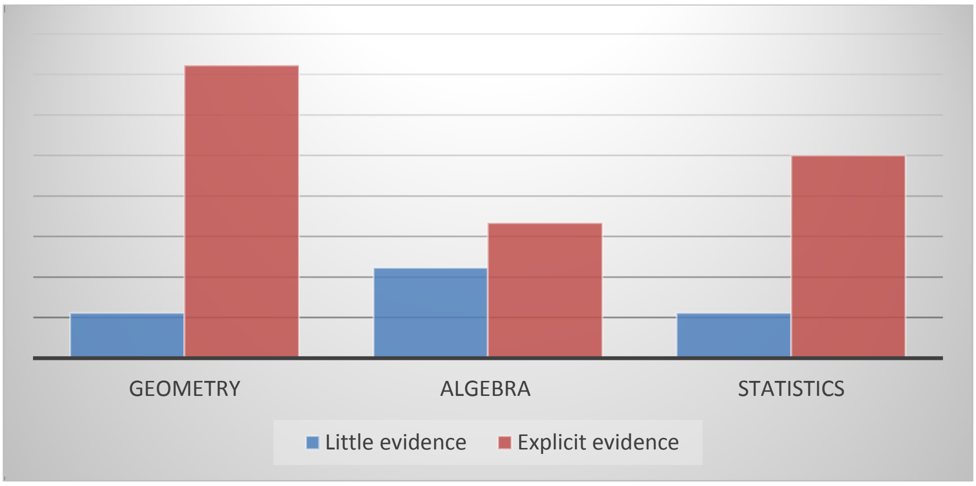

Figure 1. Distributions of evidence of worthwhile tasks by mathematics content areas

The result in Figure 1 indicated substantial proportion (77.8%) of the task contents examined contained explicit evidence of worthwhile mathematical tasks. Among the three mathematics content areas, the proportion of worthwhile mathematical tasks in the geometry (36.1%) web modules was higher than that of Statistics (25.0%) and Algebra (16.7%) web modules. An analysis of simultaneous 95% confidence intervals of means for within clusters for the three mathematics content areas corroborated this result. It is however, worth noting that as large as 22.2% of the web modules have little or no evidence of worthwhile mathematical tasks. These tasks may be viewed as non-worthwhile tasks as they lack significant mathematical content and may not require students to justify, interpret, conjecture or show multiple solution paths.

Perceived Usability Rating of Participants' Web Modules by Pedagogical attributes

The second objective of the study was to examine the perceived pedagogical usability levels of web modules created by prospective mathematics teachers for use on their upcoming teaching practicum at senior high schools in Ghana. Table 2 displays the levels, range of scores, and frequency and percentage distributions of Participants' web modules.

Table 2. Distribution of pedagogical usability levels of web modules

Level	**Range of scores**	**Frequency**	**Percentage**
Low	0 – 18	2	5.6
Moderate	19 – 23	21	58.3
High	24 – 30	13	36.1
Total	0 – 30	36	100.0

When total scores of the 10 attributes were categorized, 5.6% of the web modules were at a low pedagogical usability level (Table 2). A critical analysis of scores for each attribute of the usability criteria revealed that these web modules lacked variation, had little motivation, little added value to effect learning and contained poor multimedia presentations. The remaining attributes comprising goal-orientation, understand-ability, interactivity, flexibility, autonomy and collaboration were however rated high. Cumulatively, this result suggests that a small proportion of the web modules has little potential in terms of helping students to explore mathematical knowledge.

As shown in Table 2, approximately 58% of the web modules produced by the prospective teachers were at moderate pedagogical usability level. Out of the maximum score of 30, the score for this category of web modules ranged from 19 to 23. Further analysis of scores of individual pedagogical usability attributes indicated that all 10 attributes were at least averagely rated. The result suggests that this category of web contents has considerable tendency to support and enhance the cognitive processes of learners.

The last category of the web modules consisted of those that were scored from 24 to 30. These constituted 36.1% of the 36 web modules created by the prospective mathematics teachers. Each of the attributes was scored high and rated as having high pedagogical usability attributes. This suggests that 36.1% of the web modules contained: highly appropriate mathematics learning goals and contents tailored to ease students' understanding, well-integrated multimedia elements and feedback on students' actions and motivation to learn mathematics. These web modules also contained flexible mathematics contents which can support collaborative learning and offer variations and autonomy in learning.

Discussion and Conclusion

The study examined among others the perceived pedagogical usability levels of web modules created by prospective mathematics teachers during a one semester methods course on "Web Technology for Mathematics Teacher". Pedagogical usability level is viewed as an indicator of the prospective mathematics teachers' pedagogical design capacity for integrating web technologies in their future mathematics instructions. An examination of prospective teachers' web modules would lead teacher educators to clarify their mathematical task knowledge and design capabilities towards integrating web technology in instructions. The results indicated substantial proportion (77.8%) of the web modules contained worthwhile mathematical tasks. Approximately, 22% of the web modules have little or no evidence of worthwhile mathematical tasks. These tasks were found to have insignificant mathematical content and may not require students to justify, interpret, conjecture or show multiple solution paths.

The data also reflected three distinct categories of perceived pedagogical usability levels corresponding to low, moderate and high. An examination of each of the 36 pieces of web modules produced by the prospective mathematics teachers revealed that about six percent possessed low pedagogical usability attributes. Approximately 58% and 36% of the web contents met moderate and high pedagogical usability criteria respectively. The low usability rating is not surprising as studies (Akpinar & Simsek, 2007; Hadjerrouit, 2010b) have indicated that some WBLRs created and posted on the internet have considerable pedagogical usability problems. However, key to this study is the finding that approximately 94% of the web modules were found to possess appreciable pedagogical usability characteristics. The high proportion tends to signify that the web contents could be functional learning materials for mathematics instruction. The substantial pedagogical value may be attributed to the involvement of the prospective teachers in the contextual analysis of their learners' needs and examination of pedagogies aligned to the Ghanaian mathematics curriculum which are often lacking in most learning resources posted online.

The results also confirm the finding (Koehler, Mishra & Yahya, 2007) that the design-based courses provide opportunities for prospective mathematics teachers to develop pedagogical design skills needed to craft learning resources and environments for mathematics instructions. As Kay, Knaack and Patrarca (2009) acknowledged, it is anticipated that involving prospective teachers in design activities could make them feel more comfortable to integrate web resources in their future teaching practices.

In the field of mathematics education and in professional development process, constructing learning materials may not be anything new. However, the design of WBLRs with mathematically-rich tasks by classroom teachers is currently limited or non-existent in the mathematics teacher education and teaching practices particularly in Ghana. Thus, although Kay, Knaack and Patrarca (2009) noted that WBLRs may be easy and more flexible to use for teaching, mathematics teachers' inability to design their own WBLRs may perhaps, limit the use of these resources in the teaching. The findings in this study support the advocacy in current literature (Akpinar & Simsek, 2007; Nam & Smith-Jackson, 2007; Hadjerrouit, 2010b) for the involvement of teachers in the construction of technology-based learning resources and virtual environments for mathematics education.

Based on the findings, we conclude that the web contents produced by the participants through learning web technology-by-design activities have significant pedagogical value. It also clarifies hierarchical levels of prospective mathematics teachers' task and pedagogical design capacities towards the creation of WBLRs. Thus, rather than provide direct instructions on ways of technology integration, prospective mathematics teachers must be trained to author their own WBLRs. This might engender their affordance to use WBLRs for instructions.

It is therefore recommended that teacher education institutions should integrate web technology methods courses in their programs. In teaching this course, prospective mathematics teachers should be made to design their own WBLRs for teaching mathematics. This would not only improve upon their self-efficacy as reported in Akayuure, Nabie and Sofo (2013) but also help build their competencies and craft knowledge to enable them design functional WBLRs for instructions.

This study was limited to pedagogical usability of web contents created by prospective mathematics teachers. Further studies should investigate both technical and pedagogical usability attributes. In such a study, more emphasis should be on the analysis of prospective teachers' knowledge in mathematical task design. Also, as the use of web in instruction is still rare in the mathematics classroom, a study that would explore how practicing and prospective teachers apply WBLRs in their practice teaching is very imperative. The final phase of bridging the mathematics teachers' knowledge gap to integrate web technologies in mathematics instruction during teaching practice in Ghanaian senior high schools is worth investigating.

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