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PEERWISE: FLEXIBLE LEARNING AND THE CONTRIBUTING STUDENT PEDAGOGY

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Abstract

PeerWise is a freely available web-based application that allows students to contribute Multiple Choice Questions (MCQs) to a question bank. Students' engagement with Peerwise is modeled to facilitate students understanding of, and familiarity with web 2.0 and social software tools. In its socially-enabled environment, Peerwise allows students to create questions and explanations of their solutions, answer questions created by their peers and receive feedback, and provide ratings and comments to questions in the question bank. In addition, Peerwise provides an administrative interface for course instructors to facilitate easy access to questions created by students, and analyses of students' contribution. Peerwise was designed following the principles of the contributing students' pedagogy. This paper provides an overview of the contributing student pedagogy and a description of Peerwise as an instance of this model. Further, an analysis of the usage of Peerwise from the literature is explored and conclusions with experiences from a case study and an outline of areas for further research are outlined.

Key words*:* Computer Science Education, Contributing Student Pedagogy, Peerwise, Social Learning, Web 2.0

Introduction

Modern technology has influenced education and continues to change educational practices in many ways. In particular, Information and Communication Technologies (ICTs) have afforded the teaching and learning community tools that enables processes and practices previously impossible to achieve or were too expensive to undertake. Information and communications technologies facilitate new ways of creating, disseminating and searching for content, and the production of knowledge (Conole, 2013). Modern Information and Communications

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Technologies have also influenced the way learners and teachers communicate, teach and learn, and how assessments are crafted and executed. Further modern ICTs have influenced administration of the education process with the introduction of educational management information systems. Krishnaveni and Meenakumari (2010) presented an extensive range of administrative activities that are supported effectively by ICTs.

With the advent of the World Wide Web (WWW) in the early 1990s and the proliferation of the social web over the past decade, educational practices have been further disrupted. While the earlier web 1.0 facilitated the mass distribution of content to a large audience in a one-directional communication mode, the newer Web 2.0 and Social Software technologies allow multi-directional communication (Conole & Alevizou (2010). Web 2.0 has made it possible to implement a more-learner-centered mode of education and has facilitated the experimentation with learning practices that were otherwise difficult to implement without technology. Conole (2013) argues that the social and participatory media are characterized by their ability to facilitate 'user-generated content, peer critiquing, collective aggregation, community formation and digital personas'. Conole (2013) further notes that the web has shifted from a content repository, which is from the old web 1.0 to a web that facilitates social mediation and user-generated content. Collis and Moonen (2008) argues that web 2.0 is a second-generation technology that facilitates online collaboration and sharing while Anderson (2007) claims that web 2.0 facilitates social-connectedness and allows users to contribute content as much as they consume. This socially-mediated space is enabled by a range of functionalities afforded by a wide range of web 2.0 technologies that facilitates their implementation (Crook et. al., 2008).

The following sections outline four of the main components of this new mode of learning in the context of this paper: The Contributing Student Pedagogy, Flexible Learning and the Contributing Student, Social Learning, and Gamification.

The Contributing Student Pedagogy

A Contributing Student Pedagogy (CSP) can be defined as "*A pedagogy that encourages students to contribute to the learning of others and to value the contributions of others"*(Hamer et al., 2008). This definition includes two necessary components (Hamer et al., 2010):

- Students contribute to the learning of others. Such contributions may take a variety of forms, such as creating tutorial materials, demonstrations, worked examples, examination questions, providing feedback, etc.

- Students value the contributions of others. The students believe that the contributions of others are potentially useful in the context of the course.

A re-defined version of the Contributing Student Pedagogy was developed by Hamer et al. (2010) to specifically account for aspects of the pedagogy that can potentially occur accidentally. They argue that the intention of the instructor must be clear in that students' contribution "*produces an artifact that is shared with at least one other student for the purposes of learning".* (Hamer, et al., 2010). The new definition is outlined below: *Contributing Student Pedagogy (CSP): A pedagogy that requires students to produce artifacts for the purpose of contributing to other students' learning, and encourages students to value these peer contributions.* Key features of this definition are:

- the instructor is explicitly using a contributing student pedagogical design;
- the pedagogy includes the requirement that students produce artifacts;
- the students are aware that the audience for these artifacts include other students; and
- these artifacts are shared with other students, for the purposes of their learning.

They further argued that this refined definition puts students at the center of the process by shifting the power from the instructor to the students. This new definition facilitates the addition of newer activities such as oral presentations, forum discussions, peer reviews, example exam questions, and so on (Hamer et al., 2010). One of the implicit strengths of the contributing student pedagogy is the value of individual contributions of students towards the learning of their peers. In addition to the formal definition of the contributing student pedagogy, Hamer et al. (2008) identifies five characteristics of this practice: shifting roles of learners and instructors, focus on content contribution, assessment of the quality of content contribution, the development of learning communities, and the use of technology to facilitate students' contributions.

While on the surface these two attributes of the contributing student pedagogy may not be entirely new, challenges within their implementation abound. Hamer et al. (2010) argued that implementing the contributing student pedagogy in large classes could be problematic as the volume of learning artifacts contributed by large classes would be difficult to effectively captured, managed and share among peers. They further argued that in classes where anonymity is important, further challenges to maintain privacy are likely when implementing this pedagogy. An argument therefore in favor of implementing the contributing student pedagogy using technology-based solutions appears reasonable.

Flexible Learning and the Contributing Student

Collis and Moonen (2001) presented more broadly defined perspective on the contributing student within the framework of flexible learning. They define flexible learning as *"... a movement away from a situation in which key decisions about learning dimensions are made in advance by the instructor or institution, toward a situation where the learner has a range of options from which to choose with respect to these key dimensions."*

They further describe flexible learning in terms of its four key components: technology, pedagogy, implementation and institution; and one that involves a complex interrelationship that exist among these concepts (Collis & Moonen, 2002). Flexible learning can be further illustrated as a concept comprising nineteen (19) dimensions (Collis & Moonen, 2001). One of the keys of this model is the role of technology and in particular web-based information and communications technology to support flexibility. It is within this context of a web-based environment that the support for the pedagogy of the contributing student is defined. The underlying pedagogical model to support the contributing student pedagogy according to Collis and Moonen (2003) are based on two key principles:

1. *Learning situations should be designed for flexibility and adaptability.*
2. *Learning situations should involve not only acquisition of skills and concepts but also opportunities to participate in and contribute to a learning community.*

However, unlike previous models that are similar in structures with pre-determined materials and activities (Jonassen, Peck, & Wilson, 1999; Laurillard, 2003), the intention of the contributing student model is to facilitate flexibility in students learning by allowing students to share personal experiences, materials from the web and other literature, and so on. (Collis & Moonen, 2003).

Overall, the contributing students pedagogy presented by Hamer et al. (2010) is much more refined and specific as opposed to the model presented by Collis and Moonen (2003) which is more broadly defined. Both models are grounded in the principles of the contributing student but allow a degree of flexibility in their implementation. As Hamer et al. (2008) points out that the Contributing Student Pedagogy is not one particular method but a family of methodologies. However, notwithstanding the various definitions and peculiarities, challenges, and the need for technology support for its effective implementation, the contributing student pedagogy has its foundations in established traditions and theories of social learning.

Social Learning

It has been extensively argued that learning is a socially constructed process. Many theories and frameworks have been proposed on the basis of this argument. Constructivism is a perspective in education which suggests that learning is constructed by individuals through active engagement where mental models are built upon previous knowledge (Ben-Ari, 2001). A particular brand of constructivism known as social constructivism was articulated by Vygotsky (1978). Social constructivism suggests that learning occurs through social interactions and is situated in and shaped by social contexts and culture (Hamer et al., 2010). Active engagement of learners through social interactions is the hallmark of social constructivism when applied to education.

The Communities of Practice (CoP) (Wenger, 1998) framework is also used to underpin and support the development Contributing Student Pedagogy. CoPs can be defined as a "*groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis*" (Wenger, McDermott, & Snyder, 2002). Hamer et al. (2010) argues that the idea of having a group of students actively engaged in a "community of learning" fits the description of a community of practice and can be likened to it; with students representing the 'community' and their understanding of the course material constitutes 'practice'. Central to argument for developing a community of learners is the active engagement of students in the "process" of learning as they create learning resources (Collis & Moonen, 2005).

Gamification

Gamification is the use of gaming elements and game design techniques to non-game based systems (Deterding et al., 2011). While gaming mechanics have been around for many years, gamification has only emerged recently as a strategy in education for motivating and engaging students learning through active participation in the teaching and learning process (Glover, 2013). Using gaming mechanics, gamification can foster increase engagement of participants through fun and reward elements built into their learning environment. In education, this aspect of fun and engagement promises to increase students' engagement with learning activities and improve learning experiences (Cheong, Cheong & Filippou, 2013; Sitzmann, 2011). While gamification can be implemented in offline learning environments, modern information and communications technologies have facilitated its development and implementation in online learning environment that are easily accessible to learners. Web-based gamification systems in education has the promise of scalability, allowing large number of students to become involved in learning activities that are otherwise difficult to implement and manage without technology.

Peerwise

Peerwise (http://peerwise.cs.auckland.ac.nz/) is a web-based online application and was developed at the University of Auckland in 2007. This tool emerged from research efforts in the Computer Science Education domain and is modeled following the principles of the contributing students pedagogy (Denny, Luxton-Reilly & Hamer, 2008). Peerwise allows users to collaboratively develop a bank of multiple choice questions. The system allows students to create questions and provide explanations to the answers supplied. In addition, students can answer questions provided by their peers and respond with comments to answers if they need clarification or are dissatisfied with answers (Denny, Hamer, Luxton-Reilly & Purchase, 2008b). In this way, the tool allows students to actively engage with their peers to construct better understanding of their domain of study.

The tool facilitates the contributing student pedagogy by way of the various social and interactive features afforded to users (Denny, 2010). The tool has elements of gamification as a part of its design and which serves as a means of motivating students to engage and contribute actively. The system reward users with points for contributions based on the quality ratings of the questions they contributed and the answers the supply to questions contributed by their peers. Points gained are then placed on a leaderboard system that shows level of contribution (Denny, Luxton-Reilly & Hamer, 2008). Further, students can earn a range of badges based on the quality of their contribution and the points they accumulate over time.

The Figure 1 below displays the administration interface provided by Peerwise. This interface is one of the many interfaces available to course leaders administer and use various features of the system. It provides a central place to access three main categories of information: Students, Questions and Course. The student category of items provides access to students' participation summary, scores, badges, leaderboard, and so on. The Questions option allows access to individual questions, and features to export all questions and import questions. The Course lists a number of options relating to the Course itself. For example the administrator can view daily usage chart. These tools facilitate easy access to the data generated by students. A course leader can easily assess participation and contributions and provide feedback to students.

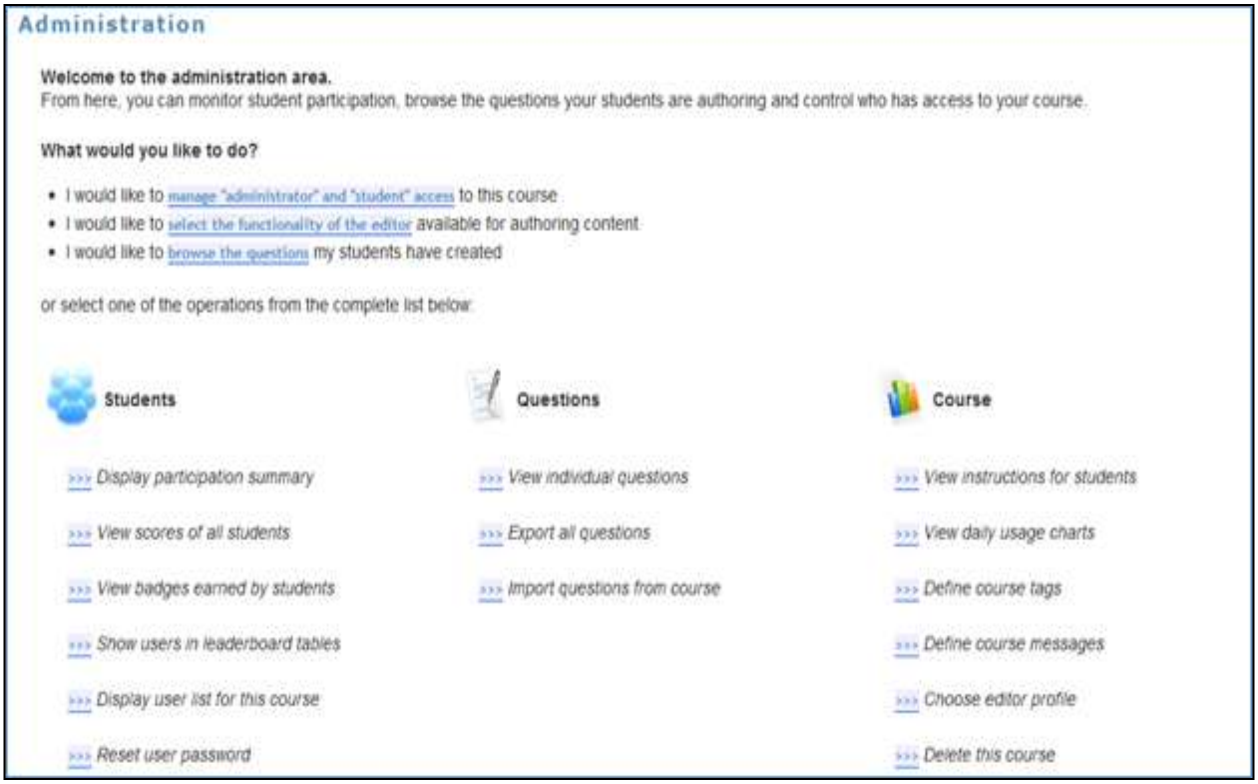

Figure 1. *Peerwise Administrative Interface*

Literature Review of related word

The first sets of published papers on Peerwise appeared in 2008. The papers were mainly exploratory in nature and documented descriptions of the tool and preliminary data about experiences on its use among computer science students (Denny, Luxton-Reilly & Hamer, 2008; Denny et al., 2008a). Since 2008, many more publications that examined various aspects of Peerwise is reported by the official Peerwise Community publications repository (http://www.peerwise-community.org/publications/). These published works have examined a range of areas: students' usage and contribution patterns; students' perception Peerwise and its utility; the quality of students' contribution; correlations between students' contribution and performance in final examinations. The following sections outline a brief analysis of these studies.

One of the first studies (Denny et al., 2008a) sign-posted a number of interesting usage patterns from students use of Peerwise. This study reported distinct patterns of contribution for questions created by students and the answers they supplied to the questions created by their peers. The researchers noted that students were more likely to contribute questions before assessment periods, with a noticeable reduction in contributions immediately after. Students answered questions following a similar pattern but would return to answering questions before final examinations as a preparation strategy for exams. They researchers attributed this behavior to the value students placed on Peerwise as a revision tool. This study also found strong positive correlations between all aspects of students' contribution and the multiple choice section of students' final examination scores. They authors also found comprehensive coverage of the course topics and that students were capable of writing good quality questions. The range of research areas covered in this paper set the tone for the types of studies that followed.

In a study that examined the quality of students' ratings of questions, Denny, Luxton-Reilly and Simon (2009) reported that students were effective at judging the quality of questions. They also found that students were generally asking questions 'clearly' and 'free from error'. Students were also good at detecting and correcting erroneous questions. In a replicated study, Denny, Hanks and Simon (2010) also found that students were asking questions clearly and free of errors. Similarly, Bottomley and Denny (2011) reported that Biochemistry students created a large repository of high quality, relevant questions. In the Physics classroom, Bates, Galloway and McBride (2011) shared comparable experiences, with the best examples described as 'remarkably high quality problems'. Bates et al. (2013) used a variant of the Bloom's taxonomy to classify students' questions and found that students were creating questions that mapped to the higher levels of the cognitive domain. They attributed this outcome to the scaffolding activities provided to students before they authored questions.

In terms of course coverage, Denny et al. (2009) found that students were creating questions from the range of course topics even though they were free to contribute questions from any topic. Denny, Hamer and Luxton-Reilly (2009) also reported that students were capable of making accurate judgments about the quality of questions. They further argued that this ability to make critical and high quality judgments of questions is important for the development of self-assessment skills.

Further to earlier studies that reported positive learning gains by students and increased motivation to learn, a number of subsequent studies have reported consistently similar results. Feeley and Parris (2012) found statistically signification correlation between students' use of Peerwise and learning gains in a political science class. They found qualitative evidence that Peerwise motivated students to learn and increase their perceptions of learning. In the health sciences, Rhind and Pettigrew (2012) found positive correlations between students' engagement and scores on final examination. They also noted that students believed that engaging with the tool improved the breath of their knowledge and understanding of the course and helped them with revision for examinations. However, correlation does not imply causation because of the influence of confounding factors. Luxton-Reilly et al. (2012) provided further insights into the value of students' participation and its effect on examination scores. They observed that question generation has a positive impact on performance of similar questions in the examination. They cautioned researchers about the use of correlation as a way of interpreting interventions and recommended further studies to unearth the real impact of educational interventions.

While much of its early use was exclusively within the research domain of Computer Science Education, Peerwise is now widely adopted across an increasingly wide range of subject areas. For example, in Engineering - Denny, Hamer, & Luxton-Reilly (2009); Shen et al., (2010), Singh (2104) Bioengineering – Denny, Micou and Simon (2010); Biochemistry- Bottomley and Denny (2011); Biology (Smith, 2011); Chemistry - Ryan (2013); Physics - Bates, Galloway and McBride (2011); Veterinary Medicine - Sykes, Denny and Nicolson (2010) and Rhind and Pettigrew (2011); Political Science - Feeley and Parris (2012). Peerwise has also been explored in the domain of teacher education (Mackey et al., 2012).

There are many positive experiences attributed to the use of Peerwise, however a number of issues remain outstanding. Peerwise has not been adopted in the developing world. This is not necessarily a limitation but a further opportunity for its utility to be evaluated in a different environment. Further, the quality of questions (Hakulinen, 2010) while positively reported in the literature in many instances, remains a challenge as it is not entirely clear what are the factors that impact the generation of high quality questions. Scaffolding and training of students is reported as one such factor that can be implemented to improve the writing of quality multiple choice questions. However, this strategy is not yet widely adopted and tested. In addition, plausible explanations of the real benefits of using Peerwise are undergoing continuous evaluation. While correlations may indicate some level of relationship between students engagement and examination scores, the need for experimental studies to pinpoint more precisely the real benefits remains an area of research interest.

The Case Study: Peerwise at the University of Guyana

To investigate the value of Peerwise in a developing country's context, the author explored the use of Peerwise with two (2) cohorts of students over successive academic years. The main objective of this case study is to examine students' acceptance of the tool and compare their experiences with those reported in the literature from the developing world. In particular students' usage pattern and contributions, perceptions of Peerwise, and the quality of questions contributed, forms the core of this study. The course under study is Introduction to Object Oriented Programming using Java (CSI 312). This course was subsequently renamed CSI 3102. This course is taken by students in the third year of a four-year undergraduate computer science degree at the University of Guyana. Figure 2 below shows the two instances of this course used in the case study.

Figure 2. *Peerwise Courses Panel*

Both instances of this course were offered over a fifteen (15) weeks period. Teaching was conducted primarily by means of lectures and practical laboratory sessions. Assessments were in the form of in class tests, programming assignments and a semester projects which totaled 40%. There is also a final exam worth 60%. Both instances of this course were taught and assessed by the same lecturer. The first cohort used Peerwise in 2011 and consisted of twenty one (21) students. The second cohort used Peerwise in 2012 and comprised twenty eight (28) students. Both cohorts were given the final eight (8) weeks of their course to use Peerwise to contribute multiple choice questions. Both cohorts were asked to contribute 3-5 questions, answer as many questions contributed by their peers, and provide critique and comments on the questions contributed by their colleagues.

In the first cohort, 2% out of the 40% for coursework was awarded for contributing the minimal number of questions. In the second cohort 3% was awarded for similar contributions. No training on the writing of multiple choice questions was provided to students. However, students were supplied with a guideline for writing high quality multiple choice questions. Similarly, no training on the use of Peerwise was provided as students were familiar with using Internet applications.

The question banks for both courses were downloaded for assessment and evaluation as the end of the semester. Pearson correlation was used to explore the relationship between contribution of students and their final examination scores. Descriptive statistics was used to summarize and present students contribution. The revised Bloom's taxonomy was used to classify the questions contributed.

Further, an open-ended online survey was administered using Survey Monkey to both cohorts at the end of the respective courses to gather feedback on students' perception of Peerwise.

Results

Summary of Students Contribution

Table 1 below shows the combined summary of questions created and answered by students for both cohorts. In total 45 out of 49 students created at least one question while all students answered at least one question.

Table 1. *Summary Students Contribution*

Metric	**Total**	**Average/Student**
MCQs Written	253	5.6 (3-5 required)
MCQs Answered	1573	32 (no limitation)
Comments made	403	8.9
MCQs Answered Correctly	1108 **(70%)**	22.6
MCQs Answered Incorrectly	465 **(30%)**	9.5

On average student created and answered more questions than the minimum stipulated requirement, while they answered approximately 6 times more than the number of questions created, with 7 out of 10 questions answered correctly.

Table 2. *Distribution of Question contribution*

# of Questions Written	# of Students	%
< 3	11	22.4
3	11	22.4
3 - 5	16	32.7
> 5	11	22.5

Table 2 above shows the breakdown of questions contributed by students using the baseline minimum required of 3-5 questions. Approximately one-third of the students contributed the required number of questions. 22.5% contributed more than the maximum required amount while a similar percentage contributed below the minimum requirement.

Breakdown of Contributed questions using Bloom's Taxonomy

The revised Bloom's Taxonomy proposed by Anderson and Krathwohl (2001) was used to categorize the questions contributed. This taxonomy was used by Bates et al. (2013) to categorize items from a study similar to the present study. Table 3 below shows the distribution of questions based on three levels. The author combined pairs of cognitive levels to simplify the classification process as it is not always clear whether a question fits one adjacent category or another.

During the classification process, approximately 10% of the questions were excluded as they were deemed incorrectly written or did not have at least 4 alternative answers. Approximately 53% of the questions contributed were at the lowest level in the cognitive domain while 11% were at the highest levels.

Table 3. Distribution of Questions using Bloom's Revised Taxonomy

Level	Identifier	Number of Questions/%
1	Remember Understand	135/**53%**
2	Apply Analyze	66/**26%**
3	Evaluate Create	28/**11%**

Correlation between students' contribution and Final Examination Scores

Pearson coefficient of correlation was calculated to explore possible relationships between students' contribution and their final examination score. Table 4 below shows the correlations between question contributions and scores obtained in final examination.

Table 4. *Correlation* - *Student Contribution and Final Exam Score*

	Correlation with Final Exam Scores		
Grades/ Scores	**Questions Written**	**Questions Answered**	**Questions Answered Correctly**
C, D, F (<65%) – 27 students	-0.06	-0.20615	-0.21244
A, B (>= 65%) – 22 students	0.481	0.133132	0.159134

For students with a score of 65% or more (equated to Grades A or B), a moderate positive correlation is noted between the number of questions written and final examination scores. However, negligible correlations are observed for the number of questions answered and the number of questions answered correctly and final examination scores. For students with a score of less than 65% (Grades C, D, F), small negative correlation is observed between the number of questions written and final examination scores. A weak negative relationship is observed for both the number of questions answered and the number of questions answered correctly and final examination scores.

Patterns of Usage

Figures 3, 4, 5, 6 (taken from Singh, 2014) below indicate students' patterns of interaction for both courses. Figure 3 and figure 5 shows that students engagement peaked at particular periods linked to assessment dates. Figure 4 and figure 6 shows the patterns of answering questions. Distinct peaks correlated to assessment and revision periods are noted.

Figure 3. *Daily question contribution – CSI 312*

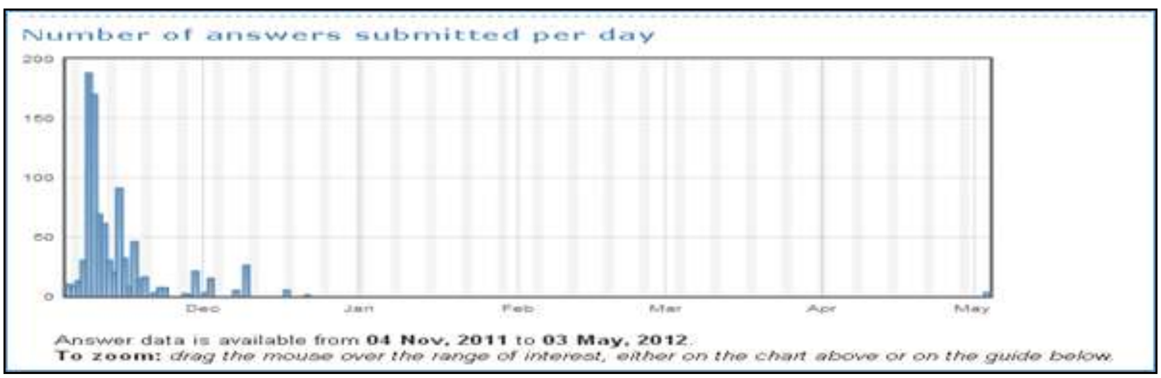

Figure 4. *Questions answered per day – CSI 312*

Figure 5. *Daily question contribution – CSI 3102*

Figure 6. *Questions answered per day – CSI 3102*

Students' Perceptions of Peerwise

Students opined that Peerwise was an easy to use recommended its further use:

"Setting up questions was easy enough."

"It was very easy, no complication at all"

"I definitely think the tool would be useful for students. My only regret is that more students didn't post and critique questions posted."

Students also expressed satisfaction with the contributing student pedagogy and the values of the process of creating questions:

"It's a very useful tool for student because it has a new method of learning whereas the student post questions, also provide answer and explanation."

"The idea of class participation motivated me whereas everyone is involved. Also both contributing and answering question motivated me."

"In choosing question content, it caused me to do research on particular areas before I posted a question. I had to be sure about something before I posted it"

"Answering and reviewing other person's questions also taught me a lot as it was important to research and be certain before presenting suggestions and reviews to questions."

"…the ability to add explanations and comments for questions was a big help in instances where I may have answered a question incorrectly"

Discussion

Students Pattern of Contribution

On average students contributed a fraction more than the maximum stipulated number of items. Similar results were obtained by Denny, Luxton-Reilly and Hamer (2008). However, when this data is disaggregated, only 22.5% of the students accounted for contributions above the maximum threshold value (5). Approximately 78% of the students contributed the required amount or below. What factors motivate students to contribute more questions than is required or conversely restrict students to minimum contribution is not entirely clear in the literature. Paterson et al. (2011) suggested that the awarding of 'marks' may be significant contributing factors. In the present study, the reward of 2-3% of total course mark could be one plausible explanation for the 78% of students who contributed the required amount of questions or below. The immediate reward of 2-3% compared to effort required to create 3-5 questions is perhaps skewed in favor of minimum engagement. However, Rhind and Pettigrew (2012) observed active students engagement even when no marks were rewarded. Intrinsic motivation on the part of some students (22.5% in this study) may explain their above average levels of contribution.

Students answered approximately 6 times as many questions as they created. This is consistent with the results noted previously (Denny, Luxton-Reilly & Hamer, 2008; Luxton-Reilly, Denny, Plimmer, & Bertinshaw, 2011). The task of answering questions is cognitively less challenging than writing questions and may explain this observation. However, Bottomley and Denny (2011) advances the argument that some students might be 'gaming' the system by trying to answer as many questions as they can. Peerwise offers rewards for students contribution. Answering questions is one of the easier ways to earn points and badges and may therefore encourage 'gaming' by students that are less inclined to write questions but desirous of improving their rating. However, it is not entirely clear whether this is indeed the case.

Approximately 30% of all questions answered by students were incorrect. An examination of incorrect responses was beyond the scope of this study as Peerwise currently does not allow an easy way to gather this data. However, a previous study suggested that incorrectly written questions and/or incorrect keys may contribute to the proportion of incorrect answers supplied by students (Denny, Hamer & Luxton-Reilly, 2009). Further research relating to incorrect answers is recommended.

Cognitive Levels of Questions Contributed

Programing is challenging for many students leading to high failure and withdrawal rates (Bennedsen & Caspersen, 2007). The challenges faced by novice programmers with fundamental programming construct and principles may impact their ability to write good programming questions. Furthermore, the nuances of good multiple choice questions are generally beyond the grasp of many students at this stage of their education.

In this study more than 50% of all questions created were rated to be at the lower levels of the cognitive levels in the Bloom's taxonomy. Denny, Luxton-Reilly and Simon (2009) reported that students contributed questions that were of good quality. However, they used a different strategy for rating question quality. Similarly, Purchase et al. (2010) found that students in computing classes were producing high quality questions but they also use a different rating and classification scheme to arrive at measure for question quality. So while a question meets all the quality standards specified little can be inferred about the cognitive level when rating scales are different. In Biochemistry, Bottomley and Denny (2011) found that most of the contributed questions were ranked in the lower three levels of the Bloom's taxonomy. However, using the same Bloom's taxonomy, Bates et al. (2013) reported higher cognitive levels of questions beyond recall in a Physics course. In this study students were provided with scaffolding activities that prepared them to write multiple choice questions.

Three issues for further discussion emerge from the preceding discussion: (i) no common approach for measuring the quality of questions are used, (ii) it is not clear whether challenge level in writing multiple choice questions in computer programming is different when compared to other domains, and (iii) whether the experience level with writing multiple choice questions may impact the quality of items created.

Correlations between engagement and final examination scores

Researchers and educators using Peerwise to facilitate learning are interested in the actual effects of Peerwise on students learning outcomes. The correlations between students' final examination scores and their level of usage of the system have appeared repeatedly in the literature as possible indicator (Denny et al., 2008a; Feeley & Parris, 2012). However, Luxton-Reilly et al. (2012) cautioned about the use of correlations as a measure of learning outcomes as there may be other confounding factors which could explain students' achievement. They suggested that students are likely to perform well on some questions in their final examinations that are similar to those encountered in Peerwise. While Denny et al. (2008b) found correlations between multiple choice questions and non-multiple choice question and Peerwise activity, in many cases final examinations may comprise items other than multiple choice questions and therefore attributing cause and effect based on final examination scores must be treated with caution. In this current study moderate correlations are observed for students that achieved grades A or B in the final examination. Negligible correlations are observed for all other cases. This perhaps could be explained by the nature of the questions in the final examination which were not multiple choice items that Peerwise facilitated.

Pattern of Interaction

Students contributed most of their questions closed to the scheduled assessment period. They answered questions following a similar pattern. However, they subsequently returned to answer questions in preparation of final examination. This pattern of interaction by students observed in the present study are consistent with those found in the literature. Students are likely to contribute items to the question bank in short periods just before assessment schedules, and are not likely to contribute much more right after. Additionally, they are likely to answer questions before assessment periods and as a revision tool (Denny, Luxton-Reilly & Hamer, 2008). The challenge for instructors is to encourage students' participation on a regular basis to enhance learning opportunities. Hakulinen and Korhonen (2010) suggested that multiple deadlines and email notifications are likely to encourage students to revisit the system and contribute more consistently. Additionally, constant feedback to students on their contributions may encourage revisits and enhance learning opportunities (Ryan, 2013). Innovative strategies for encouraging consistent use of Peerwise is likely to enhance the quality of the repository of questions contributed by students and consequently improved learning outcomes.

Students Perception of Peerwise

One of the outstanding attributes of Peerwise is its usability and the ease with which any user can access and contribute items to the system. Students have consistently opined that Peerwise is simple to use and encourages their participation (Denny, Luxton-Reilly & Hamer, 2008). Bottomley and Denny (2011) reported that students felt the system encouraged them to learn and motivated them to use it again. Similar views were expressed by students in this case study. Students felt that Peerwise provided them a new way of learning and motivated their involvement because the entire class was contributing and participating in the learning process. They suggested that the task of creating questions encouraged them to do background reading so as to create good questions. This type of engagement is put forward as one of the potential benefits of the contributing student pedagogy in the Peerwise environment (Denny et al., 2008a). Peerwise, through its design features and affordances, is a tool that appears to support students' engagement effectively.

Conclusions & Recommendations

The growing acceptance of Peerwise across various learning domains as the literature suggests can be attributed to a number of factors. Previous studies suggests that 'ease of use' contributes to Peerwise's popularity. Further, Peerwise is free to use and can be adopted by individuals, schools or any organization with little investment in time and other resources. Peerwise is a web-based teaching and learning environment which means that there is no need to set up local technology infrastructure, thus avoiding costs for the acquisition of hardware and for training. However, one of the main challenges is that of Internet access for students and teachers. Further, studies have reported positive effects on students learning outcomes and motivation. When ease of use is combined with the potential for improved learning experiences for students, the value of Peerwise increases significantly.

Many important questions remain partially or entirely unanswered and warrant future research. Support for students in developing the skills required to write high quality multiple choice questions is critical to the success of the contributing student pedagogy and Peerwise. Scaffolding and formal training have emerged as potentially effective strategies but are not yet widely adopted and researched. Additionally, students continue to show consistent patterns of usage that are linked to assessment periods and revision for exams. This we believe is a limited use of

Peerwise. Future work may explore methods for encouraging consistent engagement with Peerwise to optimize learning opportunities.

Gamification has emerged as a method to encourage students' participation in learning environments. However, it is not clear what impact the gaming elements provided for by Peerwise have on students learning motivation to use the system. While gaming elements are potentially powerful tools for stimulating students and improving motivations, the development and evaluation of the use of effective gaming strategies that leads to learning gains in the Peerwise environment remains outstanding.

Finally, it is hoped that the encouraging results from this study in the context of a developing country will inspire other educators and researchers from the developing world to explore this tool. This is a necessary first step towards the successful adoption of innovative learning technologies and one step closer towards the enhancement of teaching and learning in the challenging learning environments of the developing world.

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