The Impact of PeerWise as a Collaborative Learning Tool in Computing

Robert.Nyabawa

Abstract— This study investigated the contribution of PeerWise educational tool in engaging students to learn collaboratively on a BSc Computing module (Database Systems), at Botho University. PeerWise is a free online innovative tool that engages students to participate in the creation and assessment of multiple choice questions. The tool catalyzes the development of high order cognitive skills and improves student academic performance with the least teacher effort. In building their own question bank, students become owners of their own content and become deep learners. They are transformed from passive recipients of information to active learners who dig deeper to understand concepts. The objectives of this study were to measure the efficiency of PeerWise in enhancing student learning in a 2nd year undergraduate Computing module, (Database Systems) and to analyze the trends in student participation and collaborative learning in a non-threatening environment. A qualitative research design was adopted with a purposive sample population of sixty respondents drawn from Botho University Maun campus. Data was collected through questionnaires, interviews and analysis of grades from final examinations. Results showed that students who used PeerWise performed well, thus above the 50% threshold, in all their examinations compared to passive users. The tool was easy to implement and was user friendly. These findings demonstrate the effectiveness of this tool in supporting learning and promoting student participation. It emerged that PeerWise is going to be a useful instructional tool and has the potential to become a powerful and famous educational online tool for higher education in future.

Keywords— Collaborative Learning, PeerWise, Deep Learners, Surface Learners, Database Systems

I. INTRODUCTION

EDUCATION in the 21st century is shifting from a teacher- centered to a student focused learning and instructors need to find new effect ways of actively engaging students in the learning process. There is no doubt that in this generation, technology has taken education to another level and has changed drastically, the way students now learn. As instructors, we should strive to make the learning process as much enjoyable as possible. Even the learning method should be suitable and adaptable in order in to address the diverse learning styles found in students. Most classes rely on the instructor providing the majority of the course content which makes students to become passive learners. We ought to cultivate the idea of constructivism in students so that they construct their own content, building confidence and competence in them. Constructivism asserts that understanding is built and not received. When students collaboratively build their own learning environment, they are transformed from being knowledge consumers to knowledge assemblers. This allows them to develop initiative and critical thinking skills that improve their sense and ability of working as a team. Collaborative learning allows students to build new skills and knowledge through interaction with their peers. In as much as instructors engage students during lectures, the challenge of assisting the students to maintain the appetite as they continue to learn and revise throughout the course still remains [8]. As highlighted by [12], a solution to this dilemma is to motivate students to build a peer-to-peer interaction that engages them in collaborative learning.

To address this challenge, this study investigates the application of PeerWise, an educational tool that enables students to construct, answer, share and discuss multiple choice questions in a module and evaluate its effect on academic performance. PeerWise is a free online learning tool that provides a platform for such collaboration in the class. The tool allows students to work in a non-threatening flexible environment, at their own pace, on areas of particular concern to them and always maintaining collaboration with their peers.

Specifically, PeerWise creates an environment where students collaboratively work with their peers to construct a huge question bank of multiple choice questions. When they create their own questions rather than viewing existing ones, students becomes active learners. This means, if a student has to build a quality question, then he/she needs to have an in-depth understanding of the topic to provide a well-structured, clear and quality question together with the correct solution [6]. The question and answer will be reviewed and evaluated by peers for quality and relevance. The fact that a student's contribution to the online learning community has to be rated for quality forces the students to dig deeper before contributing because often students do not enjoy being down rated by their peers. Additionally, requesting students to critically evaluate contributed questions and proving formative feedback on the quality of the question builds higher order cognitive skills [4].

The use of PeerWise in the learning process provides a quality learning environment that engages students to achieve the intended learning outcomes. The tool brings to the learning platform a number of benefits, thus:

Robert F. Nyabawa is with the Computing Department, Botho University, Maun, P O Box 20157, Boseja, Maun, Botswana, Tel: +2676865404, Fax: +6865008, Email: robert.nyabawa@bothouniversity.ac.bw

− Students are engaged in deep learning with the least instructor effort and cost.

− High order cognitive skills are built. Students become critical judges and make well informed judgments as they evaluate their peers' contribution.

− A sense of belonging and ownership is cultivated in students and they feel confident and competent, thereby enhancing their learning for better outcomes.

− Critical thinking skills are developed. Providing a high quality question and a clearly written explanation requires a student to understand a topic deeply and its relevance to the intended learning outcomes. Furthermore, the activity of writing a question improves their written communication skill.

This study seeks to investigate the impact and use of PeerWise in addressing the challenges of engaging students in the learning processing through technology. In this study we compare the academic performance of students who actively use PeerWise in their learning process, with those who are passive users of the tool.

Basically, PeerWise is linked to constructivism learning theory with great potential for transforms students from passive recipients of information to information gatherers who have the ability to make critical judgments on the information provided. Constructivist theorists assert that, as human beings, we construct our on knowledge and as a result, our learning revolves around the experiences we encounter in our day-to-day living [2]. This educational learning tool encourages students to participate flexibly in class, making them enrich their knowledge of course content.

II. RELATED WORK

In this section the author reflected on earlier results on the use of PeerWise to set the scene for the study. Previous research on teaching, learning and assessment has revealed that collaborative and active learning [6], coupled with continuous formative assessment [7], highly motivates student to learn and raises positive perceptions of learning. According to [5] and [6], the level of PeerWise usage by students is heavily correlated with student learning benefits. They found out that level of student PeerWise interaction strongly correlated with performance in the final exam and a change in class rank. [6], discovered in their study that although PeerWise is an excellent pedagogy tool it needed to address students' validation of their own learning and teach them regular events for self-testing and reflection as originally investigated by [9], in a cohort of computer science students.

In another research, [10] revealed that students' everlasting retention of knowledge can be achieved through repeated testing which continuously force students to recall and apply their knowledge rather than repeated studying. He concluded that students' learning retention of material even after the course has ended, can improve significantly if more and frequent tests are incorporated into a course.

PeerWise provides an independent platform for students to evaluate the quality of the questions and explanations provided by their peers. This in itself develops high cognitive skills in the students enabling them to learn at the highest level of the Boom's taxonomy of cognitive domain [1]. Thinking at high cognitive levels initiates further deep learning thereby raising the level of the knowledge base.

In their study, [3] asserts that PeerWise cultivates an atmosphere of self-assessment. Students reflect on their own learning through engaging themselves in answering multiple choice questions in a drill and practice manner. On the same note, study conducted by [11] has shown that PeerWise also incorporates peer-assessment activities. Students get acquitted to peer-assessment activities through the question and answer, feedback forums. Feedback is linked to more enhanced learning in a variety of platforms, regardless of the feedback quality.

Generally, PeerWise has emerged to be an effective pedagogy tool in active and collaborative learning across the board. The tool has been evaluated in various academic courses from different educational departments. Results have shown that the tool has the potential to change education for the better by incorporating a student-centered learning approach.

III. DESCRIPTION OF PEERWISE

PeerWise is a free online web-based learning tool that engages students to interact and collaborate as they learn. It is a tool that is flexible to use as it is not attached to any particular field or level in education. The idea behind PeerWise is to build a database of multiple choice questions with answers, explanations, evaluations, comments and discussions, solely driven by students. This tool enhances student learning with the least administrative effort. Instructors act only as facilitators of the online activity and do not actively administer the questions and explanations given but rather encourage the students to discuss the issues arising and find corrective measures for their misunderstandings.

Basically, PeerWise is an easy to use application which is very user-friendly. A student will post a question and its options to the online community. The contributor must as well provide an answer with an explanation to justify the option selected. Preview of the PeerWise interface and an example of creating a question is shown in Fig.1 and Fig. 2 below.
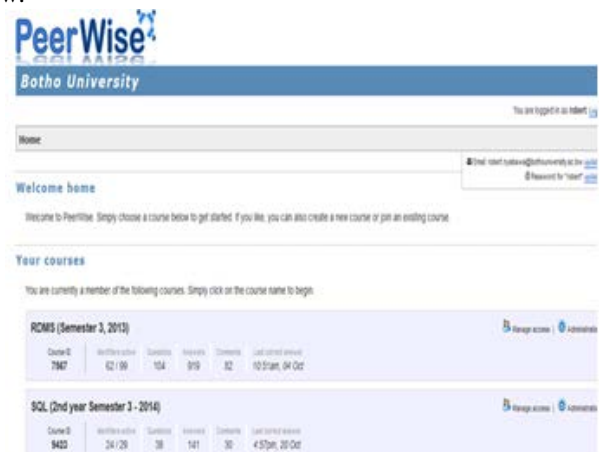

Fig. 1 Peerwise Login Interface

Fig. 2 Example of creating a question

When the question has been attempted, the choice and explanation provided by the contributor and other answers provided by peers are revealed. The answerers are then platform to rate the level of quality and difficulty of the question and then provide formative feedback. All comments provided by the answerers are visible to the contributor and rest of the online community who have joined the course group. The feedback given provides a convenient platform for discussion on any matters arising related to the question.

PeerWise keeps the students engaged and stirs their appetite to continuously become involved through gamification. The application has elements of games, ranging from awards in the form of badges for contributing the highest number of questions answers to score keeping. This environment encourages students to continuously be involved and engaged actively with content leading to more and more question construction, thereby improving the student intended learning outcomes.

IV. RESEARCH DESIGN

In this study, the author evaluates the usage and impact of PeerWise on education at Botho university Maun campus. The author investigated the effect of incorporating PeerWise as pedagogy tool in enhancing student learning in a collaborative environment. The study seeks to answer the following research questions:

RQ1: What is the impact of PeerWise on academic performance in the final examinations?
RQ2: What are the students' perceptions of using PeerWise as a learning tool?
RQ3: Does PeerWise build and develop emotional skills in students?
RQ4: What are the learning benefits of using PeerWise in the learning process?

V. RESEARCH METHODOLOGY

The author seeks to determine how PeerWise activity is linked to success before mid-assessment in both mid and final examinations. PeerWise was implemented for the first time at Botho University in the second semester on the Relational Database Management Systems course in 2014. An analysis of the correctness and quality of questions in the repository was done based on the data collected. The data was also used to validate the reliability of the students' rating of questions and to construct a method for identifying poor quality questions automatically. Furthermore, the author examined the learning benefits and the perception of students on using the tool to improve their learning. To measure the learning benefits, PeerWise was used over the whole semester in order to use the final course score as a performance indicator. Through this evaluation, the author was able to analyze the changes in class rank of each individual student according to how they frequent they used the tool on their own study time.

Students' perception of the importance of using PeerWise was cross-examined by analyzing the level of voluntary usage of the application in the class. To examine the quality of questions generated by students, a set of questions was answered and rated by three senior instructors in the faculty of Computing. Questions in the repository that were rated by at least six students or more were sorted in terms of average ratings. The rest of the other questions were then evaluated by the expert IT instructors. This method ensured that all the 150 questions evaluated had different average quality ratings. However, comments provided no the questions by students were not visible to instructors so that they would not rate the questions with a bias.

Sixty students were required to interact with PeerWise during their own spare learning time. Each student was expected to contribute 5 questions and attempt 10 questions, as a minimum requirement. This activity contributed 5% of the student's final grade, regardless of the quality of the questions, whether the questions were answered correctly or not and whether the question remained unanswered. The purpose of the 5% weightage was to entice the students to participate in using PeerWise.

VI. STUDENT FEEDBACK

Feedback on PeerWise was collected through open-ended questionnaires and interviews at the end of the course. Students rated the answers to questions and explanations, and question construction separately. They were required to provide a scaling from 1-5 for their perceptions on the usefulness of PeerWise during their learning through the semester. Students had an opportunity to provide formative feedback on the effect of the tool on their learning. The formative feedback was categorized then validated for quality and relevance.

VII. RESULTS

In this section, the author presents results of the investigation of the three domains, learning benefits, question bank quality and students' perception of engagement value.

A. Question Bank Quality

Findings have revealed that the questions that were rated highly for quality had a high number of responses compared to those rated poorly.

This indicates that regardless of the variance in quality of the questions, students made use of the question quality ratings assigned by their peers to assist them in determining the best questions to concentrate on. Apart from quality ratings, students had the opportunity to also rate the level of question difficulty on a five point scale of 0-4. These levels of difficulty allowed students to answer questions that they were

comfortable with. Results have shown that those questions rated more difficulty provided fewer correct answers.

B. Learning benefits

Results have shown that students who actively engage in the use of PeerWise frequently performed well above the average threshold of 50% than the passive users in both mid and final examinations. The final examination grades were used as a baseline performance indicator that assessed the impact of PeerWise on academic performance. In this study, the students' mid examination grade gave them a class rank. The class rank was computed again at the end of the course. Results showed that most students had a change in class rank based on a rise or decline in position, in relation to their peers.

These positions clearly bring out the fact that the more questions a student answers, the better the improvement in class rank. In actual facts, the most actively engaged students in the use of PeerWise improved their class rank by an average of seven places in class of sixty, showing a correlation between increased PeerWise activity and improvement in academic performance. Students who frequently use PeerWise tended to be better academic performers compared with their peers.

C. Students Perceptions of PeerWise Activity Value

Students voluntarily used PeerWise and this is a good indicator that shows how much they appreciated the value of the tool. To obtain the 5% of the course grade from use of PeerWise, students were required to contribute five questions to the repository and answer a minimum of ten questions. 70% of the students contributed and answered questions beyond the requirement. Table 1 below shows the number of students per activity level.

TABLE I
STUDENT ACTIVITY LEVEL

Activity level (No. of Questions Answered)	Contributors
0-20	8
21-40	14
41-60	12
61-80	16
>100	10

These results show that most of the students used the PeerWise repository voluntarily and contributed beyond the borders. Finally, a survey was conducted to examine the student perception of the importance of PeerWise activity in improving academic performance. Generally, the results of the survey were positive as shown in Table 2 below.

TABLE II
SURVEY RESPONSES (STUDENTS, N=60)

Question	Agree	Disagree	Undecided
PeerWise improved my learning	75%	15%	10%
Answering peers questions forced me to research further	85%	11%	9%
I developed critical thinking skills by using PeerWise	65%	18%	17%
Feedback provided helped adjust my learning style	70%	15%	15%
I would recommend other departments to use PeerWise to improve learning	89%	6%	5%

VIII. DISCUSSION AND FUTURE WORK

In this study, the author examined a pedagogy tool called PeerWise that promotes active and collaborative learning at any level in higher education. The tool provides a learning environment that is non-threatening in which students can flexibly construct, rate and comment on multiple choice questions contributed to the online community. This tool is an original product of University of Auckland in New Zealand which was developed in the department of computer science. Based on the experience on using PeerWise discussed in this paper, the author makes the following observations and recommendations.

Results obtained from the study are quite encouraging, showing a strong correlation between PeerWise activity and academic performance in examinations. The study has revealed that active and frequent use of PeerWise fosters deep learning and expands the knowledge base enabling students to perform better, not only on multiple choice questions but also on written structured assignments.

In terms of the quality of questions, accurate student ratings may stir better usage of the repository as a revision resource. As shown in this study, students used quality ratings to determine which questions to answer. We ought to explore other options as instructors, to better assist students in figuring out the most relevant questions. Potential options include training students on how to rate questions, and appreciating accurately rated questions by rewarding the contributors.

The key and primary benefit of PeerWise usage in the learning process has emerged to be an enhancement in academic performance across the board. Results have shown that those students who actively and frequently engage in PeerWise perform very well in their examinations. Generally, both strong and weak students contributed and answered a great number of questions developing in them, a culture of deep learning. The author believes that such a positive contribution was as a result of the fact that the instructor marketed and promoted the tool very well. However, the most pleasing and encouraging part that the author noted was that, the activity was entirely a student-driven exercise. As a result of the sense of ownership of content built in them, many students took part to a greater extent than they were expected. The fact that students voluntarily answered a significant number of questions than they were required combined with positive survey results, shows that students greatly valued and appreciated the usage of PeerWise in improving their academic performance and developing new skills that built confidence and competence in them.

In future work, the author suggests a qualitative approach that will include various issue driven from the following questions raised based on the results of the study:

RQ1: Does the quality of questions generated affect the number of questions a student can answer?

RQ2: What criteria do students use to choose the kind of questions to answer?

RQ3: What is the effect of voluntary and forced usage of the tool in the learning process?

RQ4: What is the impact of not getting course credit for participating in PeerWise?

Another suggestion is to create an interface in the application that will acknowledge receipt of a questions or answers provided through email in order to encourage more participation in the PeerWise activity. Similarly, the application should also have the ability to send an alert to the contributor's email when a low quality question is submitted so that more quality questions are generated.

The author reported on the first time use of PeerWise in the Computing field in Botswana. Data collected and analyzed has clearly shown that active use of PeerWise is strongly correlated to student grades in both structured and multiple choice questions in final examinations. High performance in structured questions implies that PeerWise activity may have stirred a culture of deep learning developing students to grasp concepts better. Deep understanding of content puts students in a state of confidence and competence, allowing them to freely express their opinion for better learning outcomes.

This study concentrated on the application of PeerWise on Relational Database Management Systems module. As highlighted earlier, the tool is not confined to a particular field of study in education. The author asserts that results of the study are relevant and represents all educational disciplines in higher education; meaning to say PeerWise is a one-size-fits-all pedagogy tool. In this regard, students in all sectors of education should be motivated to fully utilize the learning benefits that emanate from frequent use of PeerWise. The application has the potential of becoming a powerful pedagogy tool given that it incorporates proven learning theories that include collaborative learning, Bloom's Taxonomy, Active learning, Peer- Reflection and Constructivism.

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