Activities, Affordances and Attitude — How Student-generated Questions Assist Learning

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ABSTRACT

Recent research has focused on tools that support the creation, review and sharing of student-generated content for peer learning. However, we know little about the student perspective of such activities. In this paper, we identify what students believe is most helpful for their learning by analysing open-ended comments from students engaged in creating, answering and reviewing exam-style questions generated by their peers. Students report learning about content and appropriate standards of work, both individually and through interaction with peer generated resources.

Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computer and Information Science Education—*computer science education*

General Terms

Design, Human Factors

Keywords

StudySieve, question-generation, peer-review, free-response, student-generated, contributing student pedagogy, constructive evaluation

1. INTRODUCTION

Technology has enabled new pedagogies that place students in the centre of learning by involving them in the *process* of education [4]. Although studies involving these pedagogies have reported quantitative evidence of positive feedback from students, few of the studies have employed qualitative measures. We argue that greater insights may be gleaned from an analysis of open-ended comments from students.

In these "contributing student" pedagogies, students take on roles traditionally occupied by teachers, generating resources for peer learning. There are many benefits claimed by advocates of these pedagogies, perhaps most important, moving students towards the goal of being independent learners. Students are encouraged to focus on determining the quality of their own work and that of others, and selecting, filtering and creating course related material that meets appropriate standards [8].

One approach, categorised by Hamer et al. [9] as *activity creation*, requires students to generate exam-style questions, with sample solutions, and submit them to an online repository. Other students may answer the questions, and having answered, may evaluate the quality of the questions and answers contributed by their peers. This pedagogy has been previously termed *constructive evaluation* [16].

The activity of generating questions for peer learning has been supported by a number of purpose-built tools [5, 11, 13, 17, 22, 23, 24]. Studies involving some of these tools show improved learning outcomes [13, 15]. However, we know little about the student perspective of these tools. In this study, we present qualitative findings from a questionnaire administered to students engaged in constructive evaluation.

2. RELATED WORK

Numerous tools that support the generation and sharing of questions created by students have been reported in the literature. The evaluations of student attitudes towards these tools have been predominantly conducted using quantitative feedback from students obtained using Likert-scale questions.

Quantitative analysis of student attitudes show that students believe creating questions is beneficial for learning in studies of QPPA [24], ExamNet [22], Concerto [11], PeerWise [5], QuARKS [23], CodeWrite [6] and StudySieve [17]. Answering questions in drill-and-practice form was also reported as beneficial for learning in studies of QPPA, CodeWrite, PeerWise and StudySieve.

Quantitive results from student surveys also show that viewing the questions authored by peers was reported as beneficial for learning in studies of ExamNet [22], QuARKS [23] and StudySieve [17]. Students using CodeWrite reported that seeing solutions of other students helped them learn [6], as did students using StudySieve. The evaluation phase (i.e. peer assessment) was reported as useful in QPPA [24], PeerWise [5], QuARKS [23] and StudySieve. Summary statistics and online ranking lists (features also present in PeerWise) were noted as being beneficial for learning by students using QPPA.

Only studies with QPPA [24] and Concerto [11] have reported qualitative findings. Although open-ended comments

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were collected from students about how QPPA helped them to learn, the analysis of the data was not reported in detail. Comments from students using Concerto were also collected, but few of the students who answered the survey had used Concerto to write questions (of the 77 students enrolled in the course, 66 completed the survey, but only 20 had used the system to author questions). A few exemplar student comments were presented, but no systematic analysis of the qualitative data was performed.

3. METHODOLOGY

StudySieve [17] is a web-based system designed to support student-generated free-response questions. Students in three large undergraduate courses were required to use StudySieve to author questions, answer questions created by their peers and evaluate both questions and answers. After the deadline for completing the tasks, a questionnaire consisting of both Likert-scale and open-response questions was administered to students.

Qualitative data were collected from students in response to the questions "What was most helpful for your learning?" and "What improvements would you like to see?". Comments about improvements tended to be system-specific and have been used to inform the modification of the interface and workflow of StudySieve. However, the focus of this paper is to analyse student responses to the question "What was most helpful for your learning?". In this section, we report on the context in which the activities took place, the questionnaire response rates and the analysis procedures.

3.1 Context of use

StudySieve was used as part of the teaching and assessment activities used in three large undergraduate courses (COMPSCI 111, COMPSCI 101 and COMPSCI 105) taught at The University of Auckland during 2010 and summer 2011. All students were provided with written information that explained the philosophy underlying student-generated content and a simple guide that outlined different kinds of questions. In all courses, students were required to submit questions and answers for a small portion of their final grade. When students answer a question, StudySieve requires them to evaluate that question, their own answer to the question and a minimum of one other answer, although students may choose to evaluate more than one other answer if they choose. The courses involved in this study, and the requirements for the activities involving student-generated content are described below.

COMPSCI 111 — Mastering Cyberspace: An Introduction to Practical Computing (hereafter referred to as CS0) is a service course that provides non-majors with an introduction to computing concepts and their practical application. Students enrolled in CS0 during the second semester 2010 and the summer semester 2011 were surveyed. In both semesters, students were required to author 2 questions and answer 10 questions for a small percentage of their final grade (1% in 2010 and 2% in 2011).

COMPSCI 101 — Principles of Programming (hereafter referred to as CS1) is a standard introduction to programming using Java. Students enrolled in the second semester 2010 were surveyed. Each student was required to author 1 question and answer 5 questions to receive 1% of their final grade.

COMPSCI 105 — Principles of Computer Science (hereafter referred to as CS2) is a standard introduction to data structures and algorithms using Java. This course is normally taken by students who have completed CS1. Students enrolled in the second semester 2010 were surveyed. Each student was required to author 1 question and answer 5 questions for 1% of their final grade.

3.2 Questionnaire response rates

Across the first-year cohort surveyed, 853 students participated in the activities and 54.6% of those students returned the questionnaire. Of the 466 questionnaires returned, 218 included responses to the open-ended question "What was most helpful to your learning?".

Table 1 summarizes the courses, the number of students that used StudySieve in each course, and the percentage of students that completed the questionnaire. The low response rate to the questionnaire in the CS1 course was a consequence of distributing the questionnaire during lectures (which have a relatively low attendance rate), rather than during tutorials/labs as in the other courses.

Course	Users	Survey	Response rate
CS0	491	333	67.8%
CS1	173	27	15.6%
CS2	189	106	56.1%
Overall	853	466	54.6%
Complete		218	25.5%

Table 1: Questionnaire response rates

3.3 Analysis procedure

The qualitative feedback provided by students was data-entered prior to being coded. Initially, the data was *open-coded* [20] by the first author. The procedure of open-coding focuses on individual words and phrases in detail, generating a multitude of codes which are grounded in the data. During the open-coding process, the comments provided by students were broken into units of meaning, each containing one distinct idea [18]. In most cases, individual sentences acted as a unit of meaning, but compound sentences were frequently divided into component parts.

Through an iterative process of refinement, the first author grouped the initial codes into topics, constantly comparing [20] the topics with the original data to ensure that the topics adequately captured the meaning inherent in the data. These topics were subsequently grouped into categories, which were in turn grouped into themes.

To determine the reliability of the coding scheme, a second researcher coded the data according to the list of topics, and the inter-rater reliability was calculated using Cohen's kappa. An almost perfect [14] level of agreement was found (κ=.83).

4. RESULTS

Three main themes were identified during the analysis of student responses to the question "What was most helpful to your learning?". No negative feedback was provided in response to this question. The three themes distinguished between *activities* described by students, the *affordances* provided by StudySieve, and the *attitudes* of students. The

activity theme includes categories that distinguish between individual learning and peer learning, and between content knowledge and knowledge about a course (i.e. the standards and expectations of performance).The following subsections describe the major themes and categories that emerged through the analysis of the qualitative data.

4.1 Activities

Student feedback about the activities that were most helpful for their learning are organised into the categories of: individual content; peer content; individual standards; and peer standards. Figure 1 summarizes the different categories of student activity and lists the topics that belong to each category. The activity categories are described in more detail in this section, along with comments that exemplify the different topics.

4.1.1 Activities – Individual content

Individual learning about content occurs when a student interacts with resources that are not peer generated, or when they create material in response to requests from teachers. Most of the learning activities in traditionally delivered courses would fit into this category. For example, students may read a textbook or complete an individual programming assignment set by their teacher.

In this study, activities involving writing questions, reviewing study material, or reflecting on the content they have learned in class are all classified as individual learning of content. In all of these cases, the learning occurs through interaction with traditional course material rather than peer generated content, although it is possible that peer interaction acts as a catalyst for learning.

The most frequent activity mentioned by students was **writing questions**. The following comments are typical:

> *Having to develop a question.*
>
> *Writing a question of my own.*

In addition, some students gave an explanation of *why* writing questions helped them to learn. Students described how the act of creating a question caused them to return to the instructional material delivered during the course and **review content** (described by students as revising content) before they were able to generate a question. For example:

> *The fact that we had to create our own questions and provide the answers. Need to do some revision first in order to complete them*
>
> *When developing new questions I had to revise the course book*

Similarly, when students described why *answering questions* helped them to learn, they explained that they used resource material to try and find a solution to questions they couldn't answer. In other words, they **reviewed content** in order to answer a question. Although some students used the term "research", all the questions in the repository involved material that had been presented during lectures or laboratories. The use of "research" in this context is therefore interpreted as trying to understand course content that was previously missed, either by reviewing the instructional material, or by finding alternate explanations. For example:

> *This means we have to try to solve it ourselves to understand the topic or to find more info in the Internet.*
>
> *. . . because research needed*
>
> *. . . you would have to find out the answer*

Writing questions, and the sample solutions to those questions, caused some students to **reflect on the content** they had learned during the course. Students felt that the *process* of creating a question (and associated solution) required them to really focus on the course content and engage in analysis of the material. For example:

> *Having to think more deeply about the info in order to create questions (interact with the study material)*
>
> *The construction of questions I thought was useful. And by this I mean the process of thinking of a question and logically finding a good response to own question was useful*

4.1.2 Activities – Peer content

Peer learning of content occurs when a student learns from material produced by their peers. The quantity and variety of content produced by students can act as a valuable learning resource. In this study, reading the questions authored by peers, reading the answers authored by peers, and answering the questions authored by peers are all activities classified as learning about content from peer-generated resources.

Students reported that **viewing questions** contributed by their peers was beneficial, although it is unclear *how* simply seeing the questions helped them. The following examples are typical of student comments categorized as **viewing questions**

> *That I could look at other people's questions*
>
> *Seeing other student's questions*

Students also reported that **answering questions** improved their understanding of the course material.

> *Answering questions from other students helped me with difficult topics*
>
> *Access to the database of questions allowing me to answer the questions as it allowed me to understand the coursework better*

Using the questions generated by their peers for drill and practice helped students to prepare for tests and exams. For example:

> *The large database of questions allows for a lot of practice which I find is essential to doing well in tests/exams*

The large number of questions available in the repository was appreciated, and both the variety of topics covered and the different styles of questions were described as being beneficial.

> *Having a lot of questions to answer covering all topics*

	Content	Standards
Individual	• Write question • Review content • Reflect on content	• Evaluate self • Check content • Establish expectations
Peer	• View questions • Answer questions • View answers	• Evaluate others • Receive feedback • Compare self with others

Figure 1: Categorization of activities that help students learn.

> *Many new questions on the StudySieve these new questions I never see before*
>
> *I feel it was really helpful being able to answer other peers questions because they would often be quite different to questions asked by the examiners/lecturers etc.*

Students also felt that **viewing the answers** contributed by other students was helpful, particularly when the answers varied. For example:

> *Seeing other student's answers as most questions can be solved multiple ways so it is interesting to see the different approaches to solve the problem*

Exposure to solutions of varying levels of correctness was identified as being valuable by some students. The better solutions provided an opportunity to learn by modelling a high quality answer, while poor solutions highlighted mistakes that students could avoid. The following comments illustrate how students used both high and low quality answers to learn.

> *I can see some other programming codes that give me more ideas on how to implement mine*
>
> *Having a reference answer/template helps me understand what to put in my own answers to get the best possible mark*
>
> *By seeing the common mistakes made by other students allowed me to make sure I avoid that pitfall*
>
> *If some other students answer is wrong then I can learn what errors student occurred in particular question. This thing help me a lot and I never made that mistake in future*

4.1.3 Activities – Individual standards

Individual learning about appropriate standards of work occurs when a student engages in self-assessment to determine their own knowledge or judges the quality of their own work. These evaluations are typically based on criteria specified by an external authority such as a teacher or a textbook. In this study, activities in which students evaluate their own knowledge, check the correctness of their own work, or make judgements about the nature of course content (such as difficulty or relative importance) are classified as individual learning about standards.

There are many different kinds of judgements that students make when using StudySieve. Students reported that they focused internally through **self-evaluation**, either by evaluating their own work, or by assessing their understanding. For example:

> *Evaluating my own question*
>
> *Writing and answering questions helped test my knowledge*

Students also described how they **checked content** by verifying the accuracy or correctness of material in external, authoritative sources.

> *Checking the coursebook to be sure I had it right*
>
> *Anything I was unsure of I went back to notes and the manuals to check my answers. I also did this to clarify answers posted by other students.*

The entire process encouraged them to think about the **expectations** of the course, reflecting on the topics that would be examined and the relative difficulty of those topics.

> *Actually having to do it made you think about things what would be the most difficult*
>
> *. . . think about what kind of questions might be asked in a text/exam*
>
> *. . . give a good idea of what to focus on.*

4.1.4 Activities – Peer standards

Learning about standards from peer-generated resources occurs when students focus on judging the quality of those resources. In this study, both the giving and receiving of feedback is categorised as learning about standards through interaction with peers. Situations in which students compare their own work against the work produced by their peers also fall into this category.

Students reported that **evaluating others** by rating the quality of peer content (both questions and answers) helped them to learn, as did **receiving feedback** from their peers.

> *Evaluating other student's questions*
>
> *. . . rating other student's answers*
>
> *Seeing how other students rated my answer*

More commonly, students described how they used the peer content to **compare themselves with their peers**. The answers contributed by peers acted as sample solutions

against which students could benchmark their own solutions, identify errors and note possible improvements. For example:

> *After answering you can compare your question with others and find out that there were more correct solutions or more effective ones*
>
> *It was good being able to check answers against other people because you could see where you had gone wrong.*

4.2 Affordances

Although the majority of comments from students were related to their activities, the functions provided by StudySieve were also mentioned. Since these features were described in response to the question "What was most helpful for your learning?", we assume that students found these features to be critically important to the usability of the system.

The most common function identified was the ability to organize the questions in different ways using filtering and sorting. The filtering and sorting features make it much easier to find relevant questions, which is particularly important when there is a large number of questions present in the repository.

> *Being able to choose questions by topic*
>
> *View all the questions before answering, browse by rank*
>
> *The difficulty of each question shown is helpful.*
>
> *The ability to choose which questions does mean you can only do easy questions, but it also means that you can pick questions relevant to what you are studying and matching your difficult without being forced to answer a multitude of bad or easy questions*

4.3 Attitude

The final category captures comments that describe the emotional state of a student. Some students describe how the activities or features experienced when they interact with StudySieve improved engagement, confidence or enjoyment.

Students noted that the ranking and overall statistics were motivating and enjoyable.

> *I found the personal ranking and stats motivating, made me want to do more.*
>
> *Seeing my statistics compared to the rest of the students is motivating to answer more questions*
>
> *I think the ratings and comments systems along with the large amount of statistics and "achievements" were fun*

The anonymity and student-centric focus of the activities were described favourably. The activities were considered to be low-risk by students, which made it easy to practice and interact with other students.

> *Mainly the viewing of questions from other students. This helped to familiarize me with CS topics in a more communicatively approachable manner*
>
> *It was like exam questions but the pressure was not there so it is a small confidence booster*
>
> *The anonymity of questions and answering made it "safe" to have a go.*

A few students also noted that they had fun being involved in the question-generation and answering process and that it was interesting.

> *The system was relatively fun to use.*
>
> *I think the system itself was very interesting and useful for learning.*

5. DISCUSSION

We have focused on identifying the major themes and categories of activity evident in students' comments, rather than quantifying the comments falling into each category. These themes and categories may inform future studies of student-generated questions for peer learning. Students report that they learn from both individual activities and from interacting with resources generated by their peers. In addition, students report that they learn not only context specific knowledge (course content), but also metacognitive knowledge such as the standards and expectations of a given course.

The comments from students provide evidence that they are engaged in both *comprehension fostering* and *comprehension monitoring activities* [19].

Comprehension fostering activities such as **writing questions** resulted in students **reviewing content** and **reflecting on course content** which are strategies that promote deeper learning. Students also report learning vicariously [2] from the behaviour of their peers by modelling the examples of good solutions and avoiding the errors present in poor solutions.

Students engaged in **answering questions** for drill and practice, **evaluating** their own questions and answers, or **comparing themselves with others** are monitoring their own understanding, and having identified their strengths and weaknesses, may be able to use their study time more efficiently. Such comprehension monitoring activities are described by Boud [3] as being essential for successful life-long learning.

Although there have been no previous qualitative studies of student-generated exam-style questions, there are reports on the student perspective of peer review activities that show similar findings to this study. Williams [21] found that students valued being able to compare different solutions, being able to compare standards of work, and exchanging information and ideas, all of which are also mentioned by students in this study. Similarly, Hanrahan and Isaacs [10] found that students enjoyed the opportunity to compare their own work with others, that it was useful to see examples of good and bad work, that it gave students a good idea of the expected standards and it helped to develop critical thinking skills.

The large size of the repository and the variety of questions and answers is reported as valuable. Sharing such a large resource within a learning community is only possible when a tool is provided to assist with the administrative burden imposed by activities that involve peer assessment [1]. The focus on student-generated content and the anonymity provided by the online tool both helped to create an environment in which students felt confident to contribute.

Howe, McWilliam and Cross [12] suggest that peer interaction does not result in immediate gains in learning, but rather acts as a catalyst for future learning. Students who engage in peer discussion or generate a solution that disagrees with peers are *primed* to learn when they encounter that topic in future. Draper [7] suggests that interacting with peers is more effective than interacting with teachers in this regard because the opinion of teachers are accepted without thinking, while peer opinions are treated with an element of suspicion and encourage students to verify material for themselves. In this study, students do indeed report checking content with authoritative sources and engaging in research to resolve conflicts in understanding.

6. CONCLUSIONS & FUTURE WORK

The results from this study are consistent with findings from studies involving self- and peer-assessment. Students learn from a wide variety of activities, both individually and through interaction with peer-generated resources. The qualitative analysis of student feedback confirms that they are engaged in activities that promote deeper learning while developing important metacognitive skills. In future, we hope to use the categories identified in this study to quantify the proportion of students engaged in these various kinds of learning to improve our understanding of how student-generated questions can be used most effectively in the classroom.

7. REFERENCES

[1] R. Ballantyne, K. Hughes, and A. Mylonas. Developing procedures for implementing peer assessment in large classes using an action research process. *Assessment and Evaluation in Higher Education*, 27(5):427–441, 2002.

[2] A. Bandura. *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, 1986.

[3] D. Boud. Sustainable assessment: rethinking assessment for the learning society. *Studies in Continuing Education*, 22(2):151–167, 2000.

[4] B. Collis and J. Moonen. *An on-going journey: Technology as a learning workbench*. University of Twente, Enschede, The Netherlands., 2005.

[5] P. Denny, A. Luxton-Reilly, and J. Hamer. The PeerWise system of student contributed assessment questions. In Simon and M. Hamilton, editors, *Tenth Australasian Computing Education Conference (ACE 2008)*, volume 78 of *CRPIT*, pages 69–74, Wollongong, NSW, Australia, 2008. ACS.

[6] P. Denny, A. Luxton-Reilly, E. Tempero, and J. Hendrickx. Codewrite: supporting student-driven practice of java. In *Proceedings of the 42nd ACM technical symposium on Computer science education*, SIGCSE '11, pages 471–476, New York, NY, USA, 2011. ACM.

[7] S. W. Draper. Catalytic assessment: understanding how MCQs and EVS can foster deep learning. *British Journal of Educational Technology*, 40(2):285–293, March 2009.

[8] J. Hamer, Q. Cutts, J. Jackova, A. Luxton-Reilly, R. McCartney, H. Purchase, C. Riedesel, M. Saeli, K. Sanders, and J. Sheard. Contributing student pedagogy. *SIGCSE Bull.*, 40(4):194–212, 2008.

[9] J. Hamer, H. C. Purchase, A. Luxton-Reilly, and J. Sheard. Tools for "contributing student learning". In *Proceedings of the 2010 ITiCSE working group reports on Working group reports*, ITiCSE-WGR '10, pages 1–14, New York, NY, USA, 2010. ACM.

[10] S. J. Hanrahan and G. Isaacs. Assessing stlf- and peer-assessment: the students' views. *Higher Education Research & Development*, 20:53–69, 2001.

[11] Y. Hirai and A. Hazeyama. A learning support system based on question-posing and its evaluation. *Creating, Connecting and Collaborating through Computing, International Conference on*, 0:178–184, 2007.

[12] C. Howe, D. McWilliam, and G. Cross. Chance favours only the prepared mind: Incubation and the delayed effects of peer collaboration. *British Journal of Psychology*, 96(1):67–93(27), February 2005.

[13] Y.-F. Lan and P. C. Lin. Evaluation and improvement of student's question posing ability in a web-based learning environment. *Australasian Journal of Educational Technology*, 27(4):581–599, 2011.

[14] J. R. Landis and G. G. Koch. The measurement of observer agreement for categorical data. *Biometrics*, 33(1):pp. 159–174, 1977.

[15] A. Luxton-Reilly, D. Bertinshaw, P. Denny, B. Plimmer, and R. Sheehan. The impact of question generation activities on performance. In *SIGCSE '12: Proceedings of the 43rd ACM technical symposium on Computer Science Education*, Raleigh, NC, USA, February 29 – March 3rd 2012. ACM.

[16] A. Luxton-Reilly and P. Denny. Constructive evaluation: a pedagogy of student-contributed assessment. *Computer Science Education*, 20:145–167, 2010.

[17] A. Luxton-Reilly, P. Denny, B. Plimmer, and D. Bertinshaw. Supporting student-generated free-response questions. In *Proceedings of the 16th annual joint conference on Innovation and technology in computer science education*, ITiCSE '11, pages 153–157, New York, NY, USA, 2011. ACM.

[18] M. B. Miles and A. M. Huberman. *Qualitative Data Analysis*. SAGE Publications Inc., 1994.

[19] A. S. Palincsar and A. L. Brown. Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, 1(2):117–175, 1984.

[20] A. L. Strauss. *Qualitative Analysis for Social Scientists*. Cambridge University Press, 1987.

[21] E. Williams. Student attitudes towards approaches to learning and assessment. *Assessment & Evaluation in Higher Education*, 17(1):45–58, 1992.

[22] E. V. Wilson. Examnet asynchronous learning network: augmenting face-to-face courses with student-developed exam questions. *Computers & Education*, 42(1):87 – 107, 2004.

[23] F.-Y. Yu. Scaffolding student-generated questions: Design and development of a customizable online learning system. *Computers in Human Behaviour*, 25:1129–1138, 2009.

[24] F.-Y. Yu, Y. H. Liu, and T.-W. Chan. The efficacy of a web-based domain independent question-posing and peer assessment learning system. *Computers in Education, International Conference on*, 0:641, 2002.