Constructivist Learning with Participatory Examinations

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Abstract

Can we improve the examination process, making it more enjoyable and increasing perceived learning? The participatory exam process provides opportunities for students to learn from creating, reading, answering and grading exam questions. An on-line asynchronous learning network system facilitates the process. This paper presents the process framework, our research model and experimental results. A majority of students preferred the participatory exam and believed that it increased their learning.

Keywords: *exam, learning theory, ALN, e-learning, collaborative learning.*

1. Introduction

Can we improve the examination process, making it more enjoyable and increasing learning? Conventionally, students play a passive role regarding examinations, which are devised and graded by the instructor. McGourty et al. [10] states that students learn more successfully when they shift from being "passive receivers of information" to active participants. The "Law of Intensity" developed by the educational psychologist Thorndike [16, 17] indicates that an exciting, dramatic, vivid learning experience teaches more than a routine or boring experience. Thorndike's "Law of Readiness" states that once people are ready to learn, they will be best motivated and learn best. The students in the participatory exam are given more power and control than in a traditional exam. This provides the students an opportunity to act like an active professor rather than a passive student being tested. Our goal in designing the participatory exam process is to motivate students' active and deep learning. Students learn from designing and answering exam questions, from evaluating their peers' performance, and from reading questions, answers and evaluations.

This paper presents participatory exam research during the spring and summer 2002 semesters. After reviewing related learning and exam research in section 2, in section 3 we describe our participatory process framework. Section 4 presents our research model, research questions and hypotheses. Section 5 relates our data analysis and research results. In section 6 we discuss some issues that arise and future research directions. We close with a vision of participatory exams as an integral part of learning across the curriculum in the years to come.

2. Literature Review

Our participatory exam process is grounded in learning theory, which we review in this section. We used the asynchronous learning networks (ALN) conferencing system WebBoard™ as our on-line environment for the exam.

2.1. Pedagogical Theories

Pedagogical theory describes two major approaches to learning: objectivist and constructivist [13, 21]. Most traditional education follows a teacher-centered objectivist approach, where teachers transfer knowledge to students by presenting lectures and answering questions. The

constructivist approach is less content-oriented and more student-centered. The teacher aids the students via the creation of authentic tasks and helps the students integrate multiple perspectives through reflection. These constructivist theories [13, 21] underlie our participatory exam research, which embodies student-centered learning.

2.2. Collaborative Learning

Collaborative learning can be thought of as student-centered education taking advantage of computer-mediated conferencing technologies (CMC) instead of conventional teacher-centered education [6, 12]. CMC technologies support social interaction through social networks of peers as well as instructors [18]. Collaborative learning often results in higher learning compared with individual-oriented learning [9, 14], due to this social interaction among learners. This enhances knowledge sharing, helping learners clarify confusing course materials as well as grasping understanding beyond the individual's perception [4, 5, 18].

Collaborative learning is regarded as a constructivist paradigm of teaching and learning. "Learning is conceived of as something a learner does, not something done to the learner" [8]. Instructor and student roles change. The basic principle of collaborative learning is that students actively construct their knowledge instead of passively receiving transferred knowledge. The instructor becomes a facilitator, evaluating and refining the learning environment in order to promote students' learning [8].

The literature reports on some existing collaborative learning procedures, which provide a vivid learning experience for the learners. Panitz [12] summarizes several, including the "think-pair-share" procedure and the Jigsaw method. Our participatory exam is one such collaborative learning procedure [15]. The collaboration in the participatory exam increases the on-line interaction between student and instructor, as well as among students.

2.3. Exam Research

Examinations are an important assessment process for both schools and students. They motivate students to learn and strengthen learning quality [2]. Examination strongly affects the way students learn [7]. Jacobsson points out that universities should seriously address exam formats and contents to better attain educational goals. Research on exams, however, is quite limited. Most studies focus on computer programming courses.

Berglund and Daniels [2] report their experience in changing classic final exam methods to improve the quality of education in Sweden. They used different approaches in different courses with the goal of changing the way students study and to motivate them to thoroughly understand the subjects. In an "Algorithms and Data Structures" course, the final examinations were replaced by weekly assignments that highlight certain aspects of the course. In a "Computer Architecture" course, the final examinations were substituted by seminars where final projects were presented, analyzed and discussed. The regular written exam was still kept, while the main focus of the exam questions was to show understanding and ability to analyze and synthesize. They changed the way that students study and motivated students to thoroughly understand the subjects. Their study was conducted in three computer science courses. These studies reported some positive results, such as students worked harder and more deeply understood the subjects, as well as the negative result of an increased workload for both students and instructors. Our research is similar in that we both design a better and more efficient learning environment. Our research differs, however, in that the participatory exam is a student-centered process grounded in constructivist theories. Furthermore, the participatory exam aims to decrease the workload of instructors, as we discuss later.

Woit and Mason [19] conducted a three-year study combining conventional and online-programming exams in first year programming courses. It seems that students are better motivated to learn practical skills in this combined online testing environment than the researchers expected. Several differences exist between our studies. Our research uses a writing-intensive information systems course instead of a programming course. Our exam comprised essay questions instead of computer programming questions. (We intend to

experiment with other types of exam questions in future research, including programming questions.) Also, our exam contexts are opposite. They try to avoid student communication during the online exam period, while we encourage students to collaboratively share their work. Woit and Mason look at operational and pedagogical aspects of online testing, while we measure the learning effects during the participatory exam processes. As a side note, Woit and Mason worried about cheating. We used the service Turnitin™ to detect plagiarized answers.

Based on two years' observation in two core prerequisite programming courses (CS1 and CS2), Medley [11] argues that online finals in computer programming courses are not only as good as the traditional written tests, but also can better represent students learning. The students were more enthusiastic about online testing since they received clear and immediate feedback. Students claimed that these online finals adequately proved their abilities. However, a limitation of this study is that the number of student subjects is very small. Medley's study also differs from ours because the online finals in his study are not student-centered. Furthermore, the feedback in our participatory exam is not immediate due to the multi-stage participatory process.

Arnow and Barshay [1] present an online exam system named WebToTest, supporting programming and non-programming questions. This system could automatically check coding and provided a secure exam environment. WebToTest is an adaption of the asynchronous WebToTeach tool [1]. Our study differs by not using questions created by the instructor or automatic grading, but rather student-created and student-graded questions.

Woit and Mason [20] report on another experiment comparing learning effectiveness between a group assigned to take online quizzes plus voluntary weekly assignments and a group using weekly laboratory assignments. The system could mark the quizzes automatically. The results show that student learning and retention is increased in the online quiz group. However, a negative aspect is that these online quizzes cause students considerable stress. Grades were bi-polar with no middle-range grades. The experiment was conducted in a secure, online environment.

3. Participatory Exam Procedure

At the New Jersey Institute of Technology, we conducted two participatory exams during Spring and Summer 2002 in the course CIS677. CIS677, Information Systems Principles, is a core course for masters and Ph.D. students, featuring intensive writing and reading assignments. Both sections were distance learning classes, incorporating the WebBoard™ ALN system. Students participated in weekly asynchronous (anytime, anywhere) online discussions throughout the course. Note that we have conducted studies on the participatory exam in traditional classroom-based sections as well [15], also with high rates of satisfaction from the students. Our evaluation approach for the 2002 studies reported here differs from our earlier study in that it is grounded in learning theory, which has informed our new research framework and measurements.

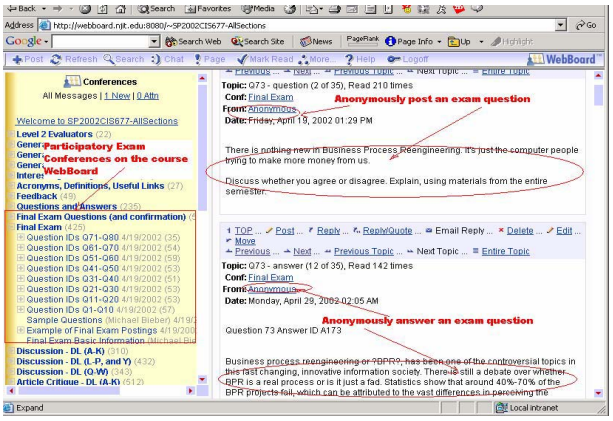

Figure 1: Participatory Examination Screen Shot on the Course WebBoard
(Note that the exam questions and answers were read by numerous participants, which is part of student learning.)

The participatory exam communication platform is WebBoard™ (Figure 1). However, it could be conducted on any educational ALN platform (e.g, WebCT, Blackboard) with only minor adaptations to the system's structure. WebBoard provides students a meaningful contextual environment to conduct the participatory examinations. Its interface is a three-window structure. The top panel lists command menus, and the two larger areas below contain messages. The left frame is a

visual structure of all message postings, while the right frame shows detailed messages by thread. Students can post and reply to messages within the detailed message frame.

During the participatory exam period, the instructor plays the role of exam procedure controller and students perform major learner roles including writing, answering and grading exam questions. The interaction among students and instructor occurs continuously. There are two major processes in the participatory exam: the instructor's control process and the students' learning process (see Figure 2).

Instructor's Control Procedure:

- ***Set up participatory exam environment.*** First, the instructor creates exam conferences on the course WebBoard™ (Figure 2). Detailed examination instructions are posted.
- ***Answer questions about the exam process.*** Throughout the whole exam period, students have the right to ask the instructor questions about the participatory exam and issues surrounding it (e.g., is it fair to ask me to grade my peers?). The instructor is responsible for explaining all aspects of the exam.
- ***Assign exam question IDs.*** When all students understand their roles in the participatory exam, the instructor will assign students exam question IDs. Postings are identified only by assigned IDs to ensure anonymity. Confidentiality is an important factor for people who are new to the peer feedback process [10].
- ***Correct the exam questions.*** Each student is required to design two exam questions that synthesize the course's multiple topics. In order to assure the quality of the students' exam questions, the instructor will review and if necessary edit the questions.
- ***Assign who answers which questions***. The instructor assigns two exam questions to each student.
- ***Assign level 1 and level 2 grades.*** There are two levels of student graders in the participatory exam. Usually the authors of the exam questions will be assigned as the first level graders; the doctoral students in this class are responsible for the second level grading. However, in summer 2002, because no doctoral students registered for CIS677, all Master's students got a chance to work as second-level graders. This is the only difference between the Spring 2002 and Summer 2002 procedures.
- ***Assign final grades***. After the students finish both level 1 and level 2 grading, the instructor is responsible for assigning the final grades.
- ***Handle student disputes.*** If the students disagree with the assigned final grades, they have an opportunity to dispute their answers. The instructor will review the student's justification and make a final decision.

Student Learning Procedure:

- ***Confirmation.*** Before the participatory exam starts, the students have to confirm that they understand the whole exam procedure. (They can communicate with their instructor during the entire exam period.) They also confirm that they have received their exam question IDs.
- ***Read other questions, answers, grade justifications and disputes.*** Throughout the whole exam process, students can read their peers' work. Though no questions are exactly the same, peers' answers help students broaden their understanding of course topics and motivate them to read more. Similarly, students learn through reading other questions, grade justifications and disputes—both specifically as they craft their own, and out of general interest and curiosity.
- ***Make up exam questions.*** Students had, in Spring 2002, 4 days to design two questions for their peers based on the course materials. For CIS677, questions require essay-length answers (up to 1500 words) that synthesize several topics from the course. Creating questions requires students to determine how to best assess the course material. Students post their questions by assigned question IDs, anonymously (Figure 1).

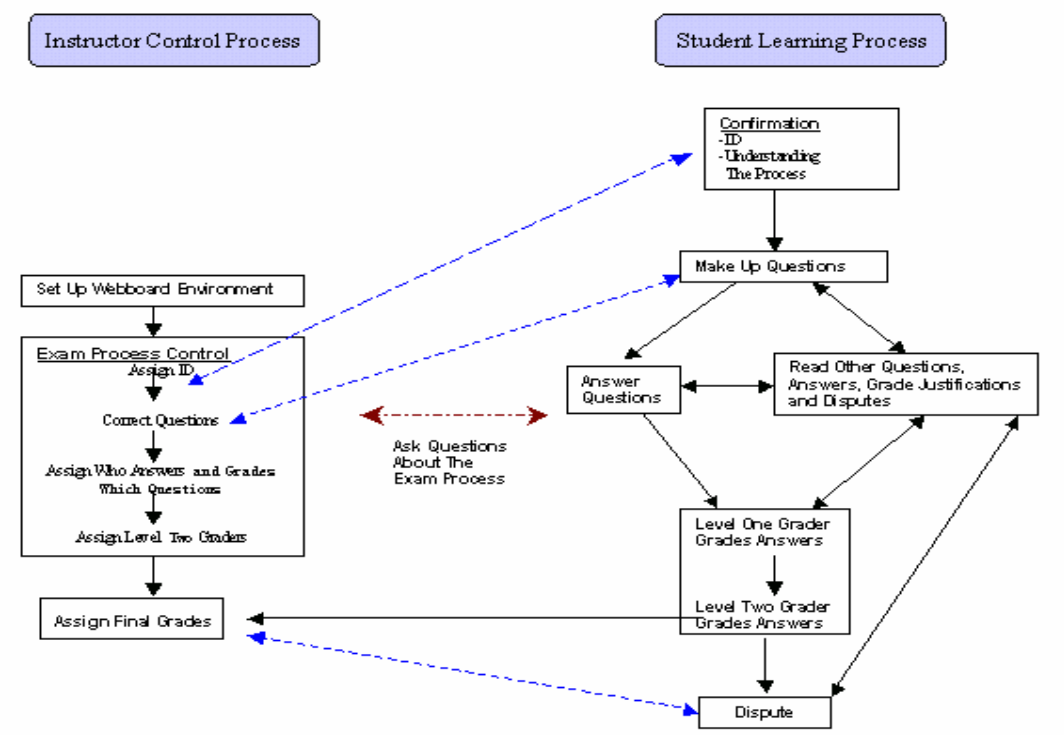

Figure 2: Participatory Exam Process Framework

← - - →	*Interaction between instructor and students*	◄·····►	*Interaction throughout the whole exam process*
→	*General process flow*	◄——►	*Students' back and forth learning process flow*

- ***Answer questions.*** Students had 5 days to post answers to their assigned questions. They could use any reference materials. Students had to submit their answers to turnitin.com to reduce the possibility that any part of their answer was plagiarized.
- ***Level one grader grades answers.*** How to judge a peer's work? That is a new challenge for students, though there are very detailed grading instructions for this exam. Students typically grade the two questions they designed. We provide very explicit grading guidelines with multiple sub-scores for different aspects of the answer. We require graders to provide two sentences of justification for each sub-score. Students have 3 days for level 1 grading.
- ***Level two grader grades the answers.*** In order to obtain a second opinion, doctoral students (Spring 2002 semester) or the Master's students (Summer 2002) re-evaluated their peers' answers using the same grading criteria.
- ***Dispute.*** If the students disagree with the final grade that the instructor assigns, they can dispute by re-grading their own answers using the same explicit grading guidelines. This provides another opportunity for learning.

4. Research Model

What types of factors can determine that the participatory examination will result in improved learning? From constructivist theories we assume that students will learn from designing, reading, answering and grading. Both for methodological reasons and for students' peace of mind, it is crucial to control exam process quality. Grading is students' primary concern [3], thus explicit grading criteria and perceived fairness will determine whether students will be satisfied with and even enjoy the whole participatory exam

process. In the exam research model below, these factors determine one independent variable, "exam process quality".

Because the participatory examination is student-dominated and students have more power than in traditional exams, it should be an enjoyable and active learning experience for them. Because our exit-questionnaires were conducted after all students received their final exam grades and any disputes were resolved, we assume that both real exam grades and perceived enjoyability will help explain perceived learning from the participatory exam. Therefore, "enjoyability" and "final exam grades" become the intervening variables in our exam research model. (We also assume that higher grades will increase enjoyability.)

The participatory examination is a unique learning process. We are greatly interested in whether this exam process will improve students' perceived learning. This would cause students to recommend it for future use. Thus, in our research model, "perceived learning" and "recommendation for future use" are the two major dependent variables. (In future research we also intend to measure actual learning.)

Figure 3 shows our resulting participatory exam research model.

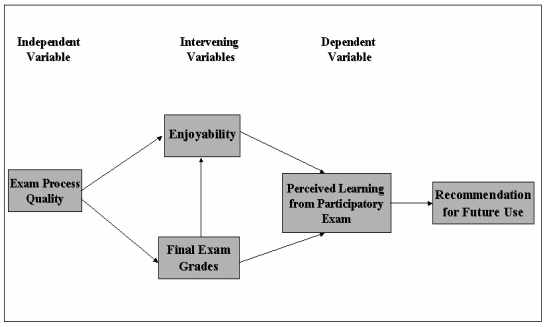

Figure 3: Participatory Exam Research Model

4.1 Research Questions and Hypotheses

Research Questions

We will examine the following research questions about participatory exams:

1. Do students enjoy their learning experience in the participatory exam?
2. Do students perceive more learning in the participatory exam?
3. How do students learn from specific participatory exam processes including designing, reading, and answering and grading exam questions?

Research Hypotheses:

The following research hypotheses are derived from the research model:

Hypothesis 1: Students who perceive higher exam process quality will report higher enjoyability from participatory exams.

Hypothesis 2: Students who perceive higher exam process quality will attain higher final grades from participatory exams.

Hypothesis 3: Students who attain higher final exam grades will report higher enjoyability from participatory exams.

Hypothesis 4: Students who perceive higher enjoyability will report higher perception of learning from participatory exams.

Hypothesis 5: Students who obtain higher final exam grades will report higher perception of learning from participatory exams.

Hypothesis 6: Students who report higher perceived learning will be more willing to recommend participatory exams for future use.

4.2 Method

During the Spring 2002 and Summer 2002 semesters, we conducted two surveys in CIS677 distance learning sections with a total of 58 students. Fifty students voluntarily participated in the participatory exam experiment by filling out consent forms and post-exam questionnaires. Our data analysis is based on these questionnaires. Table 1 shows the total number of subjects and the return rate in our surveys.

Regarding the exam process quality (see Table 2), on the one hand, students reported high perceived satisfaction. 84% of students agreed or strongly agreed that the instructors coordinated the whole participatory exam process very well. 84% also thought the grading criteria were explicit enough. However, only 54% reported that the grading process was fair. This may stem from the

students' sensitivity to being graded by peers and the competition among students. The exam process quality index had a relatively low Cronbach Alpha value (0.6040), possibly because of the low number of students in our study. However, this Alpha value is still validated at the minimum level.

When the students were asked whether they enjoyed the participatory exam, about 68% agreed that they did enjoy the exam process. Enjoyability is also strongly demonstrated by perceptions of sufficient exam time (68% agreeing) and flexibility (88%) in organizing their resources. The Cronbach Alpha value for the enjoyability index is 0.6793 (see Table 3). These results give our research question #1 a positive answer: students did enjoy their learning experience in the participatory examination.

Is the participatory exam a good learning experience for students? How do students learn from the participatory exam? From the students' answers, we found that 82% reported the participatory exam was a good learning experience. Furthermore, we observed that students did learn from multiple exam processes and their learning skills are strengthened in many ways. Specifically, 78% of students reported that their critical thinking skills were increased; 73% felt that their integration and generalization skills were greatly improved; 80% learned how to evaluate others' work; 83% felt that their synthesis skills improved; 76% thought they learned from reading others' answers and 68% of students learned from making up exam questions.

Does the participatory exam really motivate students' learning? The answer is also positive, with 75% of students reporting that they were motivated to read additional materials in order to answer the exam questions. A more exciting result is that about 80% thought that they were motivated to do their best work by the participatory exam process.

The above findings answered our research questions #2 and #3: students did perceive more learning in the participatory exam and they did learn from multiple exam learning procedures.

We validated a highly reliable construct, "perceived learning," with a Cronbach's Alpha value of 0.90 (see Table 4). Overall, these positive results have achieved our original exam design objectives.

We are also concerned about how students compare participatory exams and traditional exams and whether participatory exams should be used in the future. 62% of students reported that they would like to take this type of participatory exam rather than traditional exams. Over 70% of students recommended the participatory exam for future use (see Table 5).

What is the relationship among the exam research variables? Table 6 shows all correlations among perceived learning, enjoyability, final exam grades, exam process quality and recommendation for future use. The correlation analysis results show that exam process quality is correlated to enjoyability (0.308*) and real exam grades (0.346*), enjoyability is significantly correlated to perceived learning from the participatory exam (0.521**, p= <.01), and that perceptions of learning are also highly correlated with recommendation for future use (0.653, p<0.01).

Based on the above correlation analysis, we found some of original hypotheses are and some are not supported as follows.

Hypothesis 1: Students who perceive higher exam process quality will report higher enjoyability from participatory exams. **(Supported)**

Hypothesis 2: Students who perceive higher exam process quality will attain higher final grades from participatory exams. **(Supported)**

Hypothesis 3: Students who attain higher final exam grades will report higher enjoyability from participatory exams. **(Unsupported)**

Hypothesis 4: Students who perceive higher enjoyability will report higher perception of learning from participatory exams. **(Supported)**

Hypothesis 5: Students who obtain higher final exam grades will report higher perception of learning from participatory exams. **(Unsupported)**

Hypothesis 6: Students who reported higher perceived learning will be more willing to recommend participatory exams for future use. **(Supported)**

	Spring 2002	Summer 2002
Number of students who returned the questionnaires	32	18
Total Number of students	38	20
Return Rate	84.2%	90%

Table 1. Number of Subjects in the Two Surveys

Items	SA	A	N	D	SD	MEAN	S.D.	NR
The grading process was fair	12.0%	42.0%	24.0%	16.0%	6.0%	3.38	1.09	50
The instructor coordinated the exam process very well	30.0%	54.0%	10.0%	6.0%	0%	4.08	.80	50
The grading criteria are explicit enough	24.0%	60.0%	6.0%	10.0%	0%	3.98	.84	50

Cronbach's Alpha=0.6040

Questionnaire Categories: SA=Strongly Agree; A=Agree; N=Neither Agree nor disagree (neutral); D=Disagree; SD=Strongly Disagree; S.D.=Standard Deviation; NR=Number of Responses

Table 2: Participatory Exam Process Quality

Items	SA	A	N	D	SD	MEAN	S.D.	NR
Exam time was sufficient	14.3%	53.1%	10.2%	12.2%	10.2%	3.49	1.19	49
I enjoyed the flexibility in organizing my resources	32.7%	55.1%	8.2%	2.0%	2.0%	4.14	.82	49
I enjoyed the exam process	22.4%	44.9%	22.4%	6.1%	4.1%	3.76	1.01	49

Cronbach's Alpha=0.6793

Table 3: Participatory Exam Enjoyability

Items	SA	A	N	D	SD	MEAN	S.D.	NR
Overall, I felt the participatory exam was a good learning experience	28.6%	53.1%	16.3%	0%	2.0%	4.06	.80	49
My skill in critical thinking increased	28.6%	49.0%	20.4%	2.0%	0%	4.04	.76	49
My ability to integrate facts and develop generalizations improved	32.7%	40.8%	24.5%	2.0%	0%	4.04	.82	49
I learned to value other points of view	22.4%	59.2%	16.3%	0%	2.0%	4.00	.76	49
The exam process caused me to synthesize things I know	20.4%	63.3%	12.2%	4.1%	0%	4.00	.71	49
I was motivated to do my best work	36.7%	44.9%	14.3%	4.1%	0%	4.14	.82	49
I was stimulated to do additional reading	34.7%	40.8%	16.3%	6.1%	2.0%	3.98	1.05	49
I learned from reading peers' work	20.0%	56.0%	18.0%	4.0%	2.0%	3.88	.85	50
I learned from making up questions	20.0%	48.0%	22.0%	4.0%	6.0%	3.72	1.03	50

Cronbach's Alpha=0.9074

Table 4: Perceived Learning from the Participatory Exam

Items	SA	A	N	D	SD	MEAN	S.D.	NR
I would like to take this participatory exam rather than traditional exam	28.0%	34.0%	24.0%	12.0 %	2.0%	3.74	1.07	50
Recommendation of participatory exam use in the future course	28.6%	42.9%	20.4%	2.0%	6.1%	3.86	1.06	49

Cronbach's Alpha=0.6821

Table 5: Recommendation of Participatory Exam for Future Use

The fact that hypotheses 3 and 5 were not supported could be interpreted as showing that even students with lower exam grades felt that they enjoyed and learned successfully from the participatory exam process.

participatory exam, and each semester, the grading guidelines for these essay questions become more explicit (and longer). Still, it seems that different students grade easier or harder than others (just as different professors do). In future studies we hope

Factors	Pearson's R				
	Perceived Learning Index	Enjoyability Index	Final Exam Grades	Exam Process Quality	Recommendation For Future Use
Perceived Learning from Participatory Exam Index	1.00	.521**	.279	.312*	.653**
Enjoyability Index	.521**	1.00	.234	.308*	.582**
Recommendation For Future Use Index	.653**	.582**	.448**	.338*	1.00
Exam Process Quality Index	.312*	.308*	.346*	1.00	.338*

**Correlation is significant at the 0.01 level (2-tailed)

Table 6: Correlation Analysis: Perceived Learning, Enjoyability, Exam Process Quality, Final Exam Grades and Recommendation for Future Use from the Participatory Examination

5. Discussions and Future Research

Many interesting issues arise from giving students the responsibility to assess their own knowledge of the field and that of their peers. The first question normally raised is fairness—assessment traditionally is the job of the professor and would students not be qualified to judge others? We counter with the argument that in their profession they will be called upon constantly to assess designs, products and people. We believe they are perfectly capable of judging one another, plus the professor has an overview and final say over the process. (Unfortunately, for fear of corrupting experimental results, we could not tell them that theoretically they should learn more from the constructivist aspects of this process.) Also, in this kind of course, they should have learned enough to design good questions to assess others' knowledge of the field. We still need to work harder to reassure students of the fairness of these aspects, and to give them the confidence that they have the right and privilege to be assessors.

Fairness also arises in grading consistency. This is the fifth semester that we conducted the

to include participatory exams as well as class projects and homework projects throughout the semester, so students become trained in assessment. Grading is a skill, and hopefully students will become more confident, better and more consistent at it over time.

In future studies, we hope to extend the types of exam questions (e.g., short essay, programming), the levels of students (high school through graduate) and the types of courses (e.g., engineering, humanities). We shall look for collaborators to join us in this effort. We also intend to increase the collaboration within the exam process by experimenting with teams of students designing questions, answering them, grading answers, and arbitrating disputes.

We also plan to determine how to structure our experiments to assess actual retained learning instead of perceived learning. This may lead to longitudinal studies across courses and semesters to determine whether actual learning can be increased across a curriculum.

The workload is an important aspect for anyone considering adopting the participatory exam. With

the correct structure (especially more collaborative) and online administrative tools, we believe that the process will be equal or even less work for the instructor to manage than traditional exams. In some semesters the workload did seem equal and so far we have been manually managing the process. We intend to build a general participatory exercise management tool that will work for many different kinds of exams and projects.

While we have just conducted preliminary studies, we are greatly encouraged and excited by the results of the participatory exam. We can envision this becoming a major part of pedagogy in the future, and look forward to a time when all students are confident and skilled in self- and peer-assessment as part of their learning process.

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