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# ExamNet asynchronous learning network: augmenting face-to-face courses with student-developed exam questions

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## Abstract

This paper investigates how students' attitude and performance are affected by using an asynchronous learning network (ALN) to augment exams in a traditional lecture/lab course. Students used the ExamNet ALN to create, critique, and revise a database of questions that subsequently was drawn upon for course exams. Overall, students considered ExamNet to be useful and important in understanding course material, reviewing for exams, and succeeding in the course. Most found the process of developing exam questions to be intrinsically motivating and an interesting part of the course.

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*Keywords:* ALN; Collaborative learning; Collaborative argumentation; Asynchronous collaboration; Course exams

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## 1. Introduction

Instructors throughout history have looked for ways to involve students more deeply in the subject matter at hand. One such method is *collaborative learning* (Brandon & Hollingshead, 1999; Lin & Hsieh, 2001; Rockwood, 1995), in which students who have already achieved foundational knowledge in a subject area work together to develop group products. Working in semi-autonomous groups exposes students to multiple viewpoints and methods, and in such circumstances it is theorized that knowledge will be socially constructed and refined through interactions with others (Kirschner, 1999). Empirical research offers encouraging support for the theorized benefits of collaborative learning. A meta-analysis of 39 studies conducted in science, math, engineering, and technology courses finds collaborative learners to have more persistence, better attitudes, and higher achievement than students who work alone (Springer, Stanne, & Donovan, 1999). In collaborative

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learning environments, the primary role of the instructor is to facilitate and empower student groups (Rockwood, 1995), with the assumption that “knowledge is created as it is shared, and the more it is shared, the more is learned” (Lin & Hsieh, 2001).

A second method of involving students is to incorporate active argumentation into the curriculum, a process Veerman, Andriessen, and Kanselaar (2002) describe as *collaborative argumentation*. From this perspective, education is framed as “an ongoing argumentative process . . . of discovering and generating acceptable arguments and lines of reasoning underlying scientific assumptions and bodies of knowledge” (Veerman et al., 2002, p. 157). Argumentation requires students to explicitly confront and deal with a wider variety of ideas than would be found in typical lectures and deepens students’ reflection (Scardamalia & Bereiter, 1993). The need to develop convincing arguments motivates “the active search for knowledge in the problem-solving environment” (de Vries, Lund, & Baker, 2002, p. 69), and students’ abilities to present and criticize ideas are strengthened in the argumentation process (Scardamalia & Bereiter, 1994). The role of the instructor in collaborative argumentation is “to design a teaching situation that in fact *exploits* the diversity of student conceptions and the variety of meanings of scientific terms by encouraging students to mutually question these conceptions and meanings” (de Vries et al., 2002, p. 67, italics in original).

Computer technologies have been configured to facilitate both collaborative learning (Ligorio, 2001) and collaborative argumentation (de Vries et al., 2002), as well as a variety of other knowledge-building methods that emphasize collaboration (Scardamalia & Bereiter, 1996). The present paper focuses on asynchronous computer applications, in which students are not required to use the technology simultaneously. These applications are called asynchronous learning networks or ALNs (Hiltz & Wellman, 1997).

ALNs can provide a wide range of support for instructors, such as organizing and coordinating group interactions, sequencing the group’s workflow, storing and distributing group products, and automatically documenting messages and group processes. In distance-learning settings where students never meet face-to-face, ALNs have proved capable of supporting a full range of course activities. For example, the Virtual Classroom ALN developed at the New Jersey Institute of Technology can be used to conduct online seminars and discussions as well as “debates, group projects, case-study discussions, simulation and role-playing exercises, the sharing of solutions to homework assignments, and collaborative composition of essays, stories, or research plans” (Hiltz & Wellman, 1997, p. 47). However, the present paper addresses an ALN that supports a specific topic in the curriculum rather than the entire course. This topic is the creation and refinement of course exams by students, an area where ALNs are now beginning to be applied (Hiltz & Turoff, 2002). For brevity, this topic is referenced in throughout the paper as *student-developed exams*.

Applications of ALN technology to student-developed exams have incorporated aspects of both collaborative learning, e.g., working in semi-autonomous groups, and collaborative argumentation, e.g., producing and critiquing arguments relating to course materials. Cozens (1997) describes a situation where collaboration arose spontaneously among female language students at a school in the United Arab Emirates. The students were assigned to individually create multiple-choice questions on their area of research using computer-based test authoring software. Initially, instructors were surprised by the intense interest of class members in their peers’ questions and their willingness to challenge answers they felt were incorrect. A follow-up study was conducted in which students were assigned to work in groups to create exam questions. The author reports,

(Students) had wanted to find mistakes made by their peers, but had not wanted them to find mistakes in their own work and so had tried not to make any errors. As such, a competitive edge had been introduced, not by the teacher, but by the students themselves. This competitiveness had allowed the students to become more independent and motivated in their attitude to learning. (Cozens, 1997)

A second study used the Topic Commenter tool in GroupSystems software to support a question-response review process by business student teams (Corbitt, Wright, & Marz, 1999). Each student answered an assigned question. The question and response then was routed to another student, who could agree with the original answer or disagree and provide a new response. A student team then would jointly review the responses and discuss them with the instructor. The authors report positive student reactions to these team-based exams, especially toward the increased interactions and immediate feedback that the process provided.

A third study used an ALN that supports both creation of exam questions and evaluation of question responses (Shen, Hiltz, Cheng, Cho, & Bieber, 2001). Face-to-face (FTF) and at-distance students in a graduate information systems course used Virtual Classroom and WebBoard software to author essay questions which were responded to online by one of the other students. The essay response was evaluated by the question author, and the response and evaluation subsequently were reviewed by the teaching assistants and the course instructor. A survey of students following their use of the ALN showed that most considered writing exam questions and evaluating responses to be an important part of learning in the course. They also felt that their ability to communicate, critical thinking skills, ability to integrate facts, and motivation to do additional reading increased more with the ALN than with traditional exams.

Empirical research in applying ALNs to student-developed exams is still relatively new, so findings must be considered preliminary in nature. Nevertheless, the findings to date suggest ALNs can add value to the examination process. This paper investigates how students used an ALN called ExamNet to develop exam questions in a manner that combines collaborative learning and collaborative argumentation methods. The following sections of the paper describe ExamNet, develop research hypotheses, and present the method, results, and discussion of hypothesis testing.

## 2. ExamNet ALN

ExamNet is a custom software application designed to support students in creating and refining exam questions. The application implements a database-driven intranet that is accessible to students, teaching assistants, and the course instructor. Students are motivated to participate in developing exam questions through grading incentives and social pressures structured into the ALN and the course policies and procedures. Students participate in these ways:

- Teams of approximately three students each are assigned to research and contribute six exam questions in each of three weeks during the semester, i.e., each team enters a total of 18 questions during the semester. These are standing teams that participate throughout the semester in computer labs, writing a team report, and producing a large team web project.

It is suggested to students during course lectures that failure to contribute questions will reduce participation credit for team members, but in the few situations where teams actually have been late in submitting their questions, an email reminder from the instructor quickly motivated their participation.

- Individuals can receive a portion of the 10% course participation credit by writing challenges to posted exam questions, although in practice it is never stated what portion of the credit this might be. It also is suggested to students that these challenges will be evaluated for quality and relevance and that the instructor will downgrade rude or offensive challenges. However, no challenges to date have actually been downgraded because of quality, relevance, or rudeness.
- There is no requirement for teams to change their exam questions or answers in response to challenges, but teams are expected to consider and reply to challenges, i.e., explaining the team's decision, in a timely manner. Prompt attention to this responsibility is reinforced by listing the teams who have unanswered challenges on the ExamNet login page, along with the date of their oldest unanswered challenge (see Public Notices in Fig. 1). This list is displayed and noted in class several times during the semester, and most teams are careful to avoid this type of in-class attention by replying to challenges promptly.
- Students are not required to read questions in ExamNet, but they are promised that at least 50% of exam questions will be drawn directly from the ExamNet database and that reading the questions will thereby be useful in reviewing for exams.

## ExamNet Login

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**Individual Member Access**

Member ID:  Password:

Enter Individual Area

**Team Access**

Team ID:  Password:

Enter Team Area

**\*\*\*\* Public Notices \*\*\*\***

**LabTAs** Awaiting **1** Challenge Reply dating from 4/20/2002 6:57:09 PM

**team02** Awaiting **2** Challenge Replies dating from 4/22/2002 10:29:43 AM

**team03** Awaiting **1** Challenge Reply dating from 4/19/2002 3:45:54 PM

**team04** Awaiting **1** Challenge Reply dating from 4/23/2002 11:41:42 AM

Fig. 1. Login screen showing public notices relating to question challenges.

Students can log in to ExamNet in either individual or team mode. Using individual ID and password, students can access the following options:

- View photo directories and seating charts showing current course members.
- Check their current course grades and manage personal data, e.g., email address and phone numbers.
- View and challenge exam questions previously entered by teams in the course.

Using their team ID and password, students can enter exam questions, view and edit their team's exam questions, and reply to question challenges in the following ways:

- Exam questions can be entered in multiple-choice or true-false format, accompanied by applicable answer choices, the question solution, and a source where the solution may be found in the course materials.
- Prior to being challenged, questions can be deleted by team members; deletion is not available once a question is challenged, but team members can edit their own questions at any time up to one week prior to the examination (this cut-off in question editing gives students a fixed set of questions to use in their final week of reviewing for the exam).
- Challenges can be viewed and replied to; all challenges and replies are permanently linked to the exam question and are displayed in temporal order of entry.

Screen captures of ExamNet are shown in Figs. 1–3.

## ExamNet: Individual Area

### Spring 2002 Exam Questions Covering Week 02

**The Digital Millennium Copyright Act (DMCA) of 1998 made it legal to reveal how on-line copyright controls could be circumvented.** (team25 #20020206115006-706)

True or False?

*Solution: False. Source: From the article: How do you fix a leaky Net? <http://www.salon.com/tech/feature/2001/08/29/west/index.html>*

[I want to challenge this question](#)

**The new wireless Palm i705 is always on to receive:**

(team05 #20020206132811-706)

- A. Phone calls from friends and family
- B. Instant messages from palm.net
- C. Email messages from palm.net
- D. None of the above
- E. All of the above

*Solution: C. Source: 14U Future Technology News*

[I want to challenge this question](#)

**Challenge from [redacted]:** Hi Team 5. How about using 'All of the above' to fill in the fifth choice?

**team05 replies:** Thank you [redacted] for bring it up to our attention.

**Challenge from [redacted]:** You're welcome!

**team05 replies:** Ok

**Challenge from [redacted]:** Hi Team 5. It seems that 'messages' is spelled incorrectly in choice B.

**team05 replies:** Made the correction. Thanks.

Fig. 2. Individual view of exam questions, challenges, and replies.

## ExamNet: Team Area

Add New Question

Add a new Multiple-Choice question  
 Add a new True-False question

team15's Questions

Week Covered	Type	Question		
Week 08	TF	MP3s can deliver the same CD quality sound as Wave files for 1/10 the size.	<a href="#">Edit</a>	<a href="#">Reply to 2 Challenges</a>
Week 08	MC	Direct random access on disk (not tape) allows _____ video editing.	<a href="#">Edit</a>	<a href="#">Delete</a>
Week 12	TF	Cyan-Yellow-Magenta is a subtractive model.	<a href="#">Edit</a>	<a href="#">Reply to 1 Challenge</a>
Week 12	MC	Direct random access on disk (not tape) allows _____ video editing.	<a href="#">Edit</a>	<a href="#">Delete</a>

Fig. 3. Team area for managing exam questions.

It is important to note that ExamNet does not replace traditional methods of exam administration. ExamNet simply augments the process of preparing exams by allowing students to participate in creating and refining questions. Exams conducted during this research were administered on paper in multiple random-ordered versions, and optical-scan sheets were used to collect students' answers.

### 3. Hypotheses and research questions

Prior researchers report that students are generally positive about using ALNs for developing exams. Compared to conventional exams, student-developed exams increase involvement and promote a more competitive atmosphere (Cozens, 1997), provide more interactions and faster access to feedback (Corbitt et al., 1999), and result in greater skill acquisition (Shen et al., 2001). ExamNet is designed to give students a way to increase and validate their understanding of course material and prepare for exams. For these reasons, it is anticipated that students will consider ExamNet to be a valuable part of the course, leading to Hypothesis 1.

**H1.** Students will perceive ExamNet to be useful and important to learning course material, performing well on exams, and overall success in the course.

Prior studies of student-developed exams applied a variety of ALNs and collaboration designs, so it is not surprising that the features students found attractive varied across the implementa-

tions in the three cited prior studies (Corbitt et al., 1999; Cozens, 1997; Shen et al., 2001). The design of ExamNet gives students direct control over the exam questions their team contributes as well as indirect control in improving exam questions written by other teams. Students also are able to consider opinions and viewpoints of their peers during the review process. It is anticipated that students will recognize these features as benefits to them, leading to three related hypotheses.

**H2a.** Students will value the ability to participate in creating exam questions.

**H2b.** Students will value the ability to review and improve their peers' exam questions.

**H2c.** Students will value the ability to consider their peers' ideas and viewpoints.

Use of online study tools also can improve exam scores (Grabe & Sigler, 2002). If ExamNet is an effective augmentation to traditional exams, then its use should also be reflected in higher student exam grades. This assumption is tested by [Hypothesis 3](#).

**H3.** Students who use ExamNet more will earn higher exam grades.

Each of the three cited prior studies reports some aspects of user satisfaction with the ALN, however, none of these uses a validated measure. The present study applies the end-user computing satisfaction (EUCS) instrument developed by Doll and Torkzadeh (1988). This instrument is previously validated for use "as a standardized measure of user satisfaction with a specific application" (Doll, Xia, & Torkzadeh, 1994, p. 459). It is anticipated that ExamNet will satisfy students generally and that students who experience high levels of familiarity and success using the system will report higher satisfaction. This leads to three related hypotheses.

**H4a.** Students will have above-midpoint EUCS scores, indicating overall satisfaction with ExamNet.

**H4b.** Students who use ExamNet more will have higher EUCS scores.

**H4c.** Student grades will correlate positively with EUCS scores.

Finally, there are several exploratory questions in the research design that would be interesting to answer. These include the following:

- What types of dialogue arise in ExamNet? Are misunderstandings prevalent, and are students' interactions primarily helpful or confrontational in nature?
- What motivates students to challenge questions? Is this behavior primarily driven by rewards, i.e., to receive participation credit, or is it altruistic in nature?
- What do students like least about ExamNet and the collaboration process applied in this research?
- What would students like to change about the design of ExamNet? Would changes from the current structure of accountability and anonymity improve their views toward the application?

#### 4. Research method

The research was conducted over a 15-week semester with 86 students enrolled in an undergraduate course titled Emerging Information Technologies. This is a required course for information systems majors attending a large university located in the Midwest US.

Students used ExamNet throughout the semester to develop questions for midterm and final exams. Entries of exam questions, challenges, and replies to challenges were logged each time they used ExamNet. Prior to the final exam students completed an on-line questionnaire which asked them about their attitudes and self-reported activities relating to use of ExamNet, including items of the EUCS instrument (see [Appendix](#)). Grade measurements were taken from the final exam, which was held at the end of the semester. The final exam covered all course content, including material presented prior to the midterm exam.

#### 5. Results

Most of the data collection was handled by computer, with the result that no data were missing from questionnaire responses, online logs, or grades. [Table 1](#) shows item means and standard deviations as well as correlations of EUCS scores and grades with quantitative measures, e.g., *Number of challenges made*, qualitative measures, e.g., *How useful was reading challenges in reviewing for exams?*, and descriptive measures, e.g., *How old are you?* Results relating to the hypotheses and research questions are discussed in the following sections.

##### 5.1. Usefulness and importance

Students were questioned about usefulness and importance of several aspects of ExamNet. Responses were collected using five-position marked scales (see [Appendix](#)), and results are shown in [Table 1](#). Students gave high ratings to usefulness of reading exam questions in reviewing for exams (4.40) and importance of reading exam questions for course success (4.27) and understanding course material (3.72). Reading challenges and replies received relatively low ratings for both usefulness and importance measures (see [Table 1](#)). These findings support [Hypothesis 1](#), but it is clear that the feature that students principally value in ExamNet is having access to exam questions prior to the exam.

##### 5.2. Ratings of key ExamNet design features

The three parts of [Hypothesis 2](#) were evaluated through responses to the open-ended question, *What did you like most about the way exam questions, challenges, and replies were used in this course?* Responses to this question were sorted into five emergent categories. Of the 86 participants, 81 gave responses that sorted into one or more of the categories, producing 95 responses (see [Fig. 4](#)). Slightly more than half the responses reinforced findings associated with [Hypothesis 1](#)—ExamNet made studying for exams easier (33) and helped in understanding material in the course (21). Of the remaining responses, 17 noted the ability to provide feedback and improve

Table 1  
Descriptive data and correlations with grade and EUCS satisfaction

Quantitative Measures	Mean (s.d.)	Correlation with	
		Grade	EUCS
Grade from second exam ( <i>numeric</i> )	0.83 (0.10)	–	0.133
How many exam questions did you personally write? ( <i>numeric</i> )	2.73 (2.23)	0.198	–0.017
How many of the exam questions you wrote were challenged? ( <i>numeric</i> )	3.43 (3.64)	0.009	–0.063
How many challenges did you personally respond to? ( <i>numeric</i> )	3.43 (3.64)	0.087	–0.016
Number of challenges made ( <i>logged</i> )	5.08 (8.41)	0.225*	0.026
Number of dates challenges were made ( <i>logged</i> )	2.49 (3.58)	0.264*	0.054
How frequently did you access the exam question database during the semester?	4.10 (0.93)	0.255*	0.285**
Approximately how much time did you spend reviewing exam questions, challenges, and replies?	3.35 (0.94)	0.236*	0.062
EUCS satisfaction ( <i>aggregated EUCS scale items</i> )	4.20 (0.60)	0.133	–
How useful was reading the exam questions in reviewing for exams?	4.40 (0.80)	0.334**	0.387**
How useful was reading challenges in reviewing for exams?	2.51 (1.23)	0.178	0.199
How useful was reading replies in reviewing for exams?	2.28 (1.07)	0.219*	0.203
How important to your course success was reading the exam questions?	4.27 (0.99)	0.360**	0.406**
How important to your course success was reading the challenges and replies?	2.35 (1.09)	0.118	0.116
How important to your understanding course material was reading the exam questions?	3.72 (1.09)	0.146	0.479**
How important to your understanding course material was reading the challenges and replies?	2.38 (1.13)	0.165	0.242*
Did knowing that questions you wrote might be challenged bother you?	1.79 (0.90)	0.060	0.226*
Did knowing that questions you wrote might be challenged cause you to research them better than you would have otherwise?	3.16 (1.38)	0.90	0.341**
How old are you? ( <i>numeric</i> )	24.7 (5.16)	0.163	–0.025
What is your gender? ( <i>numeric</i> )	59%M 41%F	0.084	–0.006
Including internships, how many years have you worked in industry overall? ( <i>numeric</i> )	3.53 (3.54)	0.197	–0.089

(*numeric*) = responses using raw numbers; (*logged*) = logged from subjects' database accesses.

\* Significant at the 0.05 level (2-tailed).

\*\* Significant at the 0.01 level (2-tailed).

questions, supporting Hypothesis 2b; 15 noted student participation in the process of creating exams, supporting Hypothesis 2a; and nine noted viewing other peoples' ideas and considering alternative perspectives, supporting Hypothesis 2c. This finding suggests that the design elements of student-developed exams are perceived to be valuable by students, but are still secondary to ExamNet's value as a study aid.

### 5.3. Relationship of ExamNet use to exam grades

Several aspects of use correlated significantly with exam grades. High grades were earned by students who made numerous challenges and challenges across numerous dates, students who accessed the exam question database frequently, and students who spent a large amount of time

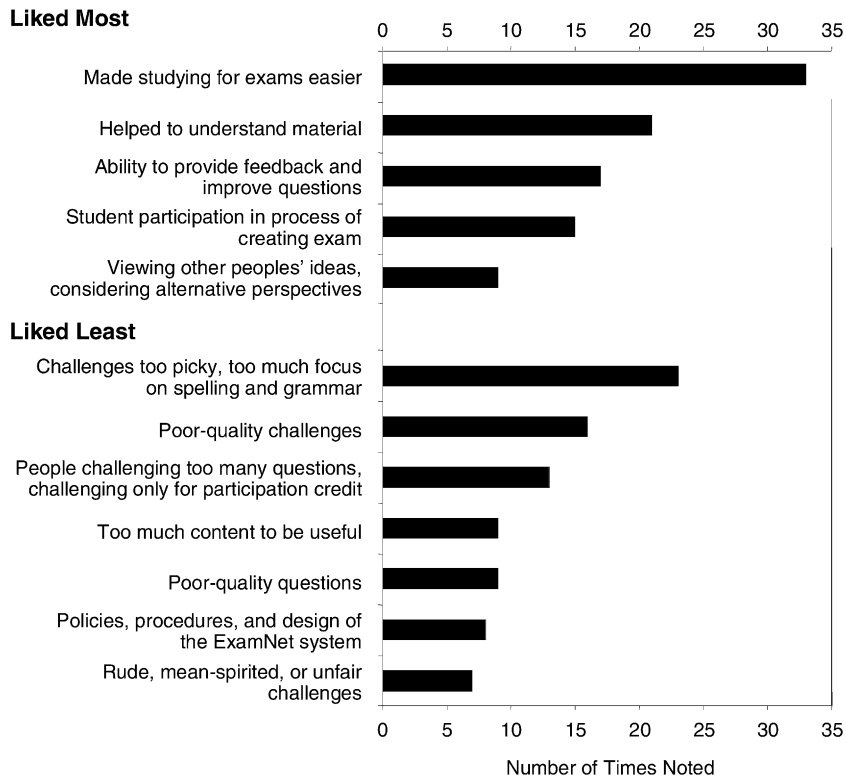


Fig. 4. Student likes and dislikes relating to ExamNet.

reviewing exam questions, challenges, and replies. No correlations were found with the number of exam questions students wrote or challenges they responded to. These findings support [Hypothesis 3](#), but suggest that some system uses, e.g., challenging questions, are more useful in preparing for exams than other uses, e.g., responding to challenges.

Another issue is that certain qualitative measures, i.e. attitudes concerning usefulness and importance, were more highly correlated with exam grades than the aforementioned measures of system use. In order to understand this phenomenon better, a stepwise regression was run between exam grade and the significantly-correlated variables shown in [Table 1](#) (see [Table 2](#)). The results suggest that exam grades in the present study are predicted best by a combination of three measures: attitude toward importance of reading exam questions to course success, number of distinct dates challenges were made, and attitude toward usefulness of reading exam questions in reviewing for exams. This is an interesting finding, as it suggests that students' attitudes toward certain aspects of the system are, at least in this case, more important than actual system use in predicting grades.

#### 5.4. Correlates of satisfaction

Prior to performing the analyses related to [Hypothesis 4](#), responses to items EUCS instrument were subjected to reliability analysis. The Cronbach's alpha statistic was calculated as 0.881, indicating the instrument is reliable in this research design.

Table 2

Stepwise regression on exam grade of other quantitative measures and qualitative measures (model adjusted  $R^2=0.198$ )

Variables (Shown in order of entry; no variables were removed)	Beta	<i>t</i>	<i>P</i>
1. How important to your course success was reading the exam questions?	0.237	2.207	0.030
2. Number of dates challenges were made	0.237	2.426	0.017
3. How useful was reading the exam questions in reviewing for exams?	0.234	2.193	0.031

Students' average rating of ExamNet on the EUCS scale was 4.20, falling between being satisfied "most of the time" (4) and "all of the time" (5). This is a high overall rating that supports Hypothesis 4a. A significant correlation was found between satisfaction and frequency of accessing the exam question database. This finding provides limited support for Hypothesis 4b. No significant correlation was found between user satisfaction and exam grades. Thus, Hypothesis 4c was not supported.

As shown in Table 1, number of qualitative measures correlated significantly with satisfaction. Although no relationship was hypothesized with these measures, appearance of the correlations prompted additional analysis via stepwise regression between EUCS score and the affected measures (see Table 3). The results suggest that satisfaction is predicted best by attitudes toward importance and usefulness of reading exam questions and by concerns that questions the student wrote might be challenged.

## 5.5. Research questions

### 5.5.1. What types of dialogue arise in ExamNet?

To answer this question, all the dialogues that took place between challengers and teams were reviewed, producing the following quantitative results:

- Of the 545 exam questions teams submitted, 287 (53%) were challenged by at least one student, and 438 total challenges were made.
- Overall, teams accepted 308 (70%) and rejected 84 (19%) of the challenges. In the remaining 11% of cases, the replies were ambiguous or no reply was made to the challenge.
- In 198 cases (69%) teams accepted all challenges made to the question, in 49 cases (17%) they rejected all challenges, and in 24 cases (8%) they gave mixed replies (both acceptance and rejection).

Table 3

Stepwise regression on EUCS satisfaction of quantitative measures and other qualitative measures (model adjusted  $R^2=0.307$ )

Variables (Shown in order of entry; no variables were removed)	Beta	<i>t</i>	<i>P</i>
1. How important to understanding course material was reading the exam questions?	0.384	4.041	0.000
2. How useful was reading the exam questions in reviewing for exams?	0.267	2.823	0.006
3. Did knowing that questions you wrote might be challenged bother you?	0.194	2.138	0.035

Qualitatively, dialogues are characterized by several themes. The most prominent theme is dialogues consisting of a simple informative challenge and reply, without follow-up. The primary function of these dialogues is to advise a need for minor editing, for example:

Challenge from C.A.: This is only a minor mistake in the question, but ‘you own’ should be changed to ‘your own’ to fix the grammar.  
team31 replies: Correction has been made.

A second theme that appears in 9% of challenges is follow-up discussion used primarily for clarification, e.g., of the challenger’s motives, rationale for the question, or adherence to course procedures:

Challenge from M.M.: Hi team03, your choices for D and E are absent.  
team03 replies: Yes M., the reason for only having 3 choices, is because we thought that it wasn’t necessary to add choices that were completely wrong, we thought that it was more important to just focus on the 3 choices that most people would consider when answering this question.  
Challenge from M.M.: Hi team03, I just mentioned it because Dr. W. had said in class that we need to have 5 choices for every question.  
team03 replies: We added 2 more choices.

A third theme is a high level of deference and politeness among the parties that occurs in the majority of dialogues:

Challenge from S.B.: Hi Team 5. How about using ‘All of the above’ to fill in the fifth choice?  
team05 replies: Thank you S., for bring it up to our attention.  
Challenge from S.B.: You’re welcome!  
team05 replies: Ok  
Challenge from M.E.: Hi Team 5. It seems that ‘messages’ is spelled incorrectly in choice B.  
team05 replies: Made the correction. Thanks.

It is possible this effect may be an artifact of the instructor’s implied policing of the challenges or the asymmetrical anonymity of ExamNet’s design, i.e., anonymous teams vs. identified challengers. Analysis of the messages does not point to a clear cause. Finally, a fourth theme emerged in a critical tone of some challenge replies. Although no dialogues occurred that were overtly abusive or rude, teams were occasionally frustrated by challengers’ comments and reacted in a small number of cases by criticizing their challengers’ knowledge or motives:

Challenge from S.D.: Can you tell me where in your source article this answer can be found?  
team21 replies: read the article again!

Overall, these results suggest that relatively few dialogues in ExamNet are characterized by misunderstandings and that students’ interactions using the ALN tend to be more helpful than confrontational.

5.5.2. What drives students to challenge questions?

It was anticipated that students would have several motivations to challenge questions, including course participation credit promised for challenges, improving other teams’ questions prior to encountering them on an exam, and learning more about the question by discussing it with its author. In order to answer this research question, students were asked *Please list in order the factors that were important in motivating you to challenge other peoples’ exam questions*. Four text boxes were provided, labeled *Most Important*, *Second Most Important*, and so on. Students were required to enter at least a *Most Important* factor motivating their challenges. Their responses were categorized into five basic reasons for challenging (see Fig. 5).

The two key factors students considered to be *Most Important* were improving question accuracy and gaining participation credit. Improving question clarity was the leading factor among *Second Most Important* entries, and improving question language and increasing knowledge were other factors receiving multiple mentions. This distribution indicates that students perceived themselves to be motivated primarily by the urge to improve questions in one way or another. Statements entered by students suggest that this motivation was grounded in the urge to correct distinct problems with questions rather than a generalized desire for improvement. Their rationales include:

- “Question was wrong”
- “Forgot to include choice ‘E’”
- “Did not understand a question”

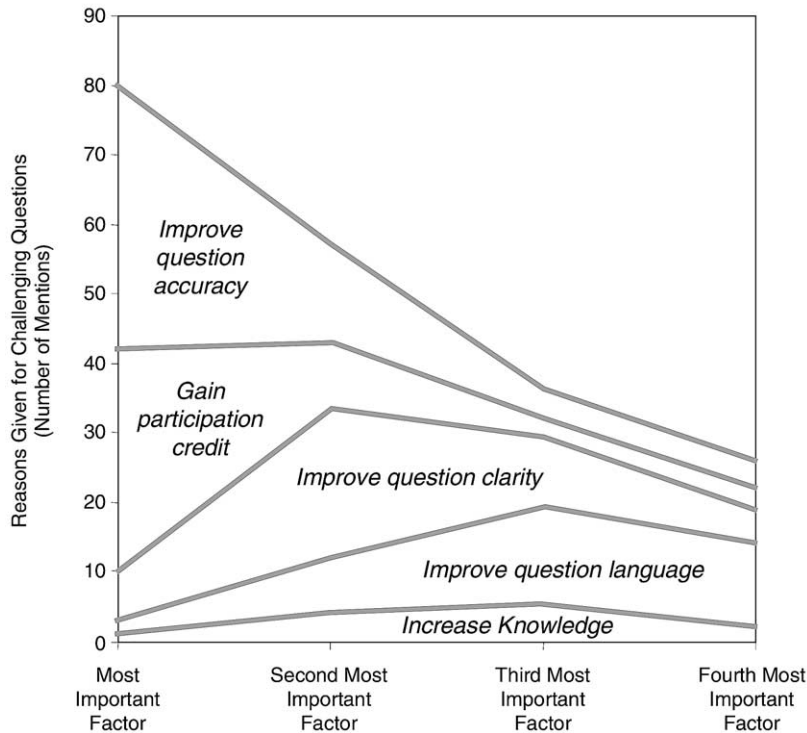


Fig. 5. Students’ motivation for challenging questions (cumulative graph).

“Challenge the confusing questions”  
“Try to make questions grammatically correct”  
“Mis-spelled”

Significant participation credit for the course was directly linked to students' question challenges, and this factor was listed an important reason for challenging. However, references to participation credit accounted for only 23% of reasons given overall, suggesting that once students began reading the questions, they became involved in the process and their motivation turned from extrinsic to intrinsic. Some students noted this phenomenon in discussing what they liked most about the system:

It kept me aware of what was challenged, why it was challenged, the quality of the challenge, response, the person who thought of it all, the way the team responded, all of this like a game, where learning took place alongside. It motivated me and also helped me to remember answers.

I liked the ability to question the thinking behind questions.

You could get people to alter their crappy questions.

Students made relatively few mentions of motivating factors that are abstract or altruistic. Increasing knowledge accounted for less than 6% and helping others for approximately 2% of reasons given overall.

#### *5.5.3. What do students like least about ExamNet and the collaboration process applied in this research?*

The major categories that emerged from student comments are shown in Fig. 4. Interestingly, most of the things students disliked about the process stemmed from their fellow students. Over 71% of complaints focused on question challenges. Students thought challenges were poorly thought out, too detail-oriented (especially regarding spelling and grammar), rude or mean-spirited in tone, and improperly motivated by desire to earn participation credit. Their comments included the following:

Challenges were usually not valid. People just challenged to challenge. They were quite picky and very opinionated!

GRAMMAR corrections unrelated to the correct syntax (example: someone forgets to put a period at the end of a sentence. I hope no participation is given for weak challenges like this!)

I think sometimes questions could be over challenged. Also, I found that some individuals challenged a lot, which may limit others' participation.

Complaints about quality and quantity of questions accounted for 19% of the total, and less than 10% of student complaints referred to the design of ExamNet or course policies and procedures.

#### 5.5.4. *What would students like to change about the way ExamNet was implemented?*

Five questions addressed this issue. Each compared the current situation as described in this paper with a hypothetical alternative. Students were asked if they would prefer that different responsibilities (team vs. individual) be assigned for questions and replies (currently written by teams) and challenges (currently made by individuals). Mean responses for these items ranged from 2.38 to 2.51, with no significant differences between the items. This finding indicates slight preference for the current situation, in which individuals challenge teams.

Students were then asked if they would prefer to change to anonymous postings from the current situation where postings are identified by individual name or team name. Mean responses were 2.52 for posting team questions anonymously and 2.78 for posting individual challenges anonymously. These figures indicate that students were more receptive to anonymous postings for individuals than teams (paired  $t=2.276$ ,  $P=0.025$ , two-tailed), however, there was no mandate for changing the current procedures in either case.

## 6. Discussion and conclusions

Overall, the findings corroborate prior studies that used ALNs to support student-developed exams. ExamNet's approach to exam question development extends the design reported by Cozens (1997) by including the ability for students to critique and revise questions. As found in that study, students in the present study became very involved in the process, displaying interest in their peers' questions, challenging questions willingly, and showing signs of game-competitiveness. Similar to findings of Corbitt et al. (1999), students liked the interactivity of participating in question development, although in the less-managed design of the present study they proved to be less keen on the feedback they received from their peers. As found by Shen et al. (2001), students in the present study considered the ALN to be an important part of learning in the course.

### 6.1. *New findings*

There are several new findings as well. First, this study suggests that it is not necessary with an ALN such as ExamNet for instructors to micro-manage students by zealously assigning and supervising their activities. High levels of participation were gained in the present study simply by setting up structural incentives and social pressures, e.g., automated public notices of laggardly performance. Students realized quickly that posting their questions ahead of schedule gave them a wider range of material to choose from, and once they accessed ExamNet to earn participation credits many students found it to be interesting and game-like to review their peers' questions and consequently became internally motivated to continue.

Second, collaboration does not have to be entirely collegial and friendly. As much as students liked to improve questions written by others, they emphatically disliked being critiqued by their peers. One interpretation is although students like to play the ExamNet "game" they don't like to see points scored against them. Further research will be necessary to learn whether this aspect of ExamNet can be minimized without reducing positive aspects of the ALN.

Third, unmoderated student interactions through ALNs do not necessarily have to become rude or abusive. It was emphasized to students in the present study that the course standard for

challenges and replies was polite and courteous communication and it was implied that the instructor would police the discussions. In addition, challenges were identified by the name of individual who posted them. These simple guidelines and structures resulted in an online culture that was surprisingly civil, given the discomfort students apparently felt when their questions were challenged.

### *6.2. Limitations of the research*

There are also some areas of concern that the present research did not address. First, students who are concerned about criticism of their questions may be motivated to perform more research before writing the questions and solutions, but it is also possible they will write questions that are simpler or less risky than would otherwise be the case. In the present study, no rewards were made for good questions other than the increased likelihood the question would not be challenged. However, a similar ALN could be structured to allow students or instructors to highlight deserving questions as exemplars, thus providing greater rewards for well-researched work.

Second, by putting a question database in place it is likely that some students will simply replace reading background materials with memorization of listed questions. This was addressed in the present study in two ways. A relatively high number of questions was developed in relation to the number used on the exams. By the date of the second exam, the question database contained 545 questions, of which 70 were used in the exam. Additional exam questions intended to fill gaps in coverage were written by the instructor. These methods appeared to provide adequate incentive for students to complete assigned course readings in addition to reviewing the listed exam questions.

## **7. Conclusions**

The initial test of ExamNet that is reported in this paper supports the view that ALNs can provide valuable augmentation to FTF courses, even when implemented as a relatively small part of the overall course. In this case, information technology provided a simple but newfound ability for students to create and refine questions for multiple-choice and true–false exams. Students found it intrinsically motivating to participate using ExamNet, and they were able to use the ALN effectively without active moderation by the instructor. These findings provide additional support for using ALN technology as a part of FTF courses as well as in at-distance settings.

## **Appendix. Online questionnaire**

### *Quantitative Measures*

1. How many exam questions did you personally write?
2. How many of the exam questions you wrote were challenged?
3. How many challenges did you personally respond to?
4. How frequently did you access the exam question database during the semester?

1. Never      2. Once or twice      3. Three or four times      4. Five to ten times      5. More than ten times

5. Approximately how much time did you spend reviewing exam questions, challenges, and replies in preparation for the second exam?

1. Less than an hour      2. An hour or two      3. Three to four hours      4. Five to ten hours      5. Over ten hours

*End User Computing Satisfaction Qualitative Measures*

1. Does the exam question database provide the precise information you need?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

2. Does the information content in the exam question database meet your needs?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

3. Does the exam question database provide sufficient information?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

4. Is the exam question database an accurate source of information?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

5. Are you satisfied with the accuracy of the exam question database?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

6. Do you think the output of the exam question database is presented in a useful format?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

7. Is the information in the exam question database clear?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

8. Is the exam question database user friendly?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

9. Is the exam question database easy to use?

1. Almost never      2. Some of the time      3. About half of the time      4. Most of the time      5. Almost always

10. Do you get the information you need in time?

1. Almost never    2. Some of the time    3. About half of the time    4. Most of the time    5. Almost always

11. Does the system provide up-to-date information?

1. Almost never    2. Some of the time    3. About half of the time    4. Most of the time    5. Almost always

### *Other Qualitative Measures*

1. How useful was reading the exam questions in reviewing for exams?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

2. How useful was reading challenges in reviewing for exams?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

3. How useful was reading replies in reviewing for exams?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

4. How important to your course success was reading the exam questions?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

5. How important to your course success was reading the challenges and replies?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

6. How important to your understanding course material was reading the exam questions?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

7. How important to your understanding course material was reading the challenges and replies?

1. Not at all useful    2. A little useful    3. Moderately useful    4. Quite useful    5. Extremely useful

8. Did knowing that questions you wrote might be challenged bother you?

1. Almost never    2. Some of the time    3. About half of the time    4. Most of the time    5. Almost always

9. Did knowing that questions you wrote might be challenged cause you to research the question better than you would have otherwise?

1. Almost never    2. Some of the time    3. About half of the time    4. Most of the time    5. Almost always

10. Currently, exam questions are posted by teams. Would you prefer to have questions posted by individuals?

1. Strongly prefer questions to be posted by teams
2. Somewhat prefer questions to be posted by teams
3. Undecided
4. Somewhat prefer questions to be posted by individuals
5. Strongly prefer questions to be posted by individuals

11. Currently, challenges are made by individuals. Would you prefer to have challenges made by teams?

1. Strongly prefer challenges to be made by individuals
2. Somewhat prefer challenges to be made by individuals
3. Undecided
4. Somewhat prefer challenges to be made by teams
5. Strongly prefer challenges to be made by teams

12. Currently, replies to challenges are made by teams. Would you prefer to have replies made by individuals?

1. Strongly prefer replies to be made by teams
2. Somewhat prefer replies to be made by teams
3. Undecided
4. Somewhat prefer replies to be made by individuals
5. Strongly prefer replies to be made by individuals

13. Currently, exam questions are identified with the team's name. Would you prefer to have questions posted anonymously (poster's team name not identified)?

1. Strongly prefer questions to be identified with poster's team name
2. Somewhat prefer questions to be identified with poster's team name
3. Undecided
4. Somewhat prefer questions to be posted without identification
5. Strongly prefer questions to be posted without identification

14. Currently, challenges are identified with the individual's name. Would you prefer to have challenges made anonymously (poster's name not identified)?

1. Strongly prefer questions to be identified with poster's name
2. Somewhat prefer questions to be identified with poster's name
3. Undecided

4. Somewhat prefer questions to be posted without identification
5. Strongly prefer questions to be posted without identification

### Open-Ended Questions

1. Please list in order the factors that were important in motivating you to challenge other peoples' exam questions. (Fill in at least the most important factor.)

- 1a. Most important
- 1b. Second most important
- 1c. Third most important
- 1d. Fourth most important

2. What did you like most about the way exam questions, challenges, and replies were used in this course?

3. What did you like least about the way exam questions, challenges, and replies were used in this course?

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