Learner Interaction and Self-Regulation in Web-Based Professional Development

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Abstract
Web-based courses are becoming increasingly popular as a means of providing professional development opportunities for technology educators. Some of the advantages of web-based courses include the ability for learners to learn at their own pace, to access information anytime and anywhere, and to communicate easily with instructors and peers. While web-based courses continue to gain acceptance as a viable alternative to traditional face-to-face professional development workshops, more research is needed to explain why some individuals perform better than others with regard to learning outcomes in online learning environments. The current body of literature suggests that learner interaction (i.e., learner-to-learner, learner-to-instructor, learner-to-content) is critical for successful learning outcomes in web-based courses. Researchers have also shown that self-regulation, a metacognitive process, is positively linked to learning outcomes in web-based courses. A gap in the research exists, however, that explains how individuals' self-regulation relates to learner interaction in online learning environments and how it contributes to successful individual learning outcomes. In this paper, we present the initial results of an ongoing study in which we examine the relationships among learner interaction, self-regulation and learning outcomes in an online teacher/faculty professional development program for technology educators. Participants in the study include 12 high school teachers and 11 community college faculty from five geographic regions across the US participating in Project Photon2, a National Science Foundation Advanced Technology Education (NSF-ATE) project aimed at increasing the number of educators across the US prepared to teach photonics technology.

Background
Currently 85% of all universities and colleges in the United States offer distance education courses, an increase from 62% in 1998[1]. According to the National Center for Education Statistics[2], enrollment in online instruction courses has more than doubled, from approximately 1,364,000 in 1998 to over 2,870,000 in 2001. One of the fastest growing forms of distance learning is online instruction. Online instruction makes education and training more accessible and more individualized, and provides more educational opportunities than traditional face-to-

face instruction[3]. Moreover, online instruction is well suited to meet the growing demand for life-long, outcome-based learning[4]. As a result, adult learners are looking increasingly to online instruction to fulfill the growing need for workplace knowledge and skills.

While online instruction continues to gain acceptance as an alternative mode for education and training, research regarding the nature of learning in an online environment and its effectiveness with regard to learning outcomes has not kept pace with increasing use, raising questions about its effectiveness and return on investment. One of the criticisms of online instruction[5] is that learners often feel isolated and unable to interact with others to construct knowledge. Interaction in online instruction is defined by Roblyer and Wiencke[6] as "a created environment in which both social and instructional messages are exchanged among the entities in the course, and in which messages are both carried and influenced by the activities and the technology resources being employed" (p. 81). Research consistently indicates that increased interaction in online courses is associated with higher achievement and student satisfaction[6, 7, 8]. The lack of interaction in online instruction, on the other hand, can cause learners to disengage from the learning process, resulting in decreased learning. Sabry and Baldwin[9] argue, however, that opportunities for learner interaction designed into a web-based course in a specific and pre-determined way can increase learners' knowledge.

Metacognition has also been linked to increased learner interaction[10, 11] as well as successful learning outcomes in online instruction[12, 13]. Metacognition consists of two constructs: metacognitive knowledge and self-regulation[14]. Metacognitive knowledge is defined as individuals' understanding of how they learn best and of what strategies to use in a given learning situation[14]. It involves both knowledge about and regulation of one's own cognition, including knowledge about one's strengths and weaknesses as a learner, learning strategies, and when and where to use different strategies. Metacognitive knowledge increases incrementally over time through practice by developing expertise within a specific domain, reflecting on experiences, and engaging in peer-regulated and autonomous learning experiences[14, 15]. Peer-regulated learning, the process by which metacognitive knowledge can be developed through learners interacting with other learners who are slightly more advanced than themselves, provides learners the opportunity to observe the proficient use of metacognitive skills and serves as a standard against which to model behaviors[14]. Providing learners with instruction that focuses on developing metacognitive knowledge will better prepare them to choose and regulate learning strategies that enhance interaction while engaged in the learning process.

Self-regulation, the degree to which individuals actively participate in their own learning process and utilize metacognitive, motivational, and behavioral strategies to orchestrate their learning is a critical element of learner success[10, 14, 15, 16,17]. Self-regulation is a continuous and integrated process utilizing reflection skills and metacognitive knowledge involving three interrelated processes (a) planning (i.e., setting goals, identifying task knowledge, and selecting and sequencing a series of strategies for achieving the goals), (b) monitoring (i.e., assessing chosen strategies, reflecting upon progress, and planning for strategies to utilize next), and (c) evaluating (i.e., examining the overall learning process, determining effectiveness in achieving learning goals, anticipating and overcoming obstacles, and determining effectiveness of the plan so it can be modified for similar tasks in the future).

The research, however, does not explain how metacognitive self-regulation enhances and supports learner interaction in an online instructional format in relation to individual learning outcomes. To better understand this relationship, the researchers in this study will address question: What is the nature of the relationship between learner interaction (i.e., learner-to-learner, learner-to-content, and learner-to-instructor), self-regulation, and learning outcomes in an online professional development course?

Research design

This study was conducted as an observational case study. Based on the literature[18, 19, 20], this approach was chosen to gain a deep description of what occurs within a selected online instruction environment and how interaction and self-regulation relate to learning outcomes of the participants involved in the course. For this study, the term "*online*" refers to the fact the course offers no face-to-face interaction among the instructors and participants and all course content and communication is delivered online. Prior to the web-based course, instructors, participants, and researchers met during a 2-day face-to-face workshop designed to introduce participants to the project goals and objectives, to facilitate participants' proficiencies using the WebCT online learning format, and to provide an introduction to the hands-on laboratory activities.

Participants and sampling

Participants were volunteers from a group of 20 high school and 2-year college science and technology teachers, the first of two cohorts, engaged in a 16-week online professional development course for college credit. The course, a product of a National Science Foundation (NSF) grant to the New England Board of Higher Education (NEBHE) aimed at increasing the number of educators prepared to teach photonics across the United States, was designed to support the participants' development of knowledge and skills in the field of photonics and their skills in designing curriculum for students. The Cohort 1 course was designed to serve as a pilot course for a subsequent course (Cohort 2) to be offered in the spring 2005 semester. The design of the web-based course, guided by adult learning principles[20, 21], engaged learners in active learning through collaborative efforts intended to enhance metacognitive skills and transfer of learning.

Data collection procedures

Five data sources were used in the study: demographic surveys, pre-post tests, threaded discussion text, reflective letters, and the Motivated Strategies for Learning Questionnaire[22] (MSLQ). Demographic surveys were administered during the introductory workshops. Pre- and post content knowledge assessments (60-item, multiple choice questions) were administered online at the beginning and end of the course. A three-member panel of experts was used to ensure content validity. Threaded discussion data, in which participants were required to contribute at least two postings per week on topics related to course content, hands-on activities, and curriculum development were collected throughout the 16-week course. Responses to three reflective letters (assigned in weeks 2, 9, and 15 of the course) were also collected in which participants were asked specific questions regarding their efforts in establishing learning goals, planning, monitoring, and evaluating their interactions, and setting objectives for the curriculum-building project were also collected. Lastly, the MSLQ was administered online during the second week and last week of the course to obtain pre-post measures of self-regulation.

Data analysis

Demographic data showed a total of 23 teachers started the course for Cohort I. Participant demographics for Cohort 1 are shown in Table1. Of the 23 who started the course, one withdrew for personal reasons and four changed to an audit status because of situational constraints. Of the remaining 18 participants, complete data sets were obtained for 15 participants for analysis.

Mean scores were obtained for the pre-post knowledge assessment using a 60-point total scale. Data were screened for outliers and normality with one outlier removed. Paired t-tests were conducted to measure the change in mean scores for pre- and post-test scores. The content of the threaded discussions were open coded to identify patterns and themes regarding interaction, self-regulation, and critical thinking[19]. Interaction was identified and categorized into Roblyer and Wiencke's[6] framework of types of interaction (i.e., learner-to-learner, learner-to-content, and learner-to-facilitator). Based on Bell, Kehrhahn, James, and Vincent's[24] review of the literature and research on critical thinking, threaded discussion were coded into six indicators: linking, reflecting, analyzing, building, offering, and engaging. Self-regulation skills were identified in terms of the learners discussing their own learning strategies and coded into the three constructs of self-regulation[15] (i.e. planning, monitoring, and evaluating). Frequency analysis was also conducted on threaded discussion data to quantify the number and type of interactions that occurred throughout the course (see Appendix A). Reflective letters were interpreted to provide descriptions of the role of metacognition and self-regulation in learner interaction. Emerging categories and themes were described with specific evidence from the data[25]. All data was analyzed for common and supporting themes and presented using thick descriptions that corroborate the theoretical framework and experiences of the participants[18]. MSLQ data (42 items) were scored using a 7–point Likert scale. Mean values were computed for total score and the self-regulation subscale (18 items). Data were screened for outliers and normality. Paired t-tests were conducted to measure the change in mean scores for total MSLQ score and self-regulation. Pearson-moment correlations were also conducted to identify significant relationships among pre- and post content assessment scores, self-regulation, and level of interaction.

Results

Pre-post assessment of content knowledge

Results of paired t-tests showed a statistically significant increase ($t = -7.02$, $p < .001$) in content knowledge as measured by the pre-post content knowledge assessment. Given that the majority of participants had little or no background in photonics technology, this result was encouraging, although not surprising. The course instructors reported similar results using the same course material, but in a traditional face-to-face classroom format. This result suggests that learning outcomes (as measured by a pre-post content knowledge assessment) in a web-based course in photonics technology are comparable to learning outcomes in traditional classroom instruction.

Threaded discussions

Learners interacted in the web-based course through a variety of threaded discussions (i.e., asynchronous written contributions of thoughts, ideas, and questions in response to specific topics: content, curriculum, hands-on activities, and administrative). In total, learners posted 681 messages over the 16-week period: 291 to content, 256 to curriculum, 110 to hands-on activities, and 24 to administrative. Interaction was broken down into five categories, learner-to-all, learner-to-learner, learner-to-instructor, instructor-to-individual learner, and instructor-to-all. The number of postings was divided into 4-week quarters to provide information on trends. Postings from learner-to-all decreased from 20 in the first quarter to 5 in the last quarter; postings from learner-to-learner increased each of the three semesters from 22, 26 to 32 respectfully, but decreased to 3 in the final quarter; postings from learner-to-instructor increased slightly in the first two quarters from 57 to 62, increased in the third quarter from 62 to 83 and decreased to 34 in the forth quarter; postings from instructor-to-individual learners increased from 56 in the first quarter to 72 in the second quarter, 95 in the third quarter, and then decreased in the final quarter to 9; postings from instructor-to all remained fairly consistent throughout the course. A graph of the results is presented in the Appendix (Figure A1).

Overall, participation in the course increased in of the first three quarters and dramatically decreased in the final quarter. These finding are consistent with Bell, Kehrhahn, James, and Vincent's[24] study of three online courses in which the researchers found similar increases in participation in the first three quarters of a web-based course and then a dramatic decrease in the fourth quarter. One possible reason for the decrease in participation in the Photon2 course could be attributed to the Thanksgiving and Christmas holiday season coupled with the end of the semester obligations of the participants to their students. While sometimes unavoidable in a fall/spring semester sequence, we recommend that in order too maintain more consistency in online interaction, web-based courses designed for professional development of teachers and faculty be scheduled to commence either before or after the normal semester breaks so participants are giving the time needed to fully engage in the course.

With regard to the topics of threaded discussions, the majority of postings were to the content section, although learners also tended to share their classroom experiences in this section. Among a sampling of 150 postings, we found the majority of statements were characteristic of learners sharing their classroom experiences; for example, "I use the Slinky demonstration in my classroom when demonstrating waves." Moreover, participants were more eager to respond directly to the instructor's technical questions, but did periodically offer suggestions to other participants for additional resources such as websites, applets, and laboratory experiments. While several attempts were made by the instructor throughout the semester to get participants to engage in more learner-to-learner discussions in an effort to facilitate collaborative learning as recommended by Collison[25] et al., participants were still somewhat reluctant to "step outside the box." One possible reason for the low level of learner-to-learner interaction could be the lack of social rapport among participants. Participants in the study were from five geographic regions across the US, and with the exception of those in their own immediate geographic region, most had never met face-to-face. In a study on the role of social comments in problem-solving groups in an online class, Molinari[26] found that social commentary embedded in the fabric of online dialog in the beginning of a course improved learner interaction as well as learning outcomes by creating a social foundation (i.e., a supportive environment) that supported learning. We also found some instances where small groups of two-to three individuals within a particular school district did meet face-to-face on a regular basis to perform course work, which may have had an impact on the level of learner-to-learner interaction. Overall, the implication for Cohort 2 as well as web-based instruction in general is that more attention should given at the beginning of the course to engaging participants in social dialog in an effort to break down social barriers that may limit their participation in subsequent discussions.

Critical thinking

Critical thinking is "a dynamic activity, in which critical perspectives on a problem develop through both individual analysis and social interaction[27]." In this study we found the level of critical thinking increased throughout the course. In the first month of the course, participants' postings showed low levels of critical thinking, for example, "The topic is well-covered. I have found the differentiation of waves and photons quite challenging but it is done very well in this textbook." Responses from other participants included statements such as, "I do agree that the topic for week 2 was well-covered." In an effort to increase levels of critical thinking, participants were given a guide containing six strategies for critical thinking (i.e., link, reflect, analyze, build, offer, and engage) to be applied before posting to an online discussion. Instructors also used probing questions in response to postings with low levels of critical thinking, for example, "Can you give some examples of what you would do in your own classroom and what resources would you use?" Participants' responses to these types of questions showed higher levels of critical thinking, as evidenced by statements that start with "I think, I do, I have, and I find." Indicators of critical thinking most utilized by the participants were reflecting, linking, building, and offering. Participants exhibited lower amounts analyzing and engaging in their postings. Based on these findings, we recommend that instructors of web-based courses introduce critical thinking indicators to participants in the beginning of the course and provide an opportunity to discuss how to implement critical thinking into postings. Instructors should model high levels of critical thinking in their postings, ask questions that require participants to post critical responses, and encourage interaction between participants in a way that provides opportunities to question, test assumptions and develop new ideas.

Self-regulation

Results of paired t-tests performed on the MSLQ self-regulation scale data showed a statistically significant increase ($t = -7.8$, $p < .001$) in learner self-regulation. These data were corroborated by analysis of both threaded discussions and reflective letters, which showed as the semester progressed, learners were more reflective in their postings, as indicated by the increased level of critical thinking, and through comments such as, "I remember trying that in my class once and I didn't work very well. Maybe next semester I'll try modifying the experiment by changing…" Interestingly, while the level of learner-to-learner interaction was less than expected, many of the participants were very active in engaging the website content (i.e., learner-to-content interaction), some accessing the course website over 1000 times during the semester. This finding, however, did not produce any significant results when correlated with pre-post content knowledge or self-regulation data. It is possible that even though the level of interaction between peers was low, the increase in critical thinking as a result of using the critical thinking template coupled with the use of reflective letters designed to help to learners plan, monitor, and evaluate their learning may have contributed to the increase in self-regulation skills. While this conclusion is speculative and merits further investigation, the results suggest that the development of self-regulation skills may be more a function of the reflective activities required for critical thinking in postings and in the preparation of reflective letters than in the level of learner interaction.

Conclusion

In this paper, we presented the initial results of an ongoing study in which we examine the relationship between learner interaction, self-regulation and learning outcomes in an online teacher/faculty professional development program for technology educators. Results showed statistically significant increases in pre-post content knowledge assessment and in learner self-regulation. Increases were also reported for levels of critical thinking, likely the result of applying specific instructional strategies. While the results did show a slight sequential increase in the level of learner interaction over the first three quarters of the semester, no significant relationship was identified between learner interaction and self-regulation, or between learner interaction and learning outcomes. The researchers conclude that while more research is needed, preliminary results suggest that web-based instruction that includes reflective activities that encourage critical thinking and reflective letters designed to help learners plan, monitor, and evaluate their learning can improve learner self-regulation. To increase learner interaction, the researchers recommend engaging participants in social dialog at the beginning of an online course in an effort to break down social barriers that may limit their participation in subsequent discussions.

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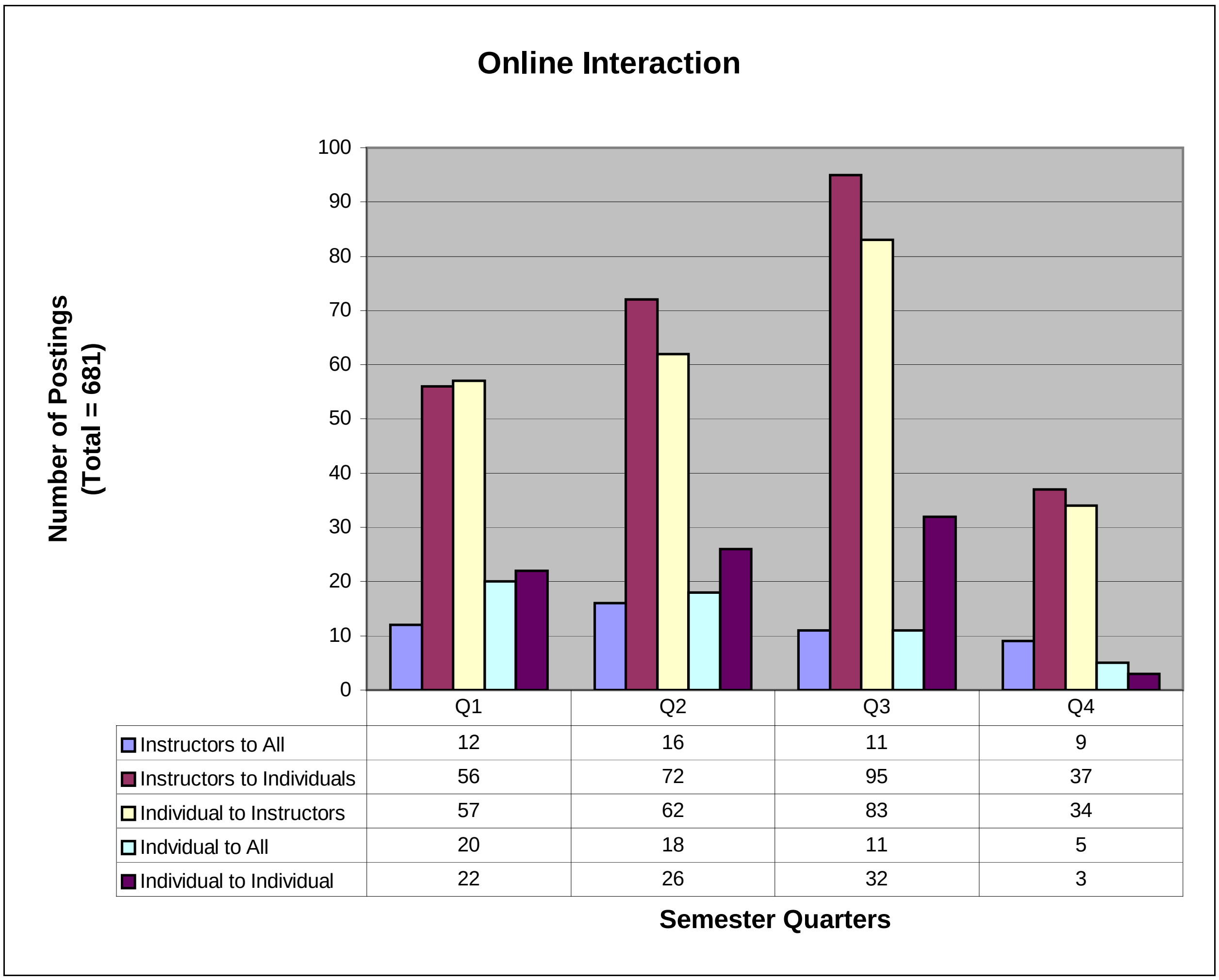
Appendix A1

Table A1 – Demographic Breakdown for Cohort 1 Teachers/Faculty

Demographic (N = 23)	n	Percentage (%)
Number of High School Teachers	12	53
Number of Community College Faculty	11	47
Female	6	26
Male	17	74
Highest Educational Level		
BS Degree	13	57
MS Degree	5	21.5
PhD	5	21.5
Never taken a web-based course	9	39
Average number of years teaching	9.6	-



	Q1	Q2	Q3	Q4
Instructors to All	12	16	11	9
Instructors to Individuals	56	72	95	37
Individual to Instructors	57	62	83	34
Indvidual to All	20	18	11	5
Individual to Individual	22	26	32	3

Figure A1 – Online Interaction Chart