A Multi-Level Analysis of Engagement and Achievement: Badges and Wikifolios in an Online Course

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Abstract: Multiple levels of data from an asynchronous online course were analyzed to explore student engagement and achievement around a particular course concept. This study examined how productive disciplinary engagement around "wikifolios" via threaded commenting on those wikifolios fostered learning that transferred to performance on external achievement measures not directly targeted in the course. The findings show that a new course feature, peer awarded badges, were effective markers of productive disciplinary engagement, and impressive achievement gains were accomplished without resorting to dreary expository instruction that typifies the majority of online learning. Implications for the design of productive online learning and further areas for research are discussed.

This paper describes a multi-level analysis of learning outcomes using data from one cycle of ongoing design based research of a fully online graduate-level education course. This course and the underlying design principles foster diverse learning outcomes by aligning activity across three increasingly formal levels: (1) *productive disciplinary engagement* (PDE; Engle & Conant, 2002) in drafting and discussing weekly *wikifolios*, (2) enduring individual understanding of targeted course concepts in those wikifolios, and (3) aggregated achievement on multiple-choice items drawn from the publisher's item pool for the textbook.

Asynchronous online learning is unique in that it allows instructors and students time to process exchanges and formulate meaningful posts, allowing for thoughtful responses and deep processing of concepts (Swan, 2002). The existence of online artifacts and persistent threads of discourse around those artifacts creates an opportunity for rich analysis of the trends in computer mediated discourse (Rovai, 2002). A previous analysis of a prior iteration of the course examined individual understanding and aggregated achievement (Hickey & Rehak, 2013). This present analysis traces the learning of a particular course concept, teaching & learning mathematics, across all three levels (PDE, enduring understanding, and aggregated achievement). The following questions were addressed: (1) to what extent did students engage with this concept? (2) Did a new course feature (peer awarded badges) accurately flag PDE? (3) Did student engagement foster enduring understanding of teaching & learning mathematics? (4) Did this course design positively impact aggregated achievement on measures that were independent of the way the content was taught?

Research Context

Since wikis were invented in 1995, they have transformed the way we catalog, construct, share, and refine information. However, the potential uses of wikis in education have been somewhat overshadowed by debates surrounding the accuracy of information found on collaborative encyclopedias (e.g. Crovitz & Smoot, 2009). This course uses wikis as a type of alternative to e-portfolios; thus, they are called "wikifolios" (Hickey & Soylu, 2012). However, both the wikis and the threaded comments in which students discussed the course concepts are remarkably simple. This made the wikifolios ideal for everyday class use and allowed the students and course refinements to focus deeply and directly on engagement and learning.

Much research in Computer Supported Collaborative Learning (CSCL) focuses on analysis of individual and shared knowledge building using some type of collaborative communication technology (e.g. Cress & Kimmerle, 2008; Greenhow & Belbas, 2007; Moss & Beatty, 2006). It has been argued that the differences in theoretical and methodological perspectives in this body of research can be reconciled by careful positioning of results (Clara & Mauri, 2010). In an effort to explicate the positioning of this particular study, it is necessary to delve into the constituent context of the environment, regarding context not as a variable external to the course but, as Cole (1996) discusses, *context as that which intertwines*.

Instead of going beyond the individual actions and mind (as suggested by Arnsenth & Ludvigsen, 2006), this analytical approach employs a situative theory of learning (Greeno et al., 1998) that examines the aggregated engagement of the class and how the affordances of the context are taken up by the students. Overall performance on distal achievement items (assessment items that are not directly aligned to the curriculum activities) is used to make arguments regarding validity of the course design in the seemingly inevitable broader context of increased accountability.

In light of the surging expectations for educational accountability, assessment and evaluation of e-learning has taken on new significance (Harmon & Lambrinos, 2008). In response, instructors, schools, and researchers are exploring various strategies to ensure security of online tests and document the validity of scores (Jung & Yeom, 2009; Rowe, 2004). A melding of these concerns with situative approaches to assessment and

learning, along with design based research methodology, has resulted in a set of core design principles that are currently called *Participatory Assessment* (Hickey & Rehak, 2013).

The data for this study comes from the online archive of an asynchronous graduate course, *Learning & Cognition in Education*. In this particular semester fourteen School of Education students were enrolled. The instructor had been teaching the course in its current format since the fall of 2008, making use of a Sakai course management platform, OnCourse. OnCourse has a wiki feature that allowed the students to post their weekly wikifolios locally. Each student had her own wikifolio where all of her artifacts were displayed and discussed. Reflecting one of the core design principles and Engle & Conant's (2001) suggestions for problematizing disciplinary content, every wikifolio had students articulate the three *most relevant* and one *least relevant implications for education* found at the end of each chapter of a disciplinary text, as they related to each student's self-defined instructional goal and setting. In the last five weeks of the course, subgroups of students created collaborative group wikifolios around the chapters on literacy, comprehension, writing, mathematics, and science. Reflecting another core design principle, the wikifolios and student comments were never directly graded. Instead, students only needed to post three coherent reflections on their engagement and collaboration to receive full points for the wiki posting, which made up the majority of their course grade. The grading mechanisms for the course have been explored in a prior paper (Hickey & Rehak, 2013) and are beyond the scope of the current analysis.

Design-based refinements had been made across four prior semesters. Many of these refinements focused on increasing the amount and meaningfulness of interactive engagement via threaded comments posted directly on individual wikifolios. One new feature, peer awarded "badges," were integrated into students' weekly assignments. Quite simply, badges were comments that included the distinctive string "$$$" to highlight a classmate's particularly productive contribution. Figure 1 shows a typical badge in context.

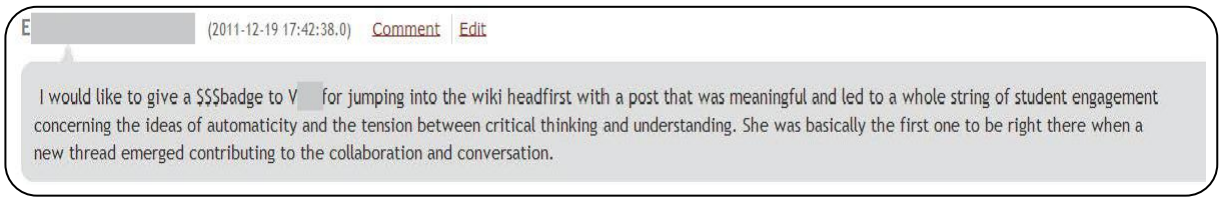

Figure 1. Typical Peer Awarded Badge

Synergy between the design of this feature and the design of the research were obtained by framing both using Engle and Conant's (2002) notion of PDE. More specifically, the assignment prompt included an explanation of the types of engagement that were productive and disciplinary, and students were asked to award badges to contributions that exemplified PDE. It was articulated that a valid badge needed to explain why the engagement was productive and disciplinary. As described below, the content of the badges and interactive context was then analyzed to determine the extent to which the feature actually represented PDE.

Resulting Engagement

Overall student engagement in the course was high. The ten individual weekly wikifolio posts averaged 1,569 words with an average of 120 comments per week, or 9 comments per individual wikifolio. The comments were an average length of 95 words per comments. Of these comments, just 16% were standalone comments that were not part of a threaded discussion. The five collaborative group wikifolios averaged 3,473 words, with an average of 40 comments that were a length of 92 words, and just 8% of comments were non-threaded. The mathematics group wikifolio was collaboratively composed by three students; it was the longest group wikifolio at 4,630 words and had 50 comments.

Out of the 50 comments on the mathematics group wikifolio, 8 of the comments were peer-awarded badges. Both the badge awarder's rationale for awarding and the context that resulted in a badge were a priori coded using the construct of PDE. Rationale and context were considered to represent PDE if they were both disciplinary (concerning the field of teaching and learning) and productive (intelligently moved the conversation forward). Two coders had 100 percent agreement that 2 of the 8 badges did not sufficiently warrant how the engagement, to which they were awarding a badge, was productive or disciplinary. Figure 1 (above) shows one of the two badges that lacked PDE in the awarding rationale. Encouragingly, all 8 of the badged interactions were determined (with 100 percent agreement) to be both productive and disciplinary. While the awarder of the badge may have failed to continue the disciplinary conversation, all badges did recognize engagement that was both disciplinary and productive.

Content Analysis

Ongoing qualitative content analysis based on the concept of community "uptake acts" (Suthers, 2006) of course ideas (referred to as text) is revealing how this online context fosters discourse that should leave behind

enduring individual understanding of course concepts and aggregated achievement that should convince skeptics of the value of this approach. Examining uptake reveals how the learners take up the abstract course concepts within the context of teaching & learning mathematics and other related domains. Table 1 displays the analysis of an illustrative thread that was typical of the exchanges in the mathematics group wikifolio.

Table 1. Content analysis of a thread. (emphasis added)

Student (timestamp)	Content of post	Analysis
Mariah (2011-12-02 17:09:42.0)	I really appreciated your relevant debate. **In reading this chapter, I kept thinking, "I wish I had been taught like this!"** I enjoyed solving equations because they're so black-and-white - and I excelled at them - but I've never learned how to use them beyond the classroom, even in my college level honors calculus course. **While practicing skills gives students a solid foundation, without some connection to real life, the skills are meaningless. I really wish I had been taught why these skills were important**. I feel like I'd be a lot smarter if that had been the case. I think your tenth and fifteenth relevant specifics tie into this debate for me.	Uptake of text by comparison to personal experience Uptake of text by comparison to personal experience
Eric (2011-12-02 18:32:10.0) -in response to Mariah	I think that the "why" component of teaching is the most power, one for the reason you mention about connections to real life. **Two, because we can't always remember the exact formulas for everything we've ever learned, but if we understand why things are the way they are, then we can reconstruct those "formulas" or "algorithms"** for ourselves in the real world to a close enough approximation to get by with whatever task we are trying to accomplish. To relate this to the learning goal: we might not remember every single rule that governs a median average, but if we understand the basic idea and the "why" of a median average, we are going to figure out a number that is close enough to the median average to satisfy the need we have in the real world.	Uptake of text by connecting current context to a previous chapter of the text
Courtney (2011-12-03 21:51:13.0) -in response to Eric	I think it also has a lot to do with students just really being curious as to how to store the information. When we are teaching them about money, they know they are going to how to use it in every day situations even to buy a pop. But when we are teaching them about these central measures of tendency they are most likely giving you that deer in the headlights look and trying not to fall asleep**. If you find something for them to tie it to they are not only going to grasp on more but already remember it better.**	Uptake of text by connecting peers' comments on the concept

This analysis suggests that all three of these students made meaning of the abstract concepts from the text by discussing them in a knowledgeable manner and built on the ideas their peers were expressing.

Another advantage of this new feature that was not explored concerned the badges' value for helping the instructor prioritize which of the numerous comments and exchanges to focus on. Specifically, once wikifolio drafts and comments were posted, the instructor would search for the distinctive string and begin contributing comments around the badged interactions.

Resulting Understanding and Achievement

Impact on individual understanding was assessed with timed (5 minutes/item) open-ended items that asked students to consider the relevance of the various chapter implications as they related to the design of the actual course. The majority of the students received full points on the majority of the items. Impact on aggregated achievement was measured using time limited tests (60 seconds/item) consisting of selected-response items randomly chosen from the subset of items in the textbook item bank whose answers could not be readily located in the textbook. The pretest was required but ungraded, and consisted of 25 items. The midterm and final consisted of 20 and 30 items that combined covered the same concepts as the pretest; these exams were graded but comprised only a small percentage of the overall course grade. A one-way ANOVA showed student engagement led to significant gains in the posttest analysis. The increase in average percentage correct on the midterm (83.82%, SD = .1189) and final (80.24%, SD = .1073) compared to the pre-test (66.23%, SD = .1189) were both statistically significant [$F(1, 26) = 10.03$, $p = .004$, and $F(1, 26) = 10.70$, $p = .003$] with respective effect sizes of $d = 1.036$ and $d = 1.060$.

Of specific interest is the gain on the item concerning a very specific mathematics concept. The question was, "CHANGE-ADD-TO and EQUALIZE are examples of?" On the pretest, only 14% of students correctly answered the question, while on the final 100% of students correctly answered the question. This

change is striking in that the students were never informed of their score or the correct answers to the pretest questions. Also this concept was never directly discussed in the group wikifolio or any of the comments on the wikifolio. Rather, it suggests that the students' personally relevant contexts did indeed provide students a means to engage with the text in meaningful ways. Additional analyses currently underway are examining other examples of this link between PDE and aggregated achievement.

Conclusions

Overall student engagement in the course and in the mathematics group wikifolio was high, and most comments were substantive in that the content of the comments built on the concepts of the text and ideas of peers. The new course feature, peer-awarded badges, appeared to recognize PDE. Because recognizing desired forms of engagement is usually necessary for promoting it, this seems like a useful direction for this research. This study compelled the addition of a new design principle to the set of core design principles employed. This new design principle necessitates exploration in future iterations of the course. A comparative study using content analysis to explore the differences in commenting with and without badges could help determine whether the badges encourage PDE or if they are simply good markers of PDE. Aggregated student achievement was satisfactory, suggesting that this course design fosters more than student engagement, but also a useful learning experience.

As online learning continues to grow more innovation and research is needed to ensure students are indeed learning in these courses. These results suggest that avoiding the discussion of concepts in the abstract and allowing students to choose their own personally meaningful context for engaging with the text can lead to efficient online interactions, despite the many barriers of online learning. Peer-awarded badges in this course were much more than "gold stars" and may offer a means of fostering meaningful engagement with typically abstract course concepts.

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