New Environments and Assessments for Knowledge Building: Large Size Pharmacy Classrooms

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Abstract

This study investigates the potential for Knowledge Building in large size Pharmacy classrooms. Knowledge Building is the social creation and continual improvement of ideas (Scardamalia & Bereiter, 2003). The pedagogy and technology that underlie it are based on a complex system involving 12 interdependent principles. This research examines principle-based classroom designs, targeting two Knowledge Building principles--epistemic agency and collective responsibility for community knowledge. Successive design changes were implemented to a self-care course for undergraduate Pharmacy students (n = 183), using case study methodology.

The goal underlying design changes was to develop a more dynamic classroom environment involving all students and empowering them to take charge of knowledge advancement at high cognitive levels, through assuming greater agency and collective responsibility for their knowledge advances. Design features that were incorporated into class procedures included class panels to discuss cases, student-generated self-assessment examination questions, and online discussion views in a virtual learning community, Knowledge Forum.

Surveys, student comments, self-assessments, field notes, online discourse and course exam scores were used to determine effects of principle-based design changes. Results, taken as a whole, indicate that each new design feature contributed to advances with no negative effects uncovered. Raters blind to authorship of student- versus instructor-generated exam questions could not distinguish between them. Analysis of

student commentary indicated advances in line with the broad network of Knowledge Building principles, as well as those specifically targeted in design improvements. Advances in performance on exams, surveys, and in student discourse further contributed to the overall picture of positive effects.

Design strategies appropriate for large classroom implementation are shown to facilitate a shift from learning as an exclusively individual enterprise, to the creation of a Knowledge Building Community with students assuming levels of responsibility and agency normally assumed by the teacher.

Introduction

According to Scardamalia and Bereiter, Knowledge Building is the social creation and improvement of ideas and can be differentiated from learning, an individual internal process altering beliefs or skills. Knowledge Building has been explored in many and varied contexts. (Scardamalia, 2000). However, little information is available about outcomes in large size healthcare or other classrooms, in which physical, administrative, curriculum, and other social-interaction constraints are fine tuned to support a learning rather than knowledge building environment. While literature suggests the possibility of collective responsibility for knowledge advancement (Scardamalia, 2002) successes report interventions in contexts where those implementing the change form their own Knowledge Building community (Bereiter & Scardamalia, 2003; Bielaczyc & Collins, 2005). The challenge is to make such advances in a context defined by time-limited, predetermined tasks and with controlled curriculum.

This research examines undergraduate pharmacy students in a large size classroom to study if classroom design interventions shift learning as individuals to building knowledge as a community, with students assuming significant levels of responsibility for advancing knowledge and skills. It reports attempts to

implement changes in this context, using quantitative and qualitative data, including participants' perceptions and classroom interventions and social supports that promote Knowledge Building practices.

Literature Review:

A. Large Size Classrooms

The inquiry into the effects of class size on learning began in the 1920's, interest increasing over the last two decades with most reports at the early elementary level, less at secondary levels and still fewer in higher education (Galton, 19981). Results of the impact are mixed and controversial. A review of 152 studies analyzing performance and reduced class size, reported no impact of reduced class size (82%), with 9.2% positive and 8.6% negative impact (Ornstein, 1995). For factual recall, class size does not seem to affect learning (Wößmann, Propper & Duflo, 2005). Differences arise when higher order functions such as ability to synthesize material are assessed. Then teaching is viewed as less effective with students learning less well in a large class format (Weimer, 1987). Problems associated with large class formats seem to be most prevalent in five areas. There are the physical problems of working with material and problems related to classroom management (attendance, communication, socialization, balance of power) and evaluation (diversity in abilities, cultures, educational backgrounds). More structure and predefined work arrangements are required, thus limiting the extent to which participants can engage in emergent goal setting and processes. There are also difficulties associated with a large assembly, making it difficult for students to take risks with the generation of ideas and continually improve them through interaction. The result is reduced student involvement in larger settings, decreased motivation to assume responsibility for learning, and impersonal learning climates (Gedalof, 2006; Goranson, 1976). A major problem is the lack of detailed studies of classroom processes that might mediate class size effects on pupils' learning (Blatchford, and Mortimore, 1994). Large classes represent complex interacting learning environments.

Articulation of classroom conditions which show improved outcomes is needed to examine educational and socio-cultural factors required to achieve individual and collective responsibility for knowledge advancement.

B. Epistemic Agency and Collective Responsibility for Knowledge Advancement

Autonomy and self-regulatory opportunities are important in engaging large class students in deeper approaches to higher level cognitive processes. How can reports regarding successful outcomes or limitations of educational approaches be interpreted in the context of medical education?

Health care professionals must be in control of their own knowledge advancement. A critical component is epistemic agency, identified by Scardamalia (2002), which empowers the learner to take charge of executive processes normally controlled by the teachers, such as setting goals, planning, motivation and evaluation of understanding (Brett, 2002). Learners demonstrate this principle by introducing their own beliefs, and negotiating how they fit with those of others in advancing knowledge, through cycles of revising internal and external ideas to a resolution. Epistemic agency may enable participants to acquire knowledge and skill in a subject area in which they did not feel comfortable or experienced.

This concept is more than being accountable for personal goals or taking responsibility for helping classmates' learning (Scardamalia & Bereitier, 2007), but taking responsibility for the state of public knowledge in a group (Scardamalia, 2002), and as such, has a significant social as well as cognitive component.

Epistemic agency entails collaborative work aimed at achieving a collective advance in understanding, through mutual support but also constructive criticism and sustained effort at idea improvement, with respect to the state of knowledge and available knowledge-building resources beyond the local group (Scardamalia & Bereitier, 2007).

Formats for self-directed discussion and self testing components can be examined for epistemic agency, also embracing the principle of “collective responsibility, community knowledge”, integral to procedures. Related concepts include self explanation and self regulation.

Health care professionals must be in control of their own knowledge advancement. The importance of self-regulatory process is drawn from several theoretical frameworks, including Knowles’ model of the adult learner (Knowles, 1984), Bereiter and Scardamalia’s model of the expert practitioner (Bereiter & Scardamalia,1993), and Ericsson’s model of expertise (Ericsson, 2004). Effective individual self-regulation depends on both the practitioner's ability to self-assess gaps in competence and also the willingness to seek out opportunities to redress these gaps when identified.

The diagnosis of one’s own learning needs is the first step in the process of self-regulation (Ward, Gruppen & Regehr, 2002). Literature reviews summarizing professionals’ ability to self-assess are both mixed and concerning. Falcikov and Boud’s meta-analysis of forty-four quantitative self-assessment studies in varied areas in higher education (Falcikov and Boud, 1989) including medicine suggested on average, self-assessors were poor to moderate judges of their own performance (correlations 0.05 to 0.82, mean 0.39). Eighteen self-assessment studies in the health professions (Gordon, 1991) also reported poor correlations (0.02 to 0.65), with six studies of global self-assessment over extended time periods had even weaker results (highest correlation 0.32).

The Handfield - Jones et al (Handfield-Jones, 2002) model self-regulation processes involves persistent monitoring and retrospective reflection: assessment of performance; identification of limitations; decision to seek improvement opportunities; pursuing measures to address deficiencies; integration of new or relearning skills into practice; re-assessment of performance; continual reiteration. Regehr and Eva (Regehr & Eva, 2006) suggest two inherent flaws in this process: self-assessment alone is not an effective mechanism to identify areas of personal weakness and even when areas of weakness are perceived,

learning in these areas is avoided because of required energy and commitment, particularly in those who are most in need.

Kruger and Dunning (Kruger and Dunning, 1999) demonstrated that subjects in the highest quartile of scores underestimated their abilities but recalibrated following exposure to the performance of others; middle quartile performers were generally accurate in assessment of their own skills and remained so after exposure to peers; those in the lowest quartile greatly overestimated their abilities and failed almost entirely to correct self-assessment following exposure to others, concluding those who know less, also know less about what they know. This pattern raises an important question for medical educators concerned with self-evaluation, how to help learners who do not perceive their incompetence and intrinsically overestimate their abilities.

Research Design

The study design focused on the advancement of the two principles, epistemic agency and collective responsibility - community knowledge which empower students to take charge at high levels of the educational process, as a community process. Other principles, which operate as a complex system were integrated into each design feature. The designs conformed to and were conducted within context limitations.

Participants

In September, 2005, 183 undergraduate students, 0T7 class, began the 13 week PHM 320F course. This session iteration built on the preliminary design affordances offered in their pre-requisite 2nd year course (pilot). In March 2006, they completed their exit oral skills clinical examination (OSCE). The Student

Education Ethics Review Committee at OISE/UT gave approval to analyze data generated during the course. Assignments, outcome measurements and survey assessments were part of routine course completion requirements. Participants, including students, guest lecturers and observer/raters gave formal, signed consent to data review based upon a reviewed protocol.

Conceptual Framework and Goals:

Curriculum structure was pre-determined, content was fixed, and classes facilitated by an expert practitioner. To provide an environment conducive to the development of epistemic agency and collective responsibility, the accountability for creating knowledge had to be shifted from the 'experts' to the student community; so students would progress and interact as individuals and as a community united in the pursuit of commonly held educational goals.

Design:

To engage students in elements of the course that could be altered while working within all curricular guidelines, the design centered on classroom panels as a key feature, and two other components, student-generated self-assessment exam questions and online discussion views to facilitate Knowledge Building, through the affordances of Knowledge Forum™. The hope was to counter some of the constraints of large class size which present management issues of attendance, communication, socialization, balance of power and evaluation. All design changes were reviewed by representatives of elected outgoing and incoming class councils, who suggested alterations. A unanimous class vote approved the new blueprint. Elements emphasized student voice in all design features.

Classroom Panels

The large-lecture context offered students little motivation to attend classes (full lecture notes were posted online). Classroom panels were tested as a design to create a more dynamic environment involving all students in discussion and collaborative building of new ideas. There were 15 panel sessions. A subset of students (25% at any one time, with all students having two turns) was randomly selected to serve on the panel, with the remainder of the students in a support role. Panelists directed their own learning by identifying a patient therapy problem related to course material. They elaborated relevant knowledge, presented this, and engaged others in discourse to address the problem. Students in the audience helped, contributing voluntarily or when a panelist requested help. Increased attendance and involvement was encouraged by the random nature of panel selection, and by the self-efficacy achieved through forming their own agenda.

Student-Generated Self-Assessment Exam Questions

Assessment was linked to learning and the panels through a system of pre and post panel self and peer assessment. Before each panel a subset of students created and contributed examination questions to the instructor (researcher). Their questions involved a hypothetical yet realistic patient problem, offering solutions as multiple-choice options.

Student Discourse in an Online Knowledge Building Environment (Knowledge Forum™)

Students created a view to discuss the self-assessment exam questions in Knowledge Forum™, plus three additional views. Two of these were related to their classroom panel work (they discussed their issues for the panel, in advance of serving on the panel, and then reflected on those issues after the panel was over).

They also created a view that they used for preparation for their Objective Structured Clinical Exam (oral) which occurs two months after course completion.

Data Collection and Analysis

Data was collected and examined for demonstration of the theoretical principles of epistemic agency and collective responsibility, community knowledge, through the following assessments and analyses of change in student performance associated with implementation of new design features. Table 1 summarizes the data collection, listing design features, and the tools and measures used for a triangulated data analysis.

Table 1

Design Features, Data Analyses and Data Sources

DESIGN FEATURE	DATA ANALYSES	DATA SOURCES
Classroom Panels	Sample of panel discourse	Narrative account; qualitative analysis of excerpted field notes
	Observer ratings of student engagement in panels	• Independent sample *t*-tests comparing student to faculty observer (TA) ratings • Descriptive comparison of sample researcher vs. TA ratings
	Student ratings of their own engagement in Knowledge Building	
	Student ratings of their own engagement in content and Knowledge Building processes: panel vs 3 tasks designs	Survey One (online): Quantitative Ratings for: - epistemic agency - combined curricular goals • Mean Likert scores • Repeated-measures ANOVA (means for each design feature compared: GG correction for significance) • Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance) Qualitative Analysis of student commentary themes- epistemic agency, collective responsibility
Student-Generated Self-Assessment Exam Questions	Samples of student questions and their reflections on those questions, recorded in Knowledge Forum.	Narrative account; qualitative analysis
	Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions	• T-test of pre vs. post scores – Solo Taxonomy (1-5) • Inter-rater reliability – Pearson correlation coefficient
	Comparison of Student vs Instructor Generated Questions	Survey Instrument • Estimation of Student vs. Instructor author - Friedman test (authorship vs. percentage correct) • - Wilcoxon paired test (percentage correct for student items vs all others)
Student Evaluation of Designs to Evaluate Knowledge Building Activity	Student survey results will be used to evaluate all study design features from the students' perspective including classroom panels, student generated self-assessment exam questions and discourse in an online Knowledge Building environment (Knowledge Forum™)	Survey Two (online) Ratings for : - epistemic agency - collective responsibility - 12 principles combined • Mean Likert scores • Repeated-measures ANOVA (means for each design feature compared: GG

		correction for significance) • Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance) - Repeated-measures ANOVA (means for each design feature compared) - Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance) Analysis of student commentary themes - qualitative analysis of epistemic agency, collective responsibility

Results

Quantitative and qualitative results for the design features of the case study showed change across the various dimensions measured. In the analysis of design features for impact on Knowledge Building theory pedagogy and technology, advances were reported in both design methodology and implementing Knowledge Building principles. The preferred design features were the classroom panels and student-generated self-testing questions, complemented by online student discourse. Together, they enabled development of an epistemic character in student engagement and increasing levels of community responsibility.

Overview of Results for Classroom Panels

A. Qualitative samples of field notes demonstrated the two principles.

B. Student vs. Pharmacist Observer (TA) Ratings: For epistemic agency, there were no significant difference for independent samples t-test ratings of students vs pharmacist observers (TAs) [4.18 vs.4.00 Sig. (2-tailed) = 0.294]. Pharmacist observers (TAs) & students perceived to the same degree high level demonstration of epistemic agency in the panel. For collective responsibility, community knowledge: there was significant difference for independent samples t-test ratings of students vs. pharmacist observers [4.58 vs. 3.36 Sig. (2-tailed) = 0.000] Students felt a sense of community responsibility more strongly than perceived by pharmacist observers (TAs).

C. Survey Findings: Student Ratings Comparing Panel Design to 3 tasks

For epistemic agency, a repeated-measures ANOVA was performed, and found to be highly significant ($F(2.39, 409.26) = 126.64$, $p < .001$) for means of 4.68/5 (panel) vs. 4.09/5; 3.94/5; 3.23/5 (3 tasks). The Greenhouse-Geisser adjusted significance correction was used (assumption of compound symmetry was not met). Pair-wise comparisons (Sidak method) show every feature significantly different than the others at the .05 level; lowest to highest mean difference ratings were 0.593 (4.68 vs. 4.09 – peer task); 0.744 (4.68 vs. 3.94 – assessment task); and 1.453 (4.68 vs. 3.23 – online task).

For combined principles, repeated-measures ANOVA was performed, and found to be highly significant ($F(2.19, 374.35)=301.36$, $p<.001$) for means of 4.24 (panel) vs 4.05; 3.87; 3.06 (3 tasks). The Greenhouse-Geisser adjusted significance correction was used (assumption of compound symmetry was not met). Pair-wise comparisons (Sidak method) showed every feature to be significantly different than the others at the .001 level, and lowest to highest mean difference ratings were 0.187 (4.24 vs. 4.05 – peer task); 0.366 (4.24 vs. 3.87 – assessment task); and 1.173(4.24 vs. 3.06 – online task).

Student comments included 69 samples pointing to epistemic agency and 46 samples demonstrating collective responsibility.

Overview of Results for Student-Generated Self-Assessment Exam Questions

A. Qualitative samples of KF notes demonstrated the two principles.

B. Pre vs. Post Panel Submissions

Percent of answers changed was 57.3%, with significant change on average (scale 1-5) from 3.14 pre to 4.34 post (paired samples t-test; sig. (2-tailed) = .000). Students who changed did not score higher at pre: 3.09 (pre not changed) vs. 3.14 (pre which were changed); sig. (2-tailed) = .0728.

C. Student vs. Instructor Questions

Raters were not able to differentiate the authorship of student vs. instructor created test questions (students 32.14; new grad 39.68; PharmD 28.57; faculty 27.89). The Friedman test for % correctly identified showed results were independent of authorship. The Wilcoxon paired test for % correct vs. all others was Z = -0.44, (non significant). Students achieved quality levels of assessment individually or by community efforts of the same caliber as teacher controlled evaluation.

Overview of Findings: Student Evaluation of all Designs for Knowledge Building Principles

A. Survey Findings: Student Ratings Comparing 5 KB Designs

For epistemic agency, a repeated-measures ANOVA reported highest means for classroom panels (4.08/5); and self-assessment exam questions (4.08/5), vs. pre-panel (3.20/5); post-panel (3.53/5) and OSCE (3.84/5) KF views and were significantly different ($F(3.53,627.49)=43.43$, $p < .001$, partial $\eta^2=.20$). The Greenhouse-Geisser correction was used to assess significance (assumption of compound symmetry was not met).

For community knowledge, collective responsibility, repeated-measures ANOVA reported highest means for classroom panels (4.23/5); and self-assessment exam questions (3.85/5) vs. pre-panel (3.20/5); post-panel (3.51/); and OSCE (3.68/5) KF views. Differences in responses among the 5 features were highly significant, again using the Greenhouse-Geisser correction ($F(3.47,611.50)=43.00$, $p < .001$, partial $\eta^2=.20$).

For all twelve Knowledge Building principles combined as a whole, repeated-measures ANOVA reported highest means for the classroom panels, (4.24/5) and for student-generated self-assessment exam questions (3.81/5) vs. pre-panel (3.12/5); post-panel (3.50/5); and OSCE (3.68/5) KF views. Results were very significant, again with the Greenhouse-Geisser correction ($F(3.21,565.45)=121.34$, $p < .001$, partial $\eta^2=.41$).

Student comments included 68 samples pointing to epistemic agency and 112 samples demonstrating collective responsibility.

Table 2

Advances in Design Methodology and Implementing Knowledge Building Principles

DESIGN FEATURE	ADVANCES IN DESIGN METHODOLOGY	ADVANCES IN IMPLEMENTING KB PRINCIPLES
Classroom Panels	• The class panel design was judged to be a unique and useful activity as measured through student survey (survey one) quantitative and qualitative analyses. Students felt the panel had merit in contributing to and changing their approach to learning.	• Pharmacist observers (TAs) and students perceived to the same degree that there was demonstration of epistemic agency in the panel, measured in t-tests comparing student to faculty observer (TA) ratings. While both faculty observers (TAs) and students indicated that the panels showed collective responsibility for community knowledge, students felt a sense of community responsibility more strongly. • Student ratings showed preference for the panel vs 3 tasks formats for enabling epistemic agency. Their preference was evident in significantly higher survey ratings (mean Likert scores), using repeated measures ANOVA and pair-wise comparisons of the four designs (panel vs. 3 tasks). • Epistemic agency and collective responsibility, community knowledge were felt by students to be advanced through the classroom panel design, as indicated through qualitative analysis of themes in student survey commentary.
Student-Generated Self-Assessment Exam Questions	• The students' second most preferred design was the 'student-generated self-assessment exam questions' design feature. Qualitative analysis of survey responses indicated it was a valuable, distinctive tool which altered their learning approach. It enabled self-direction, self-assessment, evaluation and validation of self / peer knowledge.	• Pre-panel to post-panel comparisons in Solo Taxonomy test scores for student-generated questions indicate idea improvement, epistemic agency and collective responsibility. • Student created questions were of the same caliber as instructor generated questions. Ratings of student vs. instructor generated questions showed no significant differences (Friedman test).
Student Evaluation of All Designs to Facilitate Knowledge Building Activity • Panels • Student-Generated Self-Assessment Exam Questions • KF views (pre-panel, post-panel, OSCE)	• Classroom panels and student-generated self-assessment exam questions were the first and second preferred design features as measured in student quantitative and qualitative survey (survey two) results. • Student quantitative and qualitative survey analyses of the 3 KF views indicated these designs also had positive effects in contributing to and changing their approach to learning and should be continued as part of the course format.	• Panels and student-generated self-assessment exam questions designs were strongest in enabling epistemic agency and collective responsibility individually as well as all twelve Knowledge Building principles combined as a whole, as suggested through qualitative analysis of student survey comments. • KV views (pre-panel, post-panel, OSCE) also enabled epistemic agency and community knowledge, collective responsibility

Discussion

This research investigated design interventions in a 13 week PHM 320F course commencing in September, 2005 with 183s undergraduate students. Impact on Knowledge Building principles, particularly epistemic agency and community responsibility, was assessed through a variety of triangulated data analysis measures, including descriptive narrative accounts, analysis of survey responses for prevalent themes and statistical tests performed on quantitative ratings from various instruments tools.

Results as a whole indicate that each new design feature contributed to advances: no negative effects were uncovered. Students assumed levels of control and responsibility normally assumed by teachers. Raters blind to authorship of student- versus instructor-generated exam questions could not distinguish between them. Student commentary indicated advances in line with the broad network of Knowledge Building principles as well as epistemic agency and community knowledge, collective responsibility. Effective classroom environments and new assessment techniques together with social supports for promoting Knowledge Building practices in an undergraduate Pharmacy course were determined.

Summary

This case study provides unique insights into how epistemic agency and community knowledge, collective responsibility, as tenets of Knowledge Building, might be advanced within the context of a large class size pharmacy undergraduate specialty course. It has contributed to an understanding of the complexities of large size classrooms and how design interventions aimed at supporting these principles might be transferable to enhance the development of community Knowledge Builders across broader contexts such as other health care educational programs or university curricula with increased enrollments. It is hoped

that this research will stimulate continued study of the design features which embrace new environments and new assessments to explore Knowledge Building principles.

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