Potential for Knowledge Building in Large Size Pharmacy Classrooms

by

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
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Abstract

This thesis 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 = 182), 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.
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Chapter 1
Potential for Knowledge Building in Large Size Pharmacy Classrooms

1 Introduction to the Research

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, supported by social networking opportunities, technological software supports, and communities committed to the production and continual improvement of ideas. Advancement in knowledge and social-cultural development resulting from the implementation of Knowledge Building theory and technology have been assessed, with benefits to groups spanning 5 year olds to senior citizens, and as diverse as disadvantaged inner-city primary elementary students to post-graduate health care professionals, and community, business and other cross-sector international 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) - a principle of knowledge building, successes report interventions in contexts where those implementing the change form their own Knowledge Building community, a community committed to innovation in education, most significantly turning over the highest levels of control for knowledge advancement to students (Bereiter & Scardamalia, 2003; Bielaczyc & Collins, 2005). Having students take charge at the highest levels for their knowledge advances is fundamental to Knowledge Building. The challenge to be faced in the research to be reported is to make such advances in a context defined by controlled, time-limited, predetermined tasks and with curriculum.
This research examines undergraduate pharmacy students in a large size classroom to study the effectiveness of software and social supports on Knowledge Building, with an emphasis on designs and results to turn over greater levels of agency for knowledge work to students. The issue: Can 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? The research to be reported attempts to implement changes in this context, using quantitative and qualitative data, including participants’ perceptions about Knowledge Building supports to knowledge advancements, and classroom interventions and social supports that promote Knowledge Building practices in an undergraduate pharmacy course.
Chapter 2
Literature Review

2 Knowledge Building, Large Size Class, Epistemic Agency and Collective Responsibility for Knowledge Advancement

2.1 Knowledge Building Theory

“Education must equip student with the ideas and capacities… ‘to appreciate the current thought of their epoch’
A. N. Whitehead (1929)

“…Knowledge Building is work on the creation and improvement of ideas. The dynamic is social, resulting in the creation of public knowledge. … Public knowledge can itself become an object of inquiry and the basis for further Knowledge Building. Thus there is the possibility of a Knowledge Building dynamic that drives the continual creation and advancement of new knowledge. …”
(Scardamalia & Bereiter, 2003)

Lifelong learning requires transfer of responsibility for goals and advances from teachers to students. Knowledge creation and knowledge stewardship is the basis for sustained innovation, (Scardamalia, 2001) with depth of understanding a central objective (Bereiter & Scardamalia, 1993; Feltovich, Ford & Hoffman, 1997).

As indicated above, Bereiter and Scardamalia draw a distinction between Knowledge Building and learning. They describe learning as an internal, unobservable process that results in changes of belief, attitude, or skill. When learning, students acquire established concepts and theories. When knowledge building, students create or modify a social product, worked on and used by
others (Scardamalia & Bereiter, 2003). They contribute conceptual ‘artifacts’ such as theories, designs, and proofs that are scrutinized and improved by the community. Students abstract personal understanding from the public discourse, with learning a by-product of Knowledge Building. Learning and Knowledge Building involve the same psychological processes: negotiating meaning through conversation, assimilating and accommodating ideas. The key difference is the goal: when learning students are collaboratively trying to understand an idea they might view as certain; when Knowledge Building, they are collaboratively trying to improve an idea they view as an evolutionary course.

Most instructional methods focus on assigned tasks and are not concerned with the usefulness, improvability and developmental potential of diverse ideas required for working in a creative ‘design’ mode, which is typical of work in knowledge-creating organizations.

“…Knowledge Building is defined as the production and continual improvement of ideas of value to a community: the community accomplishments are greater than the sum of individual contributions and part of broader cultural efforts. It engages learners in knowledge creation from an early age. The goal is to advance knowledge frontiers…” (Scardamalia & Bereiter, 2002; Scardamalia & Bereiter, in press)

Formal education is conducted almost exclusively in “belief mode”. Ideas are treated as “truths” = objects to be believed. Most creative knowledge work outside of school is, in contrast, carried on in “design mode.” In such a mode, ideas are valued for their potential for further development, for their desirable promise. In design mode the focus is on ideas as objects of creation, development, assembly into larger wholes, and application.

Twelve principles underlie Knowledge Building design challenges (Scardamalia, 2002).

- **Real ideas and authentic problems** Knowledge Building ideas arise from efforts to understand the world; problems are authentic, from the perspective of the knowledge builder.
• **Continual improvement** All ideas are improvable in quality, coherence, or usefulness. Participants work toward this, feeling safe in voicing opinions, giving and receiving criticism.

• **Idea diversity** Idea diversity is essential to knowledge advancement, within an environment where theories evolve and are refined.

• **Rise-above** Knowledge Building synthesizes more inclusive principles and higher-level formulations of complex problems, extending current best practices.

• **Epistemic agency** Participants negotiate the fit between their ideas and others’ using supporting evidence, assuming responsibility for goals.

• **Community knowledge** Members are responsible for advancement of community knowledge. Contributions of value to others are prized, not just individual achievements.

• **Democratizing knowledge** All participants share in the community’s knowledge advances.

• **Symmetric knowledge advancement** Symmetry in knowledge advancement results by distributing or receiving expertise within and between communities.

• **Pervasive Knowledge Building** Knowledge Building is not confined to classroom or subjects but pervades all knowledge work, in and out of educational contexts.

• **Constructive uses of authoritative sources** Participants understand, respect and critically appraise current authoritative sources. Rather than reading primarily to identify truth claims (belief mode), readers are looking for information or ideas to advance their ideas (design mode).

• **Knowledge Building discourse** Knowledge is refined and transformed through forms of discourse which are fine-tuned to support idea improvement.

• **Embedded transformative assessment** The community’s internal assessment identifies problems, ensuring their work will exceed external assessors’ expectations.

### 2.1.1 Knowledge Building Communities

"...I am discovering gold—knowledge...a new understanding. However, don’t presume that I have only great thoughts...it is not easy as pie!"

*Elementary school student*
Scardamalia and Bereiter (1996, 2000) describe a “knowledge-building communities (KBC)” model (Scardamalia, 2003, 2005). The premise is that ideas are the malleable material of Knowledge Building. This is reminiscent of Dawkins, who described ideas as ‘memes’, building blocks existing within distributed cognitive environments (Dawkins, 1976). Knowledge Building community environments encourage collaboration to improve ideas. Cooperation creates understanding, advancing individual and group knowledge. The expertise derived from collective effort produces increasingly high-order conceptual frameworks (Bereiter & Scardamalia, 1993; Choo, 1998).

Students investigate problems over sustained periods, often using technology to advance communal knowledge by creating a collective, public discourse to progressively refine ideas. Collective goals emphasize understanding, rather than individual learning and performance.

There is a broad literature on the process of expertise, ranging from works in philosophy, the history of science, and other disciplines such as medicine (Ericsson & Smith, 1991; Ericsson, 2004; Patel & Groen, 1991). Knowledge Building environments are designed to support this process (Bereiter and Scardamalia, 1993). Some of the characteristics experts display include progressive problem solving, deep understanding of knowledge within the domain, and commitment to advancing knowledge for society (Patel, Arocha, & Kaufman, 1999).

Knowledge-creating communities enable innovation (Bielaczyc & Collins, 2005). Knowledge Building environments support the work of community members. In these environments, ideas are exchanged freely, transformed and synthesized into coherent new ideas, thus creating knowledge (Brown & Duguid, 2000). Literature from psychology and education suggest that activities which engage the learner’s viewpoint strengthen understanding (Bransford, Franks, Vye & Sherwood, 1988; White & Frederiksen, 1998). Inventive communities discuss and share ideas and expertise, from different perspectives. Ideas are advanced through divergent opinions, logic and evidence, with revision of synthesis employed to create a more coherent whole. Best practices are integrated from multiple aspects and synthesized into solutions (Lampert, Rittenhouse, & Crumbaugh, 1996). Systematic ongoing reflection further supports idea improvement and refinement.

Knowledge Forum™ is computer software developed by Scardamalia and Bereiter to provide affordances for creation of community knowledge. A community writing space with an
asynchronous discussion supports sharing of ideas, reflection, challenges, citation of evidence, and improvements over time. Features include the ability to use scaffolding to focus the discussion on theory development; the capacity to cite and upload references, and the capability of creating various views to organize notes and synthesize them into more coherent ideas. It is possible to publish contributions which remain in the knowledge base for use by subsequent participants, new classes, and/or the broader community, depending on user preferences.

2.1.2 Knowledge Building Communities in the Literature:

Reports of classroom Knowledge Building communities discuss interventions which enable knowledge creation. A broad number of settings have been described, ranging from elementary school to work in businesses, health care centres, and university courses (Scardamalia, 2000; Scardamalia and Bereiter, 2000; Hewitt, Scardamalia & Webb, 1999; Lamon, Reeve & Caswell, 1990; Ferry, Kiggins, Hoban & Lockyer, 2001; Lax, 2003; Russell & Perris, 2003; Breuleux A, Laferriere T, & Lamon M, 2002; Lin et al, 1995). These settings tend to share the following characteristics.

Technology-supported knowledge-creation activities. Mechanisms enabling knowledge creation have tended to focus on three levels of strategy and outcome: 1) technology, 2) teacher-engagement, and 3) student-engagement (Bielaczyc & Collins, 2005).

The teachers/administrators themselves operate as a knowledge-building community and employ mechanisms to foster their own creativity. For example, at both the Institute of Child Study (ICS) University of Toronto and Whitman Middle School, USA, teachers and researchers formed a knowledge-building community (Caswell, 2001; Lamon, Reeve & Scardamalia, 2001; MacDonald, 2001; Messina, 2001; Moreau, 2001; Reeve, 2001). Whitman teachers functioned as a team to exchange ideas and create implementations. Both settings used reading groups to discuss articles from different perspectives in order to develop strategies for creating knowledge-building communities. Both sent members to attend the Toronto Summer Institute to share ideas with teachers and researchers of different perspectives which they subsequently incorporated. ICS teachers kept a written journal (Reeve, 2001) as well as videos of class sessions (Moreau,
2001) for reflection, discussion and refinement of teaching. Whitman teachers used these two techniques as well as student interviews to create desired classroom cultures. Both groups presented at conferences which further addressed challenges.

At a student level, a number of factors contribute to functioning as a Knowledge Building community. Students demonstrate increasing levels of control for high level processes, “Knowledge...was something tangible that could be improved upon and ... used to help in the collective knowledge advancement” (Messina, 2001). Students synthesize their understanding through developing and discussing ideas, drawing from different sources including community “experts” (Aronson, 1978; Bielaczyc, 2001), and reflecting on and integrating notes.

Knowledge Building has been used in both large and small classes (the first effort was in a class of approximately 350 students). Technology was used so that students could read and comment on one another’s work and not have the teacher initiate all discourse and feedback. There have been follow-up efforts in large classes, but since these early reports, there has been little effort to elaborate issues and constraints in large size contexts in creating conditions for Knowledge Building. The challenges are significant, as the following literature suggests. This information is of particular interest because it elaborates challenges in bringing design-mode work into a university course with approximately 180 students.

2.2 Large Size Classrooms

The inquiry into the effects of class size on learning began in the 1920’s. Over the last two decades, interest has increased, 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—all relevant to the formation of Knowledge Building communities. 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 to cope with large classes—thus limiting the extent to which participants can engage in the level of emergent goal setting and processes that typify a Knowledge Building community. 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). One review of class size research concluded that a major problem is the lack of detailed studies of complex classroom processes that might mediate class size effects on pupils' learning (Blatchford, and Mortimore, 1994). Recent evidence from secondary school classrooms challenges one-way relationships between class size and learning. Findings from the most complete analysis of educational consequences support a contextual approach to classroom learning, where influences depend upon the appropriateness of teaching adaptations (Blatchford, Bassett, Goldstein, & Martin, 2003). Positive quantitative and qualitative data are reported in a case study of an undergraduate biology class (n = 263) which utilized adaptive student-controlled activities (Robison, 2007). Positive survey results occurred with student self-reflection and assessment techniques in engineering classes (n=100-200) (O’Moore & Baldock, 2007). Further research incorporating sophisticated qualitative methods to understand and represent the kinds of teacher and student expertise to maximize high quality learning is needed (Pedder, 2006). Three directions are recommended: longitudinal studies; case studies to articulate classroom conditions which show improved outcomes; and authentic assessments of situated learning contexts (Galton, 19982).

Classrooms are cultural systems with interacting components which should be integrated in large size class designs (Biggs, 1993). Eastern students, in large classes which are socialized to minimize management problems and use whole-class methods focused on meaningful learning, consistently outperform Western students (Biggs, 1998). Reportedly successful designs have
placed the emphasis on engaging the appropriate level of learning process, rather than the technique per se. How these are engaged should show context specificity.

At levels of learning focused on foundational knowledge, techniques should be specific for the setting, and address concrete attributes such as student characteristics as well as classroom features which minimize individual differences. Some of these include reorder seating to encourage participation; embrace the entire class in sustained discourse; improve student recognition (Gleason, 1986; Kain, 1985); and determine prior knowledge of students to derive varied examples which can address diversity (Gedalof, 2006).

At levels of learning focused on mastery of component sub-skills, the direction should be on teaching techniques that prove effective for that setting. There might be more individual contact (Stevenson & Sigler, 1992); use of repetition and variation; methods for exposure to uncovered material; online interactivity; preparation for class discussion topics; motivational techniques (Gedalof, 2006); and also generation of large numbers of new, relevant exam questions. (Buchanan & Rogers, 1990).

At a Knowledge Building level, the challenge is to engage students in deeper approaches to higher level cognitive and learning processes. This must be based on interdependent theory with cultural values and resources (Biggs, 1998). Some reported approaches have incorporated fostering a community to work actively and collectively with problem-solving approaches (Stevenson & Sigler, 1992; Robison, 2007); peer collaboration and pre/post-tests (Druger & Crow, 2004); encouraging autonomy; providing self-regulation opportunities for individuals to affect the agenda and outcomes of the class; (Robinson, 2007; Van den Berg, Admiraal & Pilo, 2006); and finally, ceding control of the class to students (Gedalof, 2006; Gibbs & Jenkins, 1992; Lewis, 1990; Bauer & Snizek, 1989; Monk, 1983).

The perspective of students affects their motivation as well as their performance. It is important in engaging them in deeper approaches to higher level processes. Participant perception is often attributed to a ‘Hawthorne’ effect (Rolisberger & Dickson, 1939), which refers to the fact that any intervention tends to have positive effects merely because of the attention of the experimental team to the subjects’ welfare. Brown rejected Hawthorne criticisms of work where the researcher predicts the ability to improve selected performances, and reviewed the original Hawthorne work (Brown, 1992). She reviewed this effect and concluded that all manipulations
do not result in improvement. Best improvement in actual productivity results when subjects perceive changes are in their best interest and subjects perceive they are in control. Brown then identified the concept of control, or the illusion of control, as a precise, key goal in Knowledge Building environments. Within such environments, results of both student beliefs and teacher/researcher perspectives have been reported (Chan & van Aalst, 2003; Jayasundera & van Aalst, 2003; Hill, Cummings & van Aalst, 2003; O’Reilly & Newton, 2001; Shell et al, 1996; Peters & Hewitt, 2005). Student agency, responsibility, satisfaction, and learning in complex social environments have been shown to be important when learning effects are the highly interdependent outcomes of multi-faceted socio-cognitive interventions (Scardamalia & Berieter, 1983; Brown, 1985; Brown 1992; Robinson, 2007; O’Moore & Baldock, 2007).

In summary, large classes represent complex interacting learning environments. Further inquiry is needed into the educational and socio-cultural factors required to achieve individual and collective responsibility for knowledge advancement. These require examination with attention to both outcomes and the perspectives of teachers, researchers and students.

### 2.3 Epistemic Agency and Collective Responsibility for Knowledge Advancement

If autonomy and self-regulatory opportunities are important in engaging large class students in deeper approaches to higher level cognitive processes, what evidence do reports provide regarding successful outcomes or limitations of varied educational and socio-cultural approaches? How can these 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, a Knowledge Building principle identified by Scardamalia (2002). Epistemic agency empowers the learner to take charge of executive processes normally controlled by the teachers in traditional academic settings, 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 knowledge goals ("intentional learning") or taking responsibility for helping classmates’ learning ("cooperative" or "collaborative learning") (Scardamalia & Bereitier, 2007). Epistemic agency is 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.

In its weaker forms, epistemic agency may consist of collaborative work on production of a knowledge product (e.g., a report). In its stronger forms, epistemic agency entails collaborative work aimed at achieving a collective advance in understanding. It involves mutual support but also constructive criticism and sustained effort at idea improvement, with attention to the state of knowledge and to available knowledge-building resources beyond the local group (Scardamalia & Bereitier, 2007).

High levels of epistemic agency cannot be instituted authoritatively. However, leading edge educational approaches can be designed to encourage and support advances in that direction (Zhang et al., 2007). Empowering a significant amount of epistemic agency be turned over to students even in a large, highly structured class is an important dimension of difference. This would be a substantial contribution in supporting a research claim to theory advancement. Formats which include self-directed discussion and self-testing components are of particular value in this respect. They can be studied from the perspective of epistemic agency, while also embracing the principle of "collective responsibility, community knowledge" which is integral to procedures. A brief overview of data specifically focused on epistemic agency includes related concepts such as self-explanation and self-regulation.

For many decades, educators have debated the degree to which teachers should relinquish responsibility and authority to students. This distribution is central to understanding the distinctions between genuine epistemic agency and comparisons of other educational approaches (Scardamalia & Bereiter, 2007).

Kirschner, Sweller, and Clark review the current state of scientific discussion about distribution of agency in learning (Kirschner, Sweller, and Clark, 2006). They purport that in most large-
scale comparative studies, those providing direct instruction, in contrast to more “constructivist” approaches, obtain higher achievement scores. This is because introducing complex material serially reduces burden on memory capacity. Nevertheless, collaborative student inquiry can also be quite efficient in increasing understanding in the following way. As new insights are added and integrated one at a time, the emergent result is a deeper mutual comprehension than by solitary attempts. The traditional reluctance to entrust students with a high level of epistemic agency results in mixed approaches such as “cooperative learning,” “self-regulated learning,” and “guided discovery”.

Scardamalia and Bereiter suggest that given sufficient time and encouragement, higher levels of epistemic agency could generate understanding through students’ own efforts, through sustained inquiry and dialogue. If free to explore ideas in depth and reflect on their current state of understanding in light of top-level goals, they could become agents of their own intellectual development (Scardamalia & Bereiter, 2007).

Education and business literature suggests that increasing student agency results in the development of a variety of “higher-order skills” which are valued in the workplace. These include independent learning, planning, and reasoning; research skills; and collaboration skills (Bransford and Schwartz, 1999). However, these may not be transferable across contexts. Context is critical to educating health care practitioners, highlighting the need for consideration of the culture into which the educational process will be socializing students.

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. Unfortunately, research demonstrates repeatedly that self-assessment alone is not an effective mechanism to identify areas of personal weakness (Regehr & Eva, 2006). Moreover, even when the adult learner perceives areas of weakness, learning in these areas is avoided because of the required energy and commitment (Regehr & Eva, 2006). Advancement of epistemic agency in the health professional undergraduate curriculum might
represent a strategy to address both of these personal learning issues before entry into the profession, where they become paramount to maintenance of competency.

With respect to the latter issue, that is, willingness to undertake remediation, studies have long reported that motivational variables and outcomes are influenced by the cognitive strategies students use to learn (Green et al, 2004; Seifert, 2004). Medical education literature suggests that perceived self-efficacy, stipulated as where students felt they could control objectives and results, was a strong motivator to learn, and increased the ability to cope with poor results (Dunn, 1998).

The first issue, the ability to identify gaps in competence, is much more complex and widely addressed in medical education literature. Ward, Gruppen and Regehr have reviewed the current state of the art on the measurement of self-assessment (Ward, Gruppen & Regehr, 2002). Literature results regarding the ability to self-assess are mixed and two reviews give comprehensive summaries of findings. Published meta-analyses of quantitative self-evaluation studies in higher education (Falchikov & Boud, 1989) report 44 results in a variety of subject areas, including medicine, which show self-assessors are poor to moderate judges of their performance. A second review of 18 studies in the health professions (Gordon, 1991) show poor results for extended periods of performance. Both suggest measurement of self-evaluation yields less than promising results. Yet, one wonders if equipping health care practitioners with the skills for self-regulation in learning, might enable them to become lifelong learners, in professional practice and professional development. Indeed it has been suggested that the process of self-evaluation should be viewed as an essential element of the curriculum (Dearnely & Meddings, 2007). Unfortunately, whilst the potential benefits have long been widely acclaimed (Rowntree, 1987; Boud, 2000; Taras (2001), the use of student self-assessment in higher education is still rare.

In a health care context, it has been postulated that relying on heuristic reasoning, that is, gaining knowledge by intelligent guesswork rather than by pre-established algorithmic reasoning in an environment of incontestable evidence, may increase the risk of systematic errors, assumptions, biases and flawed thinking (Tversky & Kahneman, 1974; Austin et al., 2008). Within medical education and practice, consequences from such flawed thinking might include impaired and inaccurate diagnosis through biased or stereotyped patient assessments (Groopman, 2007;
Croskerry, 2002). Austin has hypothesized that the role of self-assessment and reflection-in-action may be the ‘missing link’ in helping individuals identify situations in which algorithmic reasoning should be employed to optimize outcomes. This would promote a shift to critical thinking and re-alignment of goals, methods, objectives and outcomes (Austin, 2008). He attempted to elucidate the connection between self-assessment tools, self-reflection and critical thinking, in a study of Pharmacy students. He found that students who were prompted to engage in reflection-in-action and self-assessment during a critical thinking test, demonstrated meaningful and measurable improvements in performance compared to students who completed the test with no interference.

Educating with high levels of epistemic agency might improve self-identification of learning gaps. This requires students practice meta-cognitive processes (Nirula, 2004; Punja, 2007). The skills component from cognitive processing strategies has been shown to improve calibration of self-regulation and agency beliefs (Chong, 2005; Eshel & Kohavi, 2003; McCann & Turner, 2004). The medical literature continues to explore this.

Several studies report that allowing clinical clerks to actively manage their own learning (ie by setting their own objectives) within a supportive environment, provides more structure. It enables students to address gaps in knowledge during clerkships, which represent a context where teaching is based on opportunistic contact and learning needs are diverse (McDermott, Curry, Stille & Martin, 1999; Schwiebert, Crandall & Brown, 1991; Smith & Morrison, 2006). In a study by Smith and Morrison, medical students worked in small groups to generate a broad range of objectives, reflected on original ideas and adapted them as appropriate. Agency may have been limited in this design, since educator supervisors provided weekly guidance. Authors acknowledge students also may have been influenced by the expectations of the department (Smith & Morrison, 2006). In another investigation, undergraduate medical students worked in groups to discuss and integrate learning. This reflective learning technique increased their ability to focus on learning needs (Grant et al, 2006). While there was no difference in examination results, this purposeful reflection helped learners recognize when their understanding was incomplete, stimulating them to address gaps and develop a deeper, more integrated and self-directed approach to learning. Beckert and colleagues describe a fifth year medical school skills course designed by students (with supervisory guidance). It was driven by student needs related to study and examination techniques (Beckert, Wilkinson & Sainsbury, 2003). Students
organized and conducted a practice exam, writing their own questions and acting as patients, examinees or examiners. Study results indicated positive student opinion and outcomes: performance in a high stakes medical school examination (written examination and OSCE) was significantly better compared with previous years and students from other schools.

These exploratory studies suggest that progress may be made in the ability to self-identify areas of weakness, and increase the motivation to improve. How then, can the quality of self-evaluation or self-assessment be enhanced in order to have positive effects on outcomes and advance self-regulation for the health practitioner?

A recent study indicated that although outcomes are intrinsically bound to skill development, stronger students are more likely to develop these skills than weaker students. In large size classrooms, where the weaker portion of the class may be 80 to 100 students, self-assessment must be practiced to become refined (Boud, 1995). The benefits of self-testing at all levels cannot be realized without engaging students to undertake self-assessment, for if students cannot assess the quality of their academic work, how can they advance their learning potential? Schön described a reflective curriculum. In this context, reflection is used as a tool to intentionally redesign both theories-in-use and espoused theories, resulting ultimately in improvements in professional practice (Schön, 1987).

Baerheim and Meland reported that medical students who were allowed to propose questions alone or in groups for written exams increased their reflective learning, even though their examination marks were not significantly changed (Baerheim & Meland, 2003). Even more promising are Sobral’s results, that both approaches to study and academic achievement were significantly related to reflective learning techniques in medical students. This implies that research which investigates student self-reflective evaluative techniques or self-testing in health care courses may advance learning processes and enhance professional self-regulation (Sobral, 2001).

How do the results of these investigations relate to advancing the social component of deeper forms of epistemic agency? It should be noted that the research on cognitive motivators and regulators of action has been mainly concerned with individuals: how self-regulatory mechanisms operate in personal accomplishments or maintenance of competency as such (Chong, 2005; Eshel & Kohavi, 2003; McCann & Turner, 2004). However, health professionals
become members of a sophisticated knowledge-creating culture. Its collective goals of advancing medical knowledge must be socially mediated through mobilizing the concerted efforts of others. The workplace context might be a hospital or community clinical site, where practitioners not only interact within their discipline but also must become part of and contribute to inter-professional teams (Russell, 2005). *Knowledge translation*, that is, the transfer of knowledge to practitioner or health system must become imbedded in performance and health care outcomes (Davis et al., 2003).

Environments which provide mutual support, constructive criticism and sustained effort at idea improvement will further community understanding. Bandura reported that groups with high levels of perceived self-efficacy and control within workplace organizations set increasingly challenging goals. They exhibited effective analytic thinking which resulted in large differences in organizational attainments compared to controls (Bandura & Wood, 1989).

The idea of empowered communities dedicated to knowledge advancement has been supported by frameworks which sustain cultures of epistemic agency in science, ie physics and molecular biology (Knorr-Cetina, 1999) and in medicine by Frankford and colleagues (2000). The latter argue in favor of medical professionalism leading to transformative learning environments for practitioners.

The teachers’ education literature has examined epistemic communities in that culture. Brett reported that epistemic agency, one of two critical components of engagement, was demonstrated through student teachers’ efforts to deepen understanding and to work with mathematical ideas towards developing a conceptually based approach to math knowledge, discourse and pedagogy (Brett, 2002). Epistemic agency and community identity were conceptualized as mutually constituting engagement in community discourse. Epistemic agency represented the focus on idea development; and identity, the connection to the community. In effect, Brett postulated that community identity and a basic level of perceived context competence may enable the conditions for epistemic agency to flourish. Through the process of directing learning (epistemic agency), participants actively engaged in community discourse, and through the engagement and feedback, in turn increased their sense of community identity.

These examples suggest that the creation of a culture which supports and engages health care students as epistemic agents with collective responsibility for community goals would help
socialize them into the professional culture they will join and to which they will contribute. Knowledge Building represents a more student-driven inquiry process in which students are charged with setting forth ideas and problems of interest for knowledge advances central to their community. Giving undergraduates responsibility to direct their learning, and engage in collective Knowledge Building discourse about clinical problems they are working with, will help to prepare them for socialization into a self-regulating profession.

Epistemic agency might be demonstrated in assessments and analyses of change in student performance associated with implementation of innovative design features. These might include such techniques as community classroom discourse in which knowledge, concepts and strategies are examined and articulated; creation of self-testing exam questions to practice reflective assessment; and through a public online forum promoting community meta-cognitive discussion about understanding and insights. This is particularly important when trying to address challenges posed by limitations inherent in large size health care classrooms. In affording students the ability to develop relevant knowledge, they may engage more, and increase their personal and community levels of knowledge and control over learning. Such an advance would have implications for all community environments. Novices are not necessarily engaged in central participation over time, unless they can develop a sense of their own perceived value and power in that community.

2.4 Summary

This chapter described literature reports of the accounts of Knowledge Building theory. It reviewed large class size influences on instructional designs and how the constraints therein present issues in methodology and in advancing educational theory. It summarized documented evidence in epistemic agency and how autonomy, and self-regulatory and community processes are important in engaging students in large class settings deeper approaches to understanding and high level cognitive processes. The next chapter describes the context of the professional culture the study participants joined and to which they contributed to pharmacy practice in Canada.
Chapter 3

3 Understanding the Frameworks for Self-Care Context: Pharmacy Education and Practice in Canada

Chapter Two provides a broad framework for epistemic agency and collective responsibility related to student engagement in large classroom settings. Chapter Three narrows the focus to a specific domain, self-care (self-medication) education for undergraduate pharmacy students. This specialty is informed by the guidelines for both pharmacy education and practice in Canada, and thus the determinants for these two contexts are important to review as background information. The purpose of this chapter, therefore, is to provide a brief account of current standards of practice that must be delivered through pharmacy education, with a view to future directions within the profession. The goal is to provide a context for understanding the roles Knowledge Building and this research may play in educational reforms and technology-mediated classroom environments for the self-care area of expertise.

The chapter begins with a brief synopsis of pharmacy education in Canada and the elements which have fundamentally shaped it nationally and at the university level. The chapter then continues with a description of requirements for licensure and maintenance of competency which are provincially mandated and dictated by current standards for professional practice. There follows a section which details how each of these two jurisdictions, higher education and regulatory bodies, have responded to calls for change in education and pharmacy practice to advance the profession and align with future health care needs. In this section, influences and constraints relevant to education designs and this study are discussed. Then interpretation of the required standards and curriculum design are applied to a self-care course within this baccalaureate program of study. General problems in implementation are reviewed, with focus on self-regulatory processes. The chapter concludes with a description of the undergraduate Pharmacy students and course studied in this research.
3.1 Canadian Pharmacists

The Canadian Pharmacists Association has summarized the current situation with respect to Canadian Pharmacists. Canada’s 31,000 licensed pharmacists make up the third largest segment of health care professionals in Canada. Pharmacists are the only health care providers whose education focuses on medications and their use. Approximately 70% of licensed pharmacists work in community pharmacies, 15% work in health care institutions, and 15% work in academia, industry, government and other areas (Canadian Pharmacists Association, 2008). Pharmacists, as medication experts, have an important role to play in the resolution of issues currently challenging governments and health care leaders, such as patient safety and improved health outcomes, timely access to care, and scopes of practice of health professionals.

3.1.1 Educational System

The education of pharmacists in Canada is built on a foundation of strong, research-intensive publicly funded universities; a universal health-care system which provides financing for prescription medication through government and private sources; a self-regulatory professional licensure system; and independent, highly collaborative educational, regulatory and advocacy groups (Austin & Ensom, 2008). These elements shape educational practices and policies. A move from a product to a patient focus has occurred in an environment of heightened awareness for patient safety, emphasizing greater need for accountability for outcomes (Al-Sukhni & Ballantyne, 2007). Current challenges include tools to ensure continuous professional development and maintenance of competency of practitioners. At this time, schools of pharmacy struggle with how enhancement of the curriculum can be best managed to meet present and future skills needs (Austin & Ensom, 2008).

In Canada, provinces are responsible for administering health care and post-secondary education, while the federal government is responsible for establishing standards for health care. All pharmacy schools exist within comprehensive, research-oriented university structures affiliated
with medical and allied health care programs. Accordingly, a mélange of dissimilar regulations and educational and licensure requirements exist.

The body responsible for developing and evaluating educational standards is the nonaligned Canadian Council for Accreditation of Pharmacy Programs (CCAPP), which reviews and accredits schools to ensure compliance with their standards (CCAPP, 2008). These standards serve as the basis for approving entry-to-practice pharmacy degrees, and are updated regularly with input from academics and practitioners, to keep abreast of changes in practice and education.

In turn, these standards are built on outcomes for educational programs, established by the Association of Faculties of Pharmacy of Canada (AFPC), which articulates both pharmacy-specific and general university graduate outcomes for pharmacy education (AFPC, 2007). Specific outcomes as well as relevant selected general outcomes are generally considered when setting learning objectives and assessment measures for curriculum planning. These are detailed in Table One. Each school of pharmacy develops its own curriculum, framed with teaching philosophies and methodologies, provided graduates demonstrate specified levels and ranges of competency with outcomes, upon graduation (Austin & Ensom, 2008). Each school utilizes an individual approach, ranging from traditional foundational content blocks to more problem-based, integrated curricula, but must provide experiential components in all years. Design features vary according to specific local needs, affordances and constraints, often financial or resource-related.

In the process of curriculum renewal, the University of Toronto, recognizing the importance of a patient-centred practice, has adopted a series of education outcomes, most recently redrafted in November, 2007, aimed at enhancing students’ abilities to provide relevant and appropriate cognitive and social activities and based on the 2007 AFPC model. Both pharmacy-specific and ability-based general outcomes are guidelines to determine graduate level competencies and therefore inform and define curriculum designs for the University of Toronto setting (the site for the current study). In Toronto, problem-based and case-based learning are
utilized as key teaching strategies, in accordance with changes in teaching philosophy which have occurred over the last decade as part of the overall trend in health sciences education.
Table 1
Statement of Educational Outcomes for Entry-Level Doctor of Pharmacy Graduates in Canada (from the Association of Faculties of Pharmacy of Canada – AFPC, 2007)

<table>
<thead>
<tr>
<th>Specific Outcomes</th>
</tr>
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<tbody>
<tr>
<td>1. <strong>Practice Pharmaceutical Care</strong>: Pharmacy graduates practice pharmaceutical care ethically and compassionately in a professional manner. In partnership with patients and other health care providers, pharmacists use their knowledge and skills to meet patients' drug-related needs, with the objective of achieving optimal patient outcomes and maintaining or improving the patients' quality of life.</td>
</tr>
<tr>
<td>2. <strong>Assume Legal, Ethical, and Professional Responsibilities</strong>: Pharmacy graduates will be able to practice within legal requirements, and the ethical and professional standards of practice, and fulfill professional responsibilities.</td>
</tr>
<tr>
<td>3. <strong>Provide Drug Information, Educate about Drugs and Promote Health</strong>: Pharmacy graduates provide information and recommendations to health professionals and the public concerning drugs, drug use and health promotion, to ensure optimum and cost-effective patient care.</td>
</tr>
<tr>
<td>4. <strong>Coordinate Drug Distribution and Service Delivery</strong>: Pharmacy graduates manage and use resources of the health care system to provide, assess and coordinate safe, accurate, cost-effective and time-sensitive medication preparation and dispensing to meet patients' requirements and to improve therapeutic outcomes of medication use in cooperation with patients, prescribers, other health care providers, and administrative and supportive personnel.</td>
</tr>
<tr>
<td>5. <strong>Understand and Apply Drug Management Principles</strong>: Pharmacy graduates demonstrate an understanding of management principles with the goals of optimizing patient care and the use of practice resources. Pharmacy graduates apply relevant principles in everyday practice.</td>
</tr>
<tr>
<td>6. <strong>Understand and Applies Principles of Research Methods</strong>: Pharmacy graduates, in partnership with researchers and other health care professionals, understand research principles and apply them to sustain and assist in the continual development of pharmacy as a profession, and the optimal design, delivery and utilization of medications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Outcomes (required of a university graduate and educated citizen and necessary for fulfillment of the professional outcomes required of pharmacy graduates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Professionalism and Ethical Behaviour</td>
</tr>
<tr>
<td>2. Scientific Reasoning, Critical Thinking and Problem-Solving</td>
</tr>
<tr>
<td>3. Communication</td>
</tr>
<tr>
<td>4. Teamwork/Interdisciplinarity</td>
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<tr>
<td>5. Self-Directed Learning Abilities/Life-Long Learning</td>
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<tr>
<td>6. Leadership</td>
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<td>7. Advocacy</td>
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</table>

Required teaching strategies and mandated outcomes are important for understanding the design features of this research, and for considering how the course format needed to be elaborated to balance curricular expectations, constraints due to large class size, and the goals of the research which require advancing the theoretical framework principles of epistemic agency and collective responsibility.

The Pharmacy Examining Board of Canada (PEBC) is responsible for the national entry-to-practice examination for pharmacists. This qualifying examination was altered in 2001 to include a two-day, case-based multiple-choice test of clinical and therapeutic knowledge. This is
followed by a sixteen station objective structured clinical examination (OSCE), which tests clinical knowledge, interpersonal, communication and patient assessment skills. Standardized patient-actors portray pharmacy situational cases.Observed by an examiner, the candidate must gather information, identify major problems and provide a management plan. It is a well established method of assessment in many health professions and used to examine clinical and applied clinical knowledge, skills and attitudes in a controlled setting. Each part of the PEBC exam must be passed successfully to qualify for provincial licensure.

3.1.2 Licensure System and Professional Practice

Licensure is not national. Provincial Colleges of Pharmacists are the licensing bodies, and establish local requirements including jurisprudence exams and maintenance of competency requirements.

Licensure regulations however, are influenced by both national and provincial organizations that develop standards of practice to define expectations for professional practice, working towards the provision of patient care. A national umbrella organization, the National Association of Pharmacy Regulatory Authorities (NAPRA), represents the provincial licensing bodies in Canada, and is charged with defining the model competencies and standards of practice for Canadian pharmacists, to be used by each province in setting their own requirements. These are reviewed and updated through their advisory committee, comprised of practicing pharmacists from across Canada and chaired by one of the provincial regulatory authorities.

In Ontario, the Ontario College of Pharmacists (OCP) regularly reviews and updates standards of practice, paralleling those developed previously by NAPRA. The current provincial standards were approved in 2003 (OPA, 2003). These outline requirements for competency, ethical conduct and application of knowledge and skills and include six key standards, found in Table Two. A comparison to the educational outcomes delineated by AFPC (Table One) shows the derivation linking education to practice requirements.
These standards fundamentally orient pharmacist’s work towards the provision of patient care based on evaluation and interpretation of valid, current pharmacy practice information interacting in collaborative inter-professional relationships. Accordingly, undergraduate education must focus on designing courses aligned to these standards.

Table 2
Standards of Practice for Ontario College of Pharmacists

| Standard 1: | The pharmacist, using unique knowledge and skills to meet a patient’s drug-related needs, practices patient focused care in partnership with patients and other health care providers, to achieve positive health outcomes and/or to maintain or improve quality of life for the patient. |
| Standard 2: | The pharmacist practices within legal requirements and ethical principles, demonstrates professional integrity and acts to uphold professional standards of practice. |
| Standard 3: | The pharmacist identifies, evaluates, interprets and provides appropriate drug and pharmacy practice information to achieve safe and effective patient care. |
| Standard 4: | While respecting the patient’s right to confidentiality, the pharmacist communicates and educates to provide optimal patient care and promote health. |
| Standard 5: | The pharmacist, in collaboration with the designated manager or hospital pharmacy manager, manages drug distribution by performing, supervising, or reviewing the functions of selection, preparation, distribution, storage and disposal of drugs to ensure safety, accuracy and quality of supplied products. |
| Standard 6: | The pharmacist, in collaboration with the designated manager or hospital pharmacy manager, manages drug distribution by performing, supervising, or reviewing the functions of selection, preparation, distribution, storage and disposal. |

The Ontario College of Pharmacists maintains the registry of the successfully licensed pharmacists and takes steps to regulate the maintenance of their competency over time. Its quality assurance program mandates that pharmacists who are directly involved in patient care must maintain a self-directed portfolio of continuous learning according to College guidelines which must be submitted upon request. This portfolio is fundamentally a manifestation of epistemic agency which must be sustained over a career of practice. It is subject to a practice peer review and remediation, if necessary, according to a random selection process. The six hour peer review consists of both a clinical knowledge and practice-based OSCE assessment examination. The practice review also has a second phase assessment based on the NAPRA competency document.
Both the licensure examination and the maintenance of competency review canvas the broad scope of practice for pharmacists, including the context of the self-care specialty (non-prescription or over-the-counter medications) for which the 70% of licensed pharmacists, who work in community sites, are accountable.

3.1.3 Call for Change

All jurisdictions have felt a need to update and refresh the current standards and outcomes which dictate curriculum in order to advance both education of pharmacists and continuing professional development. Accordingly, the following plans have been implemented.

3.1.3.1 Blueprint for Pharmacy: Vision of the Future for the Profession

The Canadian Pharmacists Association together with other pharmacy organizations developed a strategic action plan for the future of the profession in a document, Blueprint for Pharmacy – the Vision for Pharmacy (Canadian Pharmacists Association, 2008). It reviews challenges in the use of medications and the current and future role of pharmacists in the health care system. It also outlines key elements and proposed strategic actions in five key areas with approaches to be influenced by the individual provincial jurisdictions responsible for delivery of health care services. These include:

- pharmacy human resources
- education and continuing professional development
- information and communication technology
- financial viability and sustainability
- legislation, regulation and liability
Of particular interest to the development of this thesis is the issue of how guidelines for education and continuing professional development to support patient-centred, outcomes-focused care, impact curriculum design. A closer look at these guidelines follows.

In 1997, the WHO developed the concept of the “seven-star pharmacist,” detailing the skills and attitudes required of pharmacists to be effective members of the health care team (WHO, 1997). In 2000, the International Pharmaceutical Federation (FIP), of which Canada is a member, adopted this concept in its policy on pharmacy education (FIP, 2000). The roles of the pharmacist are caregiver, decision-maker, communicator, manager, life-long learner, teacher and leader. The WHO and FIP added the function of researcher in their 2006 handbook entitled Developing Pharmacy Practice: A Focus on Patient Care (FIP & WHO, 2006). As previously outlined in the AFPC specific outcomes (AFPC, 2007), the basic elements of researcher that apply to pharmacy practitioners are not associated with basic science bench research but rather clinical practice research. They include understanding research principles and the ability to apply them to sustain and assist in the continual development of pharmacy as a profession, and the optimal design, delivery and utilization of medications. Future education needs to emphasize foundational skills (such as communications, clinical decision-making, physical assessment, informatics, confidence building and research) and incorporate management, leadership, advocacy and change management skills. Accordingly, the Blueprint document calls for fourteen key actions in educating pharmacists. Amongst them are a few particularly significant in substantiating this research direction (Canadian Pharmacists Association, 2008):

- Ensure that core pharmacy curricula address the knowledge, skills and values required for future pharmacy practice
- Ensure all pharmacy professionals, including students, value and develop life-long learning and personal performance assessment skills.
- Increase the accessibility, quality, quantity and variety of experiential learning opportunities.
- Conduct and utilize research to develop, evaluate and improve education and continuing professional development programs.
3.1.3.2 Model Competencies

At the same time, regulatory bodies have responded to the call for change by elaborating a more comprehensive model of competencies, elaborated through NAPRA, directing at ensuring the essence of best practice for all pharmacy practitioners. The following diagram represents the main elements of this recent Competency Framework (NAPRA, 2008), inspired by both a NAPRA document, Professional Competencies for Canadian Pharmacists at Entry-to-Practice (NAPRA, 2007) as well as those developed by other organizations within or outside Canada (Australia, 2003, 2006; New Zealand, 2006; Great Britain, 2007, 2009; Ottawa, 2008; British Columbia, 2006). An overall structure integrates competency units, elements of competence, competence activities with performance indicators and the underlying knowledge and skill specifications. These must be addressed in any curriculum design for practice courses, with the understanding that the model was developed for a wide range of potential users with varied areas of practice.

Model Competencies and Standards of Practice for Canadian Pharmacists

Figure 1. NAPRA Model of Canadian Pharmacist Competencies and Standards of Practice (2008)
3.1.3.3 A Closer Look at Relevant Competencies

In order to understand how the theoretical principles of epistemic agency and collective responsibility, community knowledge could be advanced within the context of pharmacy, one needs to examine in more detail some specific competencies that resonate with these Knowledge Building philosophies. Competencies that are fundamental to this thesis include:

- patient safety (first and fifth competencies)
- self-regulation, maintenance of competency, fostering inter/intra professional collaboration (fourth competency)

For these, further detail regarding the individual elements (see Figure One) is provided below:

Competency 1:

Provide Patient Care

- The elements of this competency include ability to assess the patient’s needs, concerns and health status; develop a therapeutic plan; support the patient to implement the therapeutic plan; monitor the patient’s progress; document and provide patient information, recommendations, actions and outcomes and minimize patient harm after an error or incident.

Such decisions must be ‘evidence-informed’, which the document delineates as “the integration of experience, judgment and expertise with the conscientious, explicit and judicious use of current best evidence in making decisions about the care of patients.”

To ensure proficiency with this patient safety competency, curriculum design must deliver integration of knowledge and skills required to evaluate medication use, and critical appraisal of the literature, as well as ability and motivation to effectively carry out routine self assessment. Undergraduate training built on a theoretical foundation of all Knowledge Building principles, but in particular, the self-direction and reflection in independently establishing goals and measures to achieve and assess them that demonstrate epistemic agency, would provide the necessary experience and skills to perform professionally in effectively managing patient care safely based on current and authoritative sources of evidence.
Competency 4:
Maintain Professional Development and Contribute to the Professional Development of Others

- The elements of this competency include the ability to plan and implement professional development strategies to improve current and future performance; and to contribute to the professional development of colleagues.

In attaining this competency, two key terms are interpreted by the guidelines:

- professional development is: “The process whereby health care providers acquire and assimilate an increasing breadth and depth of professional knowledge and skills and apply it to their practice, with the goal of improving patient care and practice outcomes.”
- collaborative relationships are those “where two or more people or health care providers or organizations or teams work together toward an intersection of common goals by sharing knowledge, skills and learning and by building consensus.”

Both epistemic agency and collective responsibility, community knowledge are theoretical tenets that, if advanced through curricular design, would assist in enabling the graduate pharmacist to maintain and contribute to professional development. Indeed, the interpretation of the key terms of these guidelines, closely parallel the definitions of these Knowledge Building principles.

Competency 5:
Contribute to Public Health and the Effectiveness of the Health Care System

- Selected elements of this competency which are most relevant to this thesis include the ability to develop, maintain and promote collaborative relationships with health care providers and others; contribute to the education and training of students and health professionals and contribute to the discovery of new knowledge and skills and their application to pharmacy practice and the health care.

Essentially, delivery of this competency would be enhanced through experience with the establishment of Knowledge Building communities at the undergraduate level. Importantly, the
theoretical principles of epistemic agency and collective responsibility encourage and hone the skills and abilities required to contribute to and advance an effective inter-professional health care system.

3.1.4 Education and Competency for the Self Care Context

The pharmacy specialty practice of self-care is the case study context for this research, and narrows the focus of understanding for course design issues. To further elucidate the dimensions of teaching and learning important in educating students to be competent in this domain, some interpretation of current views on the required standards and curriculum design necessary for such a program of study will be elaborated. Following is a brief description that begins with context specific issues, and regulatory alerts and concludes with how they might impact education of pharmacy students.

In 1996, the International Pharmaceutical Federation adopted a ‘Statement of Principles for Self-care including Self-medication, the Professional Role of the Pharmacist’ (FIP, 1996). This defines self-care as the prevention of ill-health by appropriate diet, exercise and other measures, and the treatment of symptoms the patient observes for himself with medicines available without prescription. The statement confirms that consumer research demonstrates that patients recognize the pharmacist as the authoritative source of information and advice. It further states that pharmacists, ideally qualified and placed to advise, have a professional responsibility to provide sound, unbiased advice and to ensure patients resort to self-medication only when it is safe and appropriate.

The domain of self-care, sometimes referred to as over-the-counter medications, presents additional unique concerns for practice not encountered in other health care arenas. In addition to the various competency standards that influence performance in general settings, are considerations which come into play because of the non-prescription nature of the products, devices and medications pharmacists are accountable to supervise for purchase. The pharmacist must serve in a position of triage, assessing if the condition is self-limiting and there is no need
for therapy; if the patient should be referred to a physician or hospital; or whether self-selection is appropriate and if so, how to proceed. There are delineations between products that must be held behind the counter and require pharmacists’ intervention, products for free-selection in the aisle, and often unregulated complementary and alternative medications which may be botanical or homeopathic, and may be classified as foods rather than drugs. There are also marketing influences from manufacturers, and consumer demands which may relate to availability or media and Internet advertisements. Experience has shown that provision of this additional information may be misunderstood and often raises new questions in the minds of consumers (FIP, 1996). The public may be unaware of the potential difficulties associated with use of a product, relying on advertisements or recommendations from uneducated friends.

The FIP statement emphasizes that the education and training of pharmacists should equip them to give sound advice, and importantly, to take responsibility to extend and update their knowledge on medicines and symptom recognition throughout their professional careers. It stresses greater emphasis on communication skills, and social and behavioural aspects of self care (FIP, 1996)

Because of this complexity, for the past 20 years, there has been mounting evidence of the need for increased emphasis on nonprescription medication therapy within the pharmacy curriculum. This is highlighted by the significant expansion of nonprescription medication use and the high value that consumers place on nonprescription medications and diagnostic product use. These products are much more convenient in light of increasingly difficult and costly access to health care options requiring appointments and referrals. Self-medicating patients frequently need assistance in selecting nonprescription drug products from a learned intermediary to assure appropriate and informed self-care in conjunction with their total ongoing care regimen. Certainly, it is the pharmacist who is best prepared to do this and to consider beneficial or harmful interactions. Because this emphasis in practice will continue to expand, it is incumbent upon schools of pharmacy to develop practice-relevant, competency-based, patient-centered curricula and continuing professional education opportunities that assure contemporary competence and intellectual proficiency in nonprescription medications medication therapy and self care. In addition, since patients may also suffer from multiple concurrent disease states more complex than those that are self-treatable and are prescribed relevant therapies from multiple clinicians, self-care knowledge and competency must be integrated holistically into the total mix
of patient co-morbidity and poly-pharmacy. The pharmacist must be proficient not only in evaluating therapy but in skillfully communicating and translating this knowledge to diverse patients of a variety of milieus.

The pharmacist-assisted self-care professional practice model must be further directed, as are other contexts, by the previously described provincial and national pharmacy standards of practice which focus upon the safe, appropriate, and effective selection, use, and monitoring of non-prescription medication therapy (Popovich, 2006).

Krypel comments on these challenges for those designing a self-care curriculum (Krypel, 2006). She points out that as manufacturers of self-care products seek to satisfy consumer demand and increase market shares, rapid changes occur with brand name extensions and prescription to nonprescription product switches. Developing learning outcomes beyond drug knowledge becomes critical. Further, Krypel points out that learning outcomes must also address the multifaceted nature of self-care, including the development of skills in patient assessment (triage) and education. Determining which content areas should be included can be difficult in a time-restricted curriculum especially when consumer demand and marketplace changes need to be considered.

Due to the limitations for content in restrictive course outlines, there is a need for self-directed study and skill in self-assessment to address advances and developments in available commercial products which must be pervasive beyond the classroom. Besides the plethora of nonprescription medications and self-care products, there is a vast growing array of vitamins, herbals, dietary supplements, and homeopathic products available. However, few of these are accompanied by scientific evidence to support their use. Pray, an expert in the self-care arena, provides his viewpoint on “quackery” in discussing “ethical, scientific, and educational concerns with untested medications” (Pray, 2006). Many unproven natural products and dietary supplements are easily made commercially available since they are not subject to the scrutiny and legislation which accompanies release of prescription drugs. With increasingly frequent product advertisements, these unsubstantiated entities appear to be gaining a foothold in self-care. He cautions about the importance in educating pharmacy students and pharmacists about self-directed evaluation of existing and new commodities as they become available. They need to be
able to credibly and knowledgeably inform the consuming public, while advocating for evidence-based proof of safety and efficacy for those products that are available for patient use.

Ultimately, given the dynamic, multifaceted nature of self-care, Krypel remonstrates that pharmacist life-long learning may be the most important outcome necessary for a self-care curriculum. This supports an emphasis on self-assessment and reflection as key features in the design of the study course. Importantly it appears that the principles of epistemic agency and advancing community knowledge responsibly and collectively, resonate with and are particularly important within the self-care context. Additional Knowledge Building principles are similarly relevant (eg. pervasive knowledge building, improvable ideas, etc.) though not the focus of this investigation. Educating within this theoretical framework should help focus on achieving the required professional outcomes. Such a research design may assist in aligning curriculum delivery to the practice issues of context, consumer and manufacturers demands, regulations, patient safety and education, and the expanding marketplace outlined in this section.

### 3.1.5 Problems in Implementation

In this section, some key difficulties are highlighted in operationalizing educational designs which might address these professional issues, including balancing regulatory demands, and optimizing teaching strategies to deliver a general training program in large size classrooms.

The profession of pharmacy in Canada has been advocating for expansion of pharmacists’ cognitive skills, commensurate with their education and abilities, through expanding roles for pharmacists to meet local needs and concerns. Despite having to do this in different settings and in different ways, they must meet and follow changing guidelines and competencies from a number of different educational and regulatory standard-setting organizations. This is often difficult to harmonize and gives the appearance of a disorganized patchwork of systems, practices, and policies (Austin and Ensom, 2008). From the perspectives of both maintaining a general practitioner’s license and responding to individual patients there is merit in approaching and educating for major changes in this way. The Knowledge Building frameworks of epistemic
agency and collective responsibility appear aptly suited to navigating future advances for the profession. The challenge is in designing and providing suitable teaching strategies and methodologies within the undergraduate curriculum and university system to support these constructs and deliver the required outcomes considering local constraints and resource implications.

Figure 2 is the researcher’s representation of the various interconnecting and bridging domains of pharmacy educational and practice competency standards.

Obstacles arise in designing context-specific specialty courses which still address broadly sculpted standards of practice. Many difficulties relate to institutional barriers, including unalterable curriculum design and limited funding or resources. Moreover, in the health sciences, there is the reinforced perception that coping with sheer volume of new information may be more easily deliverable through traditional approaches, including didactic lectures and passive note taking, in parallel with equally expedient assessment techniques such as quizzes and authoritative, instructor-designed multiple choice question examinations, excluding student
involvement in learning or evaluative processes. Reports of problems inherent with these conventions appear regularly in the literature. Abrahamson (1996) comments on the undue attention paid to ensuring students acquire and temporarily retain these facts, whereas at the same time, students must develop translatable skills to satisfy problem-solving and clinical competency in the workplace.

Recently, in response to increase in health care demands and shortages in pharmacy manpower, enrollment has doubled at the undergraduate level at the University of Toronto, which in turn has reinforced methods for mass training of students.

Increased student population and the information explosion call for attempts to counter these effects through designs which make the classroom more vital and interactive, and extend beyond limitations of scheduled face to face encounters. Health science educators have deliberated how best to balance expediency and efficiency with reforms that address the changes required to meet new educational outcomes. Directions that alter the role of the teacher as the knowledge transmitter, promote student involvement, reduce content overload, promote capacity for self-direction, critical thought and evaluation of evidence are supported by a Knowledge Building theoretical framework but need to occur in a culture resistant to change (Boaden & Bligh, 1999; Towie, 1998).

The next section will focus on the specific research setting, describing the undergraduate course which is the basis for this case study and the academic and social characteristics of the pharmacy student community participating in the study.

3.2 Toward a Knowledge Building Community in a Large Pharmacy Class

The University of Toronto Pharmacy 3rd year self-care course (PHM 320F) is an environment replete with multiple limiting intricacies. We take a closer look at these constraints in this section, many of which follow from large-class size issues described previously. This autumn semester course is the final of two taught during second and third year. Students assume that the
design of the third year course will exactly duplicate the format of the preceding one and may request or resist changes. A cumulative objective skills clinical exam (OSCE), summative for both courses, occurs in early March three months after course conclusion, in which students must remember, integrate and apply knowledge and skills acquired over two years. Preparation for the exam during January to March is outside of the classroom.

Each class involves approximately two hundred adult students with prior baccalaureate or graduate educational degrees in varied disciplines including social sciences, health care, arts and basic science. Ages range from late teens to late twenties and cultural backgrounds include Oriental, East Indian, Middle Eastern and Caucasian heritage. While the goal is contribution to a professional community, the educational norm is that students work in isolation. The undergraduate emphasis is on individual achievement to meet stringent passing grades, exit competencies and high stakes licensure examinations. Competition between students is engendered through the system in which they vie for limited, coveted scholarships, summer jobs, and residencies based on academic performance. The curriculum facilitates this competition through its assessment system.

To standardize assessment, most courses use a variation of a formative and summative tool which assesses individual performance, the Solo Taxonomy Scale (Biggs, 1982), a global rating scale. It provides a method of analyzing qualitative data to validate cognitive processes of performance embedded within a mode of giving and receiving information in an objective, quantifiable 1-5 scale. This global rating scale has been acknowledged as a preferred tool to measure competence over thoroughness compared to other checklist-oriented assessments, thus distinguishing between a novice, who uses a detailed, stepwise approach, from an expert, who is not necessarily thorough, but very accurate in solving problems, and develop correct hypotheses early and with minimal information (Norman et al, 1985). In published health professional investigations, it has been demonstrated to be valid used alone (MacRae et al, 1995); to be reliable across raters (Cohen et al, 1996, Regehr et al, 1998; Regehr et al, 1999); and to have construct (Hodges et al, 1998; Regehr et al, 1998); and concurrent validity (Regehr et al, 1998). Specifically, compared with other test measures, this global rating scale, when used by expert examiners, has shown equal or higher inter-rater reliability, more accurate prediction of candidate’s training level (indicating better construct validity) and more accurate prediction of the quality of the final ‘product’ (which suggests better concurrent validity). Further, the use of
other measures did not substantially improve the reliability or validity of the global rating scale over the global rating scale used alone, when candidates with a wide range of ability levels were assessed. These data have been reported to suggest that the global rating scale is the most appropriate marking technique for problem-solving and competence measures and other or more extensive measurements are not necessary (Regehr, MacRae, Reznick, and Szalay, 1998).

This scale facilitates comparison of individual student performance across courses and is sometimes used to predict performance in future sessions (predictive validity). Notably, it is the global rating scale assessment measure for the 320F exit OSCE exam. It has reported construct and predictive validity and inter-station, inter-rater reliability in this examination (Sibbald & Regehr, 2003). Exam results are used to address individual student needs and placements in their fourth year workplace assignments. Students view the OSCE as high risk and prepare with diligence during the preceding months, limited by the cessation of face-to-face sessions.

Pragmatic constraints abound for students in PHM 320F. Most avoid socialization or collaborative work with peers, due to home responsibilities, part-time jobs, and long commutes. They are adept in mathematics and chemistry and seemingly comfortable with procedures that produced their independent successes. The curriculum is intense with nine concomitant courses. Together they create an added set of constraints on designs for new course procedures as students face a heavy workload and scheduling conflicts from this full network of courses, each with online requirements and milestone testing. Many courses are only thirteen weeks with little transfer or integration of content between courses. With time restrictions, students must balance efficiency in handling workload with effectiveness in knowledge acquisition. Most coursework is available online thus producing little incentive to attend class or interact with classmates unless required for team assignments. Technological enhancements have limitations. Home online communication may be slow remote modem. University high speed access involves considerable waiting for terminals. Students first attend to non-online coursework and may not access the Internet until after midnight. Most courses use student groups; they develop labour-division strategies to collate and distribute information. To reduce reading, asynchronous discussion notes are merged into documents posted on private websites. Weaker students may not develop ability to solve integrated problems or work independently, but rely on team-mates. For many assignments, task grades are shared. Students access discussion forums the night before an exam, not routinely. Volume creates high traffic and connectivity problems. In four years, enrollment
in these pharmacy classes has doubled. Increased academic diversity, overall lower examination scores, difficulty knowing students individually have all contributed to challenges in the effective design of courses. Independent study and self-directed work is encouraged through both online and written tasks to be completed by students.

Collaboration and adaptiveness, important to socio-cognitive and constructivist theoretical frameworks including Knowledge Building, represent a contrast to well developed procedures for school success as an individual achievement. As described by Biggs, they perceive individual and social success as unrelated. They attribute success more to ability than effort. They shun collectivist attempts to share knowledge and work collaboratively, exhibiting less effort than when working individually (‘social loafing’), and are not motivated to voluntarily work in groups. They have difficulty adjusting learning and assessment strategies appropriate to new contexts (Biggs, 1998). These attitudes, seemingly the result of the individualistic culture of schooling they have grown up in, and been socialized into, present obstacles to initiating and sustaining community Knowledge Building.

All twelve Knowledge Building principles were difficult to address and for the most part, represent a contrast to traditional procedures used in the 320F Pharmacy course that is the object of this thesis research. The most obvious contrasts are summarized briefly.

- **Discourse**: Little discourse occurred, and to the extent it did it was not knowledge-creating discourse. Students were hesitant to set forth their ideas for improvement, as they would risked peer criticism.

- **Collective Responsibility for Goals and Knowledge Advancement**: Students wanted responsibility for individual achievements not advancing community knowledge. Interdependence was limited to the assigned group term task.

- **Constructive Use of Authoritative Resources**: Learners focused unquestioningly on assigned reading to gain information for which they would be held responsible without pursuing other references, elaborating different perspectives in different resources, or seeking out additional readings to improve their ideas.

- **Assessment**: Evaluation of effort was primarily summative, and the teacher’s responsibility, not something embedded in the process of idea improvement.
Democratization of Knowledge and Levels of Engagement: A subset of students contributed to classroom discussions: the majority was not collectively engaged. Each team developed and taught one topic: working with a problem was the responsibility of one group, not the class. Thus, rather than efforts to see relationships between problems and to view problems from the different perspectives of different students, students worked independently.

Agency: Students typically avoided opportunities to take charge, believing that setting goals, monitoring progress, and other forms of knowledge work for advancing understanding to be the teacher’s responsibility.

Idea Diversity: Idea diversity was not viewed as helpful: the belief firmly held that there must be one correct, credible answer - the teacher’s. Without that, the class would lose focus and efficiency.

Idea Advancement: Reasonable preliminary evidence afforded quick consensus. Continual idea improvement required too much effort with little perceived added benefit.

Pervasiveness of Knowledge Building: Learning was confined to class, and efforts to engaged students in self-regulation and advanced knowledge work appears to be more relevant to advanced research or design teams, not to practitioners.

Authentic Knowledge Work: To the extent that there was authentic knowledge work it was the teacher’s idea of what was authentic that was the focus, and only one authentic problem per topic was explored, not the multiple variations that would surely arise if students were active in identifying problems of understanding.

Rise Above (Synthesis) and Collective Responsibility/Shared Goals: Students tended to see current educational practices, with clearly defined tasks and deadlines set by the teachers as more reliable and time efficient and fitting the goal of giving them a competitive individual edge, while sharing with others might allow them to get ahead.
3.3 Researcher Background and Perspective

The researcher is a pharmacist, and the professor who conducts the self-care courses at the Faculty of Pharmacy, University of Toronto, that is the context of this study. She obtained her undergraduate baccalaureate degree there as well, in the late 1970’s when classes were half as large, predominantly male, and primarily Caucasian. A full scholarship student, during her undergraduate years, she received a number of other scholarships and awards and developed an interest in teaching. She began teaching as a guest professor the year after graduation, while completing a residency at Toronto General Hospital and has continued to teach since that time. For many years she was a guest professor delivering the dermatology sections of these courses, while practicing as a drug information pharmacist at a teaching hospital and also a self-care advisor in a community setting. She became the coordinator of the courses in 1995, when the shift was made to a problem-based learning approach, and began a series of iterative course revisions to align with current pharmacy practice and educational theories. Subsequently, she was three times awarded the American Colleges of Pharmacy Innovations in Teaching Award for course designs, in 1998, 2001 and 2003; twice voted by students as Teacher of the Year in 1997, and 2009; as well as receiving a literary award from the Canadian Society of Hospital Pharmacists. She has published extensively in pharmacy education literature over many years, in the areas of dermatology, self-care, drug information and education, and is a frequent guest speaker both nationally and internationally. She serves on many committees and advisory boards in inter-professional health education.

From 1998 – 2001, she studied for and obtained a Master of Arts in Adult Education at the Ontario Institute for Studies in Education. Her thesis area focused on assessment: she developed the first Objective Skills Clinical Examination (OSCE) for pharmacy students in Canada and was the first to use junior students as standardized patients in health profession education. The thesis was titled: Impact on the Psychometric Properties of an Objective Structured Clinical Exam for Third Year Pharmacy Students - Using First Year Students As Standardized Patients. The following year she began her doctoral studies, also at OISE, in the department of Curriculum, Teaching and Learning, to continue her research in assessment as well as issues in Knowledge Building for Pharmacy students. She is a member of the University of Toronto Assessment
Committee for Inter-Professional Education, which oversees a program for ten disciplines, and also holds a leadership teaching certificate in Inter-professional Education from the University of Toronto (EHPIC).

As enrollment increased in University of Toronto classes, and classes diversified, she became increasingly aware of and concerned with the impact of these social changes on the classroom culture and student outcomes, as well as the accompanying demands on students, teachers, methods and environment. Interestingly, her daughter was a member of the initial larger classes and has graduated from the program. The researcher experienced from an intimate perspective how these challenges affected the skills and attitudes of her daughter as a student and new practitioner. Thus she was both professionally and personally motivated and encouraged to improve the learning environment, both within and outside of the classroom. She planned to design interventions to create a community environment that might engage students in forms of knowledge work more likely to help advance the profession. She hoped to advance the principles of Knowledge Building, theory, epistemic agency and collective responsibility that are so relevant and conducive to positive change, particularly in such a context.

3.4 Summary

This chapter presented an overview of the current status and future vision of the profession of Pharmacy in Canada, reviewing goals and standards of practice for pharmacy in Canada, and local jurisdictions. This context was provided to create understanding of the challenges to curriculum design that will be the focus of the study to be reported and to indicate how the theories of Knowledge Building, and in particular epistemic agency and collective responsibility, community knowledge might be advanced through this research. The goal is to contribute to effective education within the framework of the guidelines presented. The chapter concluded with an examination of the academic and social characteristics of the study participants.

The next chapter will describe the research approach: the research question; the case study methodology and the data collection and analyses employed.
Chapter 4
Study Design

4 Introduction

This chapter describes the research question, methods, data collection and analyses, and design strategies used during the pilot and experimental phase of this thesis. In particular the distinguishing characteristics of case study methodology are explained, as well as operational issues relevant to data analyses.

4.1 Questions and Theory Rationale

A case study approach was used to explore Knowledge Building interventions in a large enrolment Pharmacy class. The research question examines outcomes related to the goals of epistemic agency and collective responsibility for knowledge advancement.

“What classroom interventions and technological or social supports are effective in promoting Knowledge Building practices in an undergraduate Pharmacy course?”

The concept of Knowledge Building addresses the growing need for skilled professionals. A pharmacist’s primary responsibility is to educate patients about medication use as part of disease management or prevention. Given this expectation, it is important to prepare students for future roles in creating, refining and translating knowledge. Thus this thesis presents an effort to shift
from a traditional lecture-style training method to a Knowledge Building community (Scardamalia, 2002). The theoretical account of Knowledge Building presented in Chapter One guided this research.

### 4.2 Case Study Methodology

Case studies are a common way to approach qualitative inquiry (Stake, 1994). A case study is an exploration of a specific ‘bounded system’, defined over time and place, through detailed, in-depth data collection involving multiple sources of information rich in context (Creswell, 1998). Some consider a case study an object or set of experiences for intensive investigation (Stake, 1995) whereas others consider it a methodology (Meriam, 1988). The first step is to situate the case within its setting. The focus is the uniqueness of the case (intrinsic) or on issues which the case illustrates (instrumental) (Ragin & Becker, 1992). Case study research holds a long, distinguished history across many disciplines including anthropology and sociology. There is a large array of approaches from which to develop case study research. Yin (1989) espouses both quantitative and exploratory or descriptive qualitative approaches. Merriam (1988) advocates a general approach, in which an in-depth understanding of the situation and its meaning for those involved may lead to typification of other cases, generalization-producing or building or improving theory; Hamel (1993) provides problem-centred case study discussions; and Stake (1995) establishes systematic procedures.

Through data collection, a detailed description of the case emerges together with an analysis of themes or issues and interpretations or assertions about the case by the researcher (Stake, 1995). The analysis is rich in the context and conditions of the case setting, with detailed perspectives about a few incidents. The methodology can take advantage of theoretical principles to develop coding schemes to demonstrate how these concerns are manifest in the case (Stake, 1994). The interpretations involve the researcher’s reports of lessons learned (Lincoln and Guba, 1985). Most study work is done by researchers who have an interest in the case and can interpret and glean insights about what is important within that world (Stake, 1994).
Single case studies allow for in-depth accounts of settings with clearly specified time, events, and processes. The case itself is worthy of study by virtue of its individuality, and is not meant to be transferable (Creswell, 1998). Stake asserts the emphasis is to design the study to optimize understanding of the case by pursuing scholarly research questions rather than to generalize beyond it (Stake, 1994). It gains credibility by triangulating the descriptions and interpretations, throughout the period of study. As qualitative research, the case study concentrates on experiential knowledge of the case and attention to the influence of its social, political, cultural, situational and other contexts. The case is a complex entity located in a milieu embedded in a number of backgrounds, which are well described and make the relationships between them understandable. A researcher may derive theoretical conclusions through case study examination: the setting provides the context to explore qualitative research which generates or advances theoretical concepts about social processes (Bogdan & Biklen, 2003). While people, places and their interactions are constantly changing, concepts and processes endure and are the building blocks of developing theory (Glesne, 1999)

Knowledge is socially constructed, and learning from a case study involves experiential knowledge through the report of observations, and contextual accounts of phenomena. These rely greatly on subjective data and when the researcher is present to experience the context themselves, descriptions, and interpretations are grounded in deeper understanding. Researchers, particularly those who actively participate in the case setting, confirm the clarity of their perceptions and validity of their communication through procedures which triangulate data collection, a process of using multiple analyses to identify different perspectives through which the data is seen, explained and made more objective (Stake, 1994). Alternative patterns of data help develop the issues and assertions, providing the grounds for validating case study insights. The utility of case study research contribution to other practitioners is through extension of disciplined personal and particularized contextual experience, illuminated in depth in a localized configuration (Stake, 1994, Miles & Huberman, 1994).

The focus of this research is on design challenges, and change over time to highlight accomplishments not typically found in large lecture-class contexts. Due to the requirement of providing standardized classroom procedures for all students, a single case study approach is taken. It will address data collection techniques, data analyses, and concerns of reliability, validity and ethics germane to all forms of qualitative research (Merriam, 1988). In case study
methodology, the aim is for robustness since the power of single-case studies is derived from compelling “extreme or unique” cases that present themselves with rare opportunities to “observe and analyze a phenomenon previously inaccessible to scientific investigation” (Yin, 1994). In the current study, I present a series of data collection techniques and analyses in a unique setting, with large class size (n=182), newly created for the study cohort but with design features that could be adapted to large class sizes across health care education. Having the opportunity to attempt to implement Knowledge Building pedagogy and technology in this unique site allows for important analysis of a single one-of-a-kind context.

Multiple data sources will be used to explore Knowledge Building indicators, with evidence from documents, records, or surveys used for course assessment purposes. Quantitative and qualitative data will include student outcome measures, surveys from students, researcher, guest lecturers and observer/raters.

4.3 Course Background Prior to the Study - Fall 2004: Pre Knowledge Building Course (F2004: Pre KB)

The first course design involved three formats based on what many might refer to as “constructivist principles”: one web-based, and two non-web-based, including: completion of a published electronic-based (e-based) case created for the class website as an interactive learning tool; preparation/ peer teaching of topic summaries/ exemplar cases to peers; and creation of mock cases/answer keys for role playing exercises using junior students as patients. Despite several years of successful implementation, involving novel and seemingly effective tasks to actively engage students, a number of issues of increasing concern were evident to the instructor through quantitative and qualitative assessments. The issues that prompted the need for change included gradual decrease in examination scores over four sessions; increasing class size from 120 to 200 students (240 by 2007); lack of individual preparation for class; work orientation towards one or two tasks; minimal skill development; inequitable efforts within teamwork; lack of class attendance or engagement; plagiarism; inconsistency in peer teaching; lack of input from authoritative sources; and insufficient individual accountability and assessment.
4.4 Pilot Study - Spring 2005: Knowledge Building “Panel”
Design Added to Course (S2005: KB Panel)

Given growing concerns indicated above, the instructor planned an alternative approach to delivering the course based on the twelve Knowledge Building principles pioneered by Scardamalia (Scardamalia, 2002) to address the need for improved engagement and content/skills development at both the individual and community student levels. A pilot semester with third year students who had completed the second year course with the former design was conducted to explore design changes and provide recommendations.

The format was changed to a panel format, which occurred over 80 minute class periods in an interactive session with required attendance. In the introductory class, students were introduced to the twelve Knowledge Building principles and a set of scaffold supports to present and improve ideas.

Individual students prepared content information for each of fifteen topics, and participated as a panel member, along with twenty-five other students, twice in the semester. They did not know in advance if they would be assigned to the panel or to interact actively with the panel as an audience member (their turn on the panel was determined by random assignment), thus students needed to be constantly prepared. They could refer to notes and references. The instructor presented an emergent case, gradually giving information in response to the students’ discourse consisting of queries and suggestions. The panel had to solve the patient’s problem. Individual students were assessed by a peer faculty instructor, serving as an observer/rater (subsequently referred to as ‘TA’), using a global rating pass/fail scale that will be elaborated below. Students had to pass each panel to pass the course.

For the ‘Spring 2005: Panel Innovation’ implementation, the three tasks from the ‘Fall 2004’ implementation were retained to facilitate comparisons. Students completed a survey evaluating value of the panel vs. the three tasks with respect to Knowledge Building determinants. Both
performance (quantitative) and perception (qualitative) measures were compared (three tasks and one panel) to analyze relative impacts on Knowledge Building determinants.

The positive responses and reactions from students created an intuitive sense in the researcher that the panel was an important design component and became the motivation to conduct this research. These encouraging reactions are briefly summarized here in order to capture these incentives as an impetus for proceeding with the study design.

The results of this pilot indicated in general that participants were enthusiastic in their support of the panel design and loved the opportunity to discuss complex, real life issues with their peers in class, expressing that it was a very good change in teaching technique. They felt it was different, creative and extremely effective in helping understand each topic on a deeper level allowing them to learn more. Since most students learn in isolation without benefit of peer interaction, they identified increased awareness of the knowledge processes ongoing during the panels and improved audience engagement and participation. Classes were much more interactive and panels stimulated lively discussion among the audience as well.

Based on the results of this pilot, several key themes emerged. First, and interestingly from the perspective of epistemic agency, students acknowledged a change to self-direction and taking responsibility for their own active learning. They spent more time on learning aspects that needed more attention in their personal viewpoint. They felt enabled to ‘think the cases through in a 'problem-based' manner...where they had an objective in mind and selectively gathered knowledge to achieve that goal’. They felt that gathering information and working out the problems on their own was good motivation for self-learning: sometimes information was contradictory and they had to begin to master the difficult chore of choosing the right approach on their own, ‘taking learning into their own hands.

Secondly, and related to the theme of agency, was a change in the degree of preparation for class. The panels ‘forced’ students to learn efficiently and as much as possible on their own keeping up with the readings prior to each class, in anticipation that issues would become clearer during the sessions. They related that they tried hard to understand things on their own before ‘risking’ discussion in front of peers and spent more time on this than they normally would have. They did this continuously, which ensured they truly "absorbed" and made sense of the material.
“Skills lab-made me work very hard independently on an ongoing basis to make sure I knew my information before coming to class. I really tried hard to understand things on my own before risking going in front of people.”

“New format enabled self-directed learning and confidence in my abilities. I also thought that I learned more having reviewed the literature each week than I would had it been purely didactic.”

“Allows me to take my learning into my own hands and forced me to learn as much as possible on my own and then things became clear during the lecture.”

“It kept me learning the material continuously. This is a good way to keep us on track and to make sure that we truly "absorb" and make sense of the material.”

“It taught me to read actively, by thinking about the therapeutic thought process as I read the literature. It requires the student to take initiative and self-direct their learning.”

Of particular interest in terms of collective responsibility was the importance as expressed by participants, of learning from their peers and the community group discussions. This was significant since pharmacy students in prior classes preferred to learn in isolation without benefit of peer support or interaction. This is illustrated in the following comments:

“New for me was that it helped me get other perspectives from my peers. I used to prefer to work alone but I find I enjoyed working with people to hear their ideas and their thought process.”

“It challenges me to prepare but then to try to learn and decide together what is the optimal treatment that is specific to the patient that has been presented. You must work together as a class.”
“The panel required integrating information from many sources which was good for reinforcing many important points. I learned more through discussion in class and with classmates and I think because of this I’ll retain it all a little longer.”

“Panel forces you to look at the material from all points of view from the class discussion.”

“Panels allowed me to learn about a topic for myself and then incorporate the views of my peers and other professionals. This allowed for a broader perspective regarding the topic and was an encouraging way to learn.”

“Panels are great in that they bring up a lot of different insight and a lot of different point of views that one might not think of on their own.”

Pilot students felt everyone was very cooperative and there was more interaction within the classroom setting and more opportunities for all students to put knowledge into practice, having equal participation. They indicated this interactive learning component helped them to better retain the information being presented when discussing cases and that integrating independent learning with interactivity helped reinforce concepts. Many felt learning through small group discussions had become their favourite way of learning. Most enjoyed working with people to hear their ideas and their thought process that helped them overcome shyness, and to discuss with classmates and share ideas, allowing each student to add some points about the case as they wished. They thought the group discourse also helped up to bring up issues/topics that might not have been done if they worked independently. The panel sessions allowed them to hear what others had to say and helped them understand other perspectives, considering all points of view since ‘people do different things in practice’. They appreciated that in coming prepared to class, basic understanding of topics was already there. Thus they were able to appreciate the discussion regarding the complexities of the topic more, and still have the opportunity to fill in any gaps in their own pre-class preparation, increasing understanding ‘by getting clarifications from the rest of the class’. They indicated there was synthesis of ideas, working together as a class, to incorporate views of their peers and other professionals, which allowed for a broader perspective
regarding the topic: this was an encouraging way to learn. They noted that integrating information from many sources was good for reinforcing many important points, and by learning more through discussion in class and with classmates they thought they would retain it all longer.

Another important theme was the participants’ perception that panels increased their acquisition and development of content and skills more than other designs. By participating in a class discussion which was time dependent, it gave the opportunity to practice a skill that all pharmacists must have: considering all the information and narrowing possibilities in a short time frame. The emergent problems were felt to be more of applied use – more relevant to what a professional might encounter in the everyday workplace. They thought the panels invaluable because they were able to highlight important information for practice and give the confidence to be able to explain things to patients. These feelings are captured in the following quotations:

“Panels helped develop skills that are necessary in any practice setting, which we did not learn through the group tasks.”

“Panel activity made you think about the different possibilities that may arise in certain situations. A pharmacist must be able to take in all the information and narrow the possibilities down in a short time frame. Our group assignments look at one case only.”

“More of an applied use of what one might encounter in everyday life, rather than the task example.”

“I found the panels invaluable because they were able to highlight the important information for practice and give me the confidence to be able to explain things to patients. We did not address this in our group assignment.”

Finally students felt the panel discussions changed the way they learned in a variety of ways. By preparing, and listening to discussions they learned more from each week’s class even if they were not on the panel. They were better able to keep up to date with the material. Importantly they felt that they already knew and remembered information when examinations were held, and
that it had promoted life long learning. It taught them “to think outside of … what is written in the textbook/supplemental readings and to realize that each situation that a pharmacist encounters (although similar in many aspects) must be treated in its own way.” Many noted that panels help prepare them to use critical thinking while reading, and improve efficiency with time. It pushed them ‘not to just memorize the details, but also to integrate the information in a systematic way to help facilitate the problem solving. Most agreed they learned better and loved the fact that they ‘don't know what patient problem will evolve, which really makes the situation real.’ This encouraged them to consider every situation: ‘I never knew if the patient was going to be a child, elderly, pregnant, etc. It made me consider how I would change my recommendation depending on these factors.’ From a Knowledge Building perspective, this may signal moving away from a tendency to identify only one problem with one right answer, waiting for confirmation from a teacher as external expert; and represent a student shift toward epistemic agency.

The pilot confirmed the need to engage individuals within a community environment as a powerful learning context and address issues of epistemic agency in assuming more control over their goals and outcomes. It built understanding that would be more effective for course design. The researcher planned alterations for the study design, reviewed and approved by outgoing and incoming student representatives and guest lecturers to ensure improvements had collaborative input and endorsement reflecting participant feedback about collective needs.

4.5 Case Study - Fall 2005: Five Knowledge Building Design Features Added to Course (F2005: 5 KB Designs)

4.5.1 Participants

In September, 2005, 183 undergraduate students, 0T7 class, began the 13 week PHM 320F course. This session iteration enhanced 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 protocol reviewed by the Student Education Ethics Review Committee.

4.5.2 Ethics

The pilot was run January to April, 2005. The study occurred September 2005 to March, 2006, with the class in session from September to December, and the summative exam in March. Data analysis commenced in the autumn of 2008. Participants were aware that data analyses of online participation, marks, or survey results were not part of course assessment. Participants were ensured they could volunteer to have their data analyzed after the course, refuse, or withdraw, during or after the study at any time without negative consequences.

Participants, including students, pharmacist observer (TA) raters and guest lecturers signed an informed consent which explained the nature of the study, procedure description and the option of withdrawing consent to use data during or afterwards (See Appendix 1 and 2). Since assignments and surveys were part of course requirements, they could not refuse submission of these and receive a course completion grade. However, they were allowed to decline to answer any question within the surveys.

The researcher is aware there are ethical and methodological challenges associated in conducting a case study of her own class. She acknowledges that although she is an experienced researcher who understands the importance of objectivity, nevertheless as the responsible professor, she might have feelings and biases that might be perceived as influencing interpretation of collected data. Students might be wary about responding candidly on questionnaires. Accordingly she reflected thoughtfully about these and took steps to follow recommended research guidelines to reduce concerns. Student anonymity was emphasized and guaranteed by use of number identifiers in surveys submitted to a database, rather than names. Interviews were not conducted: rather, the perspectives of students were gathered through use of online surveys which included free response sections. Two different surveys were used to capture participant perceptions in
various ways (Appendix 5 and Appendix 8). No handwritten comments were collected. Analyses of responses and results were not undertaken until more than one year after graduation, which was more than two years after the course. Metrics and measures were chosen that would limit interpretive bias as much as possible, such as use of non-participant faculty observers (TAs) as raters, inter-rater reliability testing, and introducing hard data analyses in addition to qualitative measures.

Qualitative analyses are particularly important in case studies, since the context of the phenomenon is under investigation. The goal is to understand in depth, the experiences, beliefs, hopes and anxieties of the participants and to comprehend how they perceive matters in their world. These must be reported factually and not from the perspective of the researcher. To ensure objectivity, traditional qualitative strategies were used for validating the research, including using a second peer assessor to provide a cross-check on a subsample of twenty percent data rated by the instructor (researcher); triangulating sources of data; and using peer raters. An external statistician independently analyzed all quantitative data.

4.5.3 Research Design

"...I believe that education, therefore, is a process of living and not a preparation for future living."  
John Dewey

The study design focused on the advancement of the two principles, epistemic agency and collective responsibility - community knowledge. Combined, they focus on empowering students to take charge at high levels of the educational process, as a community process. However, it should be emphasized that all Knowledge Building principles operate as a complex system integrated into each design feature and the various facets cannot be viewed in isolation. Additionally, the design implemented conformed to and were conducted within limitations of the current context.

Conceptual Framework: In this context, the curriculum structure was pre-determined and included fixed content, with classes facilitated by an expert practitioner. Knowledge Building
requires high levels of student engagement with top-level goals so that they can set forth the ideas of consequence for their knowledge advances. They co-design the work of value to the community. This social process involves self-testing to engage in collective advancement of their work, and eventually self-regulation in the workplace.

**Design:** The design challenge in this research was to advance principles of epistemic agency and community responsibility by engaging students in elements of the course that could be altered while working within all curricular guidelines. The design centered on retaining the pilot classroom panels as a key feature, now approved by the curriculum committee, and added two other components, namely student-generated self-assessment exam questions and online discussion views to facilitate Knowledge Building, primarily through the affordances of Knowledge Forum™. The hope was that these Knowledge Building opportunities would counter some of the constraints of large class size which present management issues of attendance, communication, socialization, balance of power and evaluation. To give students more agency, 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.

**Goals:** The targeted advances for the study design were to provide an environment conducive to the development of epistemic agency and collective responsibility by shifting the responsibility of creating knowledge from the ‘experts’ only to the student community; and that students would progress and interact not just as individuals but as a community united in the pursuit of commonly held educational goals.

Table 3 summarizes the iterative changes in design features in the pre-study, pilot and study sessions.

Following Table 3 is a detailed summary of each new design feature, linking the design to Knowledge Building principles, and describing the feature and outlining its goals. This is followed by a description of the data collection and methods of data analysis for each design. At the end of this section is a table which summarizes the data collection, listing design features, and the tools and measures used for a triangulated data analysis.
Table 3

Evolution of Course Design Changes:
[F2004 – Pre KB]  [S2005 - KB Panel]  [F2005 – all KB Designs]

<table>
<thead>
<tr>
<th>Session for Course Design</th>
<th>Lecture Format</th>
<th>Task Assignments</th>
<th>Classroom Panels</th>
<th>Student-Generated Self-Assessment Exam Questions</th>
<th>Knowledge Forum Discussion Views</th>
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<td>Knowledge Building Designs</td>
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<td>Pre Class</td>
<td>Post Class</td>
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<td>Exam Questions</td>
<td>OSCE</td>
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<td>Fall 2004: Pre Knowledge Building Course</td>
<td>☑️</td>
<td>☑️</td>
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<tr>
<td>Spring 2005: Knowledge Building “Panel” Design Added to Course [Pilot] Study cohort Year 2 of curriculum 1st of 2 courses</td>
<td>discontinued</td>
<td>☑️</td>
<td>New</td>
<td></td>
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4.5.3.1 Classroom Panels

**Conceptual Framework:** Many educators see student driven inquiry as a high-water mark of constructivist education. Knowledge Building participants contribute to the cultural capital of their community by contributing ideas and problems of interest central to the work of the group. This fundamentally social process requires all members contribute to community dynamics for the continual improvement of knowledge. It also requires constructive use of authoritative sources, another Knowledge Building Principle, and continual idea improvement in light of resource material. In medical education, students must deeply understand the ideas they will be working with in a clinical setting. The reflective practice curricula proposed by Schón, and Scardamalia and Bereiter’s Knowledge Building framework applies a progressive problem-solving methodology to the material, subjective and objective worlds of knowledge and aims at creating improved materials, social practices and cultural and conceptual artifacts as outcomes of that process (Russell, 2005). The question was how to include features which would advance the
theoretical principles of epistemic agency and collective responsibility and integrate the epistemology in the classroom culture?

**Design Feature:** A key design challenge was to alter the structure and conditions of a large lecture-based classroom. The large-lecture context offered students little motivation to attend classes (Full lecture notes were posted online and they could get lecture notes from those who did attend). The goal was to create a more dynamic environment involving all students in discussion and collaborative building of new ideas. A new design involving classroom panels was tested as a step toward this goal. Overall, 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 then elaborated relevant knowledge, presented this during their panel time, and engaged others in collective Knowledge Building discourse to address the problem. The 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 an agenda to advance their collective goals, modeling those of the expert facilitator.

### 4.5.3.2 Student-Generated Self-Assessment Exam Questions

**Conceptual Framework:** Epistemic agency engages learners in high level processes that teachers normally direct, particularly in the area of assessment. Intelligent assessment of cognitive tasks requires meta-cognition. Reflection is part of Knowledge Building processes. This is an important aspect of self-testing and self-regulation. Research which explores self explanation, self-reflective evaluative techniques or self-testing may advance learning processes and enhance professional self-regulation. This should be done in environments which provide mutual support, constructive criticism and sustained effort at idea improvement to further community understanding.
Sircar reported one project where medical students provided questions for multiple choice examinations, students were not promised these would be used (Sircar, 1999). Baerheim and Meland allowed groups of students to propose essay type case questions for exams which had a one in three possibility for inclusion; however teachers maintained control by reserving the right to both alter and add to the questions (Baerheim & Meland, 2003).

**Design Feature:** Linking learning and assessment to the classroom panels, a system of pre and post panel self and peer assessment was carried out. 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. Here is an example:

Amy is a 17-year-old patient who is a regular customer in your pharmacy. She developed inflammatory bowel disease and was placed on oral steroids for management one month ago. She now visits your pharmacy on a Saturday morning because while during the last week, she developed a red rash on her face. Amy is a fair-skinned blonde who has bright blue eyes. She normally takes exceptional care of her skin. She has never had problems with blemishes before. This pustular rash also extends to her back, arms and chest. She is going on a one week vacation to France tonight. She has packed sunscreen (oil free) to use while away but she needs your advice about what to do for her rash. The best advice for Amy at this time would be:

1. Mild soap, OTC antibiotic lotion or referral for Rx topical antibiotic, continue steroid
2. Mild soap, referral for benzoyl peroxide/antibiotic combination, discontinue steroid
3. Avoid soap and scrubbing, benzoyl peroxide 5%, comedone extraction, discontinue steroid

Students reflected on the quality of their question after experiencing community Knowledge Building during the panel. After the panel discussion, students reflected on what they had learned and had the option of revising their test item, presumably creating an improved version of their
test question. They submitted the pre and post versions to the instructor and explained the reason for the editing if it had occurred. Overall, each student generated one pre—post panel question. The post panel questions without the answer or strategy on how to solve the case, were then contributed anonymously (as ‘testposter’) for community discussion and improvement on an ‘examination question’ view on Knowledge Forum™. Up to fifty percent of the examination can consist of student-created questions.

While students in any course should improve with practice, the literature reports inadequacies in self-regulation and voluntary self-reflection: student self-assessors are both weak judges of their own performance, and unwilling to seek opportunities to redress gaps. The goal in this design is to empower individual and collective responsibility to redress these deficiencies. Epistemic agents are not dependent upon teacher assessment, but assume responsibility to identify problems, using self-reflective evaluative techniques to monitor them individually and collectively. Thus, student ability to generate and improve questions is an indication of epistemic agency and community knowledge through the individual student’s efforts. The design is linked to the classroom panel, in that the activities centre on the same topic, yet occur outside of the classroom before and after panels, extending the learning context and addressing the principle of pervasive knowledge building. By posting the improved question from each student on a discussion view in Knowledge Forum, it further enables the principle of community knowledge, collective responsibility, by empowering everyone in the class to assess and improve the individually created questions.

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

**Conceptual Framework:** The theoretical principles of epistemic agency and community responsibility extend the boundary of learning from an individual to a collective enterprise. All community members are responsible for engaging in thinking and problem solving. When their work is contributed to a public forum, with all members building on the ideas of others, using authoritative sources to constructively and continually improve those ideas, they are engaged in
Knowledge Building discourse. This display of knowledge advancements heralds the shift of responsibility from expert to student, and is a collective cognitive responsibility.

**Design Feature:** In addition to classroom panels, and student-generated self-assessment exam questions, student discourse occurred in an online Knowledge Building Environment. 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.

The goal in this design is to create a sustained yet dynamic environment involving all students in discussion and collaborative building of new ideas beyond the limitations of the large size classroom. Student work in KF enhances collective responsibility by facilitating continuation and progression of discussion, and building synthesis from previous work, especially when semester classes are concluded but the oral exam two months later requires preparation.

**4.5.4 Data Collection and Analysis**

Data will be 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.

**4.5.4.1 Classroom Panels**

As a source of data for this case study, the panel analysis will begin qualitatively with a narrative description of the participants’ experience based on the researcher’s and student written observer notes. A detailed account of a sample panel will be presented, including student comments and various contributions, and describing how the discussion evolved. It is hoped this example will
make it possible to assess whether the class panel demonstrated the Knowledge Building principles operating cohesively with special attention to the two themes of epistemic agency and community responsibility.

To quantitatively assess students’ Knowledge Building during panels, instruments were developed that incorporated all 12 Knowledge Building principles. Knowledge Building principles operate as a complex, interactive system, with no clear dividing line between one principle and another. Thus epistemic agency and collective responsibility, community knowledge are inextricably related to other aspects of knowledge building. Consequently, the instruments involve all 12 principles. Ratings took two forms: (a) pharmacist observer (TA) and researcher ratings of student engagement in Knowledge Building (Appendix 3); (b) students self-assessment of their engagement in Knowledge Building (Appendix 4).

4.5.4.1.1 Observer ratings of student engagement in Knowledge Building (Appendix 3)

Ratings of student engagement with each of twelve Knowledge Building principles were obtained from pharmacist observers (TAs: teaching assistants) who had expertise in this content area (n = 14). Each rated one panel. The instructor (this researcher) rated each panel (n = 15). Each of 12 Knowledge Building principles was assigned a value on a scale of 1-5 and results analyzed to identify the extent to which observers thought the panel as a community was engaged in each aspect of Knowledge Building, and if so, to what extent for each principle.

4.5.4.1.2 Student ratings of their own engagement in knowledge building (Appendix 4)

Student participants (n = 182) completed the same rating instrument of 12 Knowledge Building principles used by pharmacist observers (TAs). Ratings were collected from 138 students after completion of one panel (their first).
For the purpose of analysis, to address the questions as to differences in rating by observer versus participants, a series of independent-sample $t$-tests will be performed to compare ratings from 138 students and 14 pharmacist observers (TAs). An alpha of .01 rather than 0.05 will be used for significance for this analysis because of the high number of related tests. The Levene’s test for homogeneity of variance will be examined for significance of $t$-test results.

Since only the instructor (this researcher) rated all 15 panels, it is not possible to establish inter-rater reliability between this researcher’s and the pharmacist observers’ (TAs) results because there is no other rater who rated all the panels to provide consistency for second rater comparisons across 15 panels. Therefore, this researcher’s ratings will not be included for comparison to simplify reporting and analysis. Alternatively, several instances of this researcher’s vs pharmacist observers (TAs) ratings will be contrasted to provide some descriptive comparisons.

4.5.4.1.3 Student ratings of their own engagement in content and process building skills (Appendix 5)

To examine the participants’ perception of their own engagement in Knowledge Building in the panel design as compared to the 3 task designs, an online survey (Survey One) was used to record relative ratings for the four features and to analyze feelings and perspectives in a comment section, as described below.

To assess students’ accomplishments relative to 17 content and 8 additional course objectives, an instrument was developed that incorporated 25 items (scale of 1-5) comparing for the panel vs. 3 tasks designs. The survey also asked them to rank their preference of the four designs. As reviewed in the previous chapter, any changes in course format have to function within the boundaries of the competency standards set by the curriculum. The instrument therefore had two goals: data for the study and data to present to the curriculum committee. The twenty-five items, therefore, were the curriculum course objectives for knowledge and skills and had to be included to present results to the curriculum committee as evidence regarding student opinion of the panel, to support formal acceptance of the panel as a design.
As the original intended use of the survey results was not directed towards evidence for this research, not all items are relevant to analyze and report. Results will be reported for the one individual item most directly related to epistemic agency as well as for the combined 25 items.

Students were also asked to reflect on how the different designs affected the way they learned. Comments were optional and anonymously contributed to the data base and could be given freely. Ratings and comments were collected after completion of the course (in the spring of 2006). Comments were analyzed. The data were read to create themes and identify patterns. Coded transcripts were analyzed using the ATLAS/ti™ software program for qualitative data analysis (see Appendices 10 – 13).

### 4.5.4.2 Student-Generated Self-Assessment Exam Questions

As a source of data for this case study, the analysis of student-generated self-assessment exam questions begins qualitatively with an explanatory account of the participants’ experience. From selected topics, examples of student-generated questions and notes written in Knowledge Forum™ are described, to demonstrate levels of epistemic agency and collective responsibility, community knowledge. Sample comments by students that reflect these principles are extracted. These comments are used to provide a descriptive analysis of the developing discourse, profiling the demonstration of these principles, as experienced by the students.

This narrative report is followed by two types of quantitative analyses of the self-assessment questions.

The first analysis involves an instrument used to assess students’ idea improvement. The corresponding Knowledge Building principle is idea improvement. The analysis instrument was the Solo Taxonomy Scale (1-5) of Collis and Biggs, in two different contexts of use, described as follows (See Appendix Six).
4.5.4.2.1 Comparison of Student-Generated Questions: Pre vs. Post Panel Submissions

Each student (n = 182) had a set of submissions (pre and post comparisons). The researcher instructor assessed all pre and post panel items using the Solo Taxonomy Scale (1-5) of Collis and Biggs: (1 = pre-structural; 2 = uni-structural; 3 = multi-structural; 4 = relational; 5 = extended abstract.) A second assessor also provided a cross-check on a subsample of 20% of the questions) and inter-rater reliability was calculated.

The pre and post submissions required the learners to evaluate their own understanding, a process normally controlled by teachers. Using the Solo Taxonomy scale to analyze the degree of change in their understanding, as demonstrated in the sets of comparisons, reflects advances in epistemic agency and collective responsibility. The second analysis involves an instrument that was developed to rate questions as generated by student or teacher, in order to assess the quality of student versus teacher assessment (see Appendix 7).

4.5.4.2.2 Comparison of Student vs. Instructor Generated Questions

The quality of student-generated test questions was compared to test questions created by instructors of varying levels of graduate education and teaching experience (B. Sc. Phm; Pharm. D.; or M.Sc. / Ph.D.). This reflects whether students can achieve levels of assessment individually or by community efforts that are of the same caliber of faculty controlled evaluation. A survey instrument was created that presented a series of blinded test questions, randomly ordered so raters had no way of knowing who generated the items, from students and instructors of varying levels of graduate education and teaching experience. Instructor questions were extracted from the examinations administered in the case study year (see Appendix 7). Raters were solicited from the roster of appropriate faculty of Pharmacy professors (n = 16). This represents a saturated sample of possible raters, since the selection options are derived from a small group of content experts.
4.5.4.3 Student Evaluation of Designs to Facilitate Knowledge Building Activity

To assess students’ perceptions of Knowledge Building through these study design features, a survey instrument was developed that incorporated all 12 Knowledge Building principles (Survey Two, see Appendix 8) compared for each design. Ratings and comments were collected after completion of the course (in the spring of 2006).

Students (n = 182) completed an online survey (Survey Two) after completion of the course to evaluate study design features (classroom panels; student-generated self-assessment exam questions; and student discourse in an online Knowledge Building environment separated into 3 views: pre panel, post panel, and OSCE views, for a total of 5 separate items) to be rated on a scale of 1-5, for each of these items (sample views are found in Appendix 9). The survey also asked them to rank their preference of the designs. Results will be reported for ratings for the principles of epistemic agency and collective responsibility as well as for the combined 12 principles.

Students were also asked to reflect and comment freely about how the different designs affected the way they learned. Comments were optional and anonymously contributed to the data base and could be given freely. Survey comments were contributed after the course ended, in the spring of 2006. The OSCE competency examination was forthcoming. Students responded while preparing for the exam.

Similarly as with Survey One, Survey Two comments were read to create themes and identify patterns, using the ATLAS/ti™ software program for qualitative data analysis to code and analyze the transcripts. One rater, the instructor (researcher) rated all notes. An additional peer pharmacist rater rated twenty percent, with an inter-rater reliability of r = .90. Themes for epistemic agency and collective responsibility, community knowledge are examined (see Appendices 13 - 15).
4.5.4.4 Idea Improvement

Change, pre to post panel submissions, for student generated self-assessment exam questions represent a clear measure of whether idea improvement occurred for that design. However, for the case study course format as a whole, it is interesting to see if there are indications of idea improvement overall. As indicated previously, Knowledge Building principles represent an interactive system of affordances for Knowledge Building, functioning as an ecosystem if interdependent. Thus, idea improvement, a single Knowledge Building principle, is inextricably attached to epistemic agency and collective responsibility, community knowledge. The following analyses aim to take a closer look at Knowledge Building processes by considering ways in which engagement in Knowledge Building relates to idea improvement, as reflected in more general outcomes such as course scores and independent assessments of their knowledge growth.

4.5.4.4.1 Course Scores: (F2004: pre KB) vs. (F2005: all KB Designs)

Means for the third year course completed without the full design features (class 0T6, F2004) will be compared to the means for the third year course with the combined study designs (class 0T7, F 2005) to reflect community Knowledge Building. The goal of this analysis will be to provide indication whether the designs leading to greater engagement in Knowledge Building also led to more idea improvement in the case study cohort of participants from 0T7, F2005.
4.5.4.4.2 Course scores: 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs) and second year (2004-5) vs. third year (2005-6) GPAs

Course scores and overall GPA cannot, in their own right, measure ‘idea improvement’ as discussed above. Notwithstanding, these statistics are examined for trends or influences that might reflect idea improvement.

Obviously, students naturally improve learning over time. However, in general, the curriculum course load is considerable heavier, and subjects much more difficult in third year as contrasted to second year. Historically, third year has been considered the most difficult year of the program, with most students performing less well, and with the highest number of failed students. With this in mind, it would be interesting to review what happened to the student cohort (OT7) students’ performances in other courses in second vs. third year, as contrasted to the self care courses in second (S2005: KB Panel) vs. third year (F2005: all KB Designs).

Means for the second year course completed with only the panel design feature (S2005: KB panel) and means for the third year course with all combined study designs (F2005: all KB designs) will be compared to the second and third year GPAs. The goal of this analysis will be to provide indication whether the designs leading to greater engagement in Knowledge Building also led to more idea improvement in the course context as reflected in improved course scores compared to anticipated negative trends in students’ grade point averages over these two years.

4.5.4.4.3 Course scores: 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs)

Traditionally, the third year program is more difficult and the average mean course scores usually decrease in all Pharmacy courses due to increasing demands of content and heavier course loads overall. Out of interest, the next set of analyses examines whether the increase in the course scores from second to third year, is meaningful.
Means for the second year course completed with only the panel design feature (S2005: KB panel) and means for the third year course with all combined study designs (F2005: all KB designs) will be compared. The goal of this analysis will be to seek indication that the designs leading to greater engagement in Knowledge Building also led to more idea improvement in the course context as reflected in improved course scores, despite overall increasing difficulty of course content and resultant decreases on average for third year pharmacy courses.

Table 4 summarizes the main design features and the data sources used to analyze progress towards the epistemic agency and collective responsibility, community knowledge.
## Table 4

### Design Features, Data Analyses and Data Sources

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<th>DESIGN FEATURE</th>
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<th>DATA SOURCES</th>
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<td>Observer ratings of student engagement in panels</td>
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<td>Student ratings of their own engagement in Knowledge Building</td>
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<td>Student ratings of their own engagement in content and Knowledge Building processes: panel vs 3 tasks designs</td>
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<td>• Mean Likert scores</td>
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<td>• Repeated-measures ANOVA (means for each design feature compared: GG correction for significance)</td>
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<td>• Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance)</td>
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<td>Qualitative Analysis of student commentary themes- epistemic agency, collective responsibility</td>
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<td>Student-Generated Self-Assessment Exam Questions</td>
<td>Samples of student questions and their reflections on those questions, recorded in Knowledge Forum.</td>
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<td>Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions</td>
<td>• T-test of pre vs. post scores – Solo Taxonomy (1-5)</td>
</tr>
<tr>
<td></td>
<td>Comparison of Student vs Instructor Generated Questions</td>
<td>• Inter-rater reliability – Pearson correlation coefficient</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Survey Instrument</td>
</tr>
<tr>
<td></td>
<td>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™)</td>
<td>• Estimation of Student vs. Instructor author</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Friedman test (authorship vs. percentage correct)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Wilcoxon paired test (percentage correct for student items vs all others)</td>
</tr>
<tr>
<td>Student Evaluation of Designs to Evaluate Knowledge Building Activity</td>
<td></td>
<td>Survey Two (online):</td>
</tr>
<tr>
<td></td>
<td>Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions (described previously under section 4.5.4.2)</td>
<td>Ratings for:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- epistemic agency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- collective responsibility</td>
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<tr>
<td></td>
<td></td>
<td>- 12 principles combined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mean Likert scores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Repeated-measures ANOVA (means for each design feature compared: GG correction for significance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance)</td>
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<td></td>
<td></td>
<td>- Repeated-measures ANOVA (means for each design feature compared)</td>
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<td></td>
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<td>- Pair-wise comparisons - Sidak method (response for each feature compared to others for difference in significance)</td>
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<tr>
<td></td>
<td></td>
<td>Analysis of student commentary themes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- qualitative analysis of epistemic agency, collective responsibility</td>
</tr>
<tr>
<td>Idea Improvement</td>
<td>Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions (described previously under section 4.5.4.2)</td>
<td>• T-test of pre vs post scores – Solo Taxonomy (1-5)</td>
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<td>Course Scores</td>
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<tr>
<td></td>
<td></td>
<td>F2004: pre KB vs. F2005: all KB designs</td>
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<td></td>
<td></td>
<td>• T-test of for equality of course score means</td>
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<tr>
<td></td>
<td></td>
<td>- Sig. (2-tailed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Course scores 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs) and second year (2004-5) vs. third year (2005-6) GPAs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• T-test for equality of course score means vs. means for 2nd &amp; 3rd year AGPAs -Sig. (2-tailed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Course scores 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• T-test of for equality of means - Sig. (2-tailed) - size effects</td>
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Chapter 5
Results

5 Introduction

Chapter five presents the results of the study. The analyses focus on the study year, which began and was completed within the 2005-2006 academic year (the class sessions occurred between September to December, the summative exam was in March) with consideration of work in previous years, as appropriate. Analyses were used to assess progress towards epistemic agency and collective responsibility, community knowledge.

182 Pharmacy students were enrolled in the course: all students participated in the classroom panels and the student generated self-assessment exam questions. Number of participants for each analysis is reported with results, since not all students completed the confidentiality agreements, and not all completed the surveys.

Table 4 in the previous chapter outlined the main design features and the data sources used to analyze progress towards these principles. It also provides an overview of the contents of this chapter. For each design feature, the appropriate portions of Table 4 are reproduced in this chapter, and the data sources and analyses are summarized.
5.1 Classroom Panels

5.1.1 Results

Four approaches to data analysis for the panel were undertaken. First, a narrative account of an exemplary panel is presented as qualitative analysis. From this follow two sets of quantitative ratings of Knowledge Building principles, scored by observers (TAs) and by participants during panel experiences. Finally, results of an online survey (Survey One) report both quantitative ratings of relative Likert scores for the panel vs. 3 tasks as design features and free responses (coded comments). Following is the corresponding portion of Table 4, from the previous chapter:

Table 5

Extracted Portion of Table 4, Chapter 4: Classroom Panels

<table>
<thead>
<tr>
<th>DESIGN FEATURE</th>
<th>DATA ANALYSES</th>
<th>DATA SOURCES</th>
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<tr>
<td>Sample of panel discourse</td>
<td>Narrative account; qualitative analysis</td>
<td></td>
</tr>
<tr>
<td>Observer ratings of student engagement in</td>
<td>Independent sample t-tests comparing student to faculty</td>
<td></td>
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<td>panels</td>
<td>observer (TA) ratings</td>
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<tr>
<td>Student ratings of their own engagement in</td>
<td>Descriptive comparison of sample researcher vs. TA ratings</td>
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<tr>
<td>Knowledge Building</td>
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<td></td>
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<tr>
<td>Student ratings of their own engagement in</td>
<td>Survey One (online):</td>
<td></td>
</tr>
<tr>
<td>content and Knowledge Building processes:</td>
<td>Quantitative Ratings for:</td>
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<td>panel vs 3 tasks designs</td>
<td>- epistemic agency</td>
<td></td>
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<td></td>
<td>- combined curricular goals</td>
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<td>Mean Likert scores</td>
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<td>(means for each design feature compared: GG correction</td>
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<td></td>
<td>for significance)</td>
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<td></td>
<td>Pair-wise comparisons - Sidak method (response for each</td>
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<td></td>
<td>feature compared to others for difference in significance)</td>
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<td>Qualitative Analysis of student commentary</td>
<td>Qualitative Analysis of student commentary themes:</td>
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<td>themes- epistemic agency, collective</td>
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<td></td>
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<tr>
<td>responsibility</td>
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</tbody>
</table>
5.1.1.1 Sample of Panel Discourse (Narrative Account)

The following example illustrates community responsibility and epistemic agency in the classroom panel design. This was a typical panel conducted by students.

The panel strategy was designed to encourage students to develop a case to mirror problem-solving in a real-life community pharmacy setting. The topics for all panels were identified on the basis of curricular guidelines. Students jointly created the patient case, patient’s history and care plan. They tested hypotheses, provided supporting literature and experiences, challenged the ideas of their peers with counter evidence and refined the original case details and possible solutions. An observer (TA) who was a trained pharmacist observed the panel and rated it for demonstration of Knowledge Building principles. The instructor (this researcher) supervised the panel and also recorded ratings for Knowledge Building after the session ended. The following sample panel discourse occurred in the middle of September 2005. The problem and strategies, contributed by students, (typically 25 per panel) were recorded by the instructor (this researcher) on overheads, and assisted by student note-takers, as the panel proceeded. In reviewing the excerpts from the field notes following, the reader can note building on and referencing each other’s ideas and sustained student initiated efforts to advance understanding. They began with an unfolding story about a patient who had scabies.

Field Notes: All quotations are taken from verbatim notes recorded from student transcribers and instructor (researcher) overheads, October 15, 2005, 9 – 10:30 am. Names are fabricated:

Researcher Comments:

The first student, Jacklin, began to create the patient that would represent a typical patient the students would expect to encounter in the workplace, concentrating on making the problem real and authentic. Each student in turn contributed some facts. Jacklin, for example, introduced the patient and elaborated her ideas about her presenting signs and symptoms, and her misconceptions, typically demonstrated by patients, about the cause.
Student Quotation (Jacklin):

…“Several days ago Monica’s hands began to itch and it has become very bothersome to her. She also began to notice some irritation between her fingers (tiny lines and burrows). Monica does not know what is causing the itching and suspects that it may be an allergy to plants that she may have touched in her garden...”

Researcher Comments:

Stephanie then built on her scenario by making Monica desperate to resolve her problem, but shy and embarrassed to mention it to anyone. Therefore, she pretends that it is not her, but rather a friend of hers who needs treatment.

Stephanie created the patient description. She decided that the patient would appear wearing long sleeved clothing and with her hands in her jean pockets, asking to speak with a pharmacist privately, and suggested the patient’s dialogue as follows….

Student Quotation (Stephanie):

“I’m worried about her. She’s too embarrassed to come to a pharmacy herself. Can I pick up something to stop this really bad itch for her?”

Researcher Comments:

This caused the panelist Catherine to interject and add new information that is relevant to Jacklin’s allusion to misconceptions. Catherine suggests they build on Jacklin’s idea of the patient being a gardener, and proposes that the patient should have allergies, and believe her itching may be due to the plants she works with.

Slavs’ contributed next and began to build on ideas about signs and symptoms, how they progressed and what the patient may have done for her problem:
**Student Quotation (Slav):**

“…Upon questioning from the pharmacist, Monica reveals that her friend’s itching has been getting much worse over the last week. She has tried some soothing lotion (aloe vera) on them but it hasn’t helped. It distracts Monica during classes and at work. She relates that it is almost intolerable and much worse at night and Monica has trouble falling asleep…”

**Researcher Comments:**

Julie then explored ideas that would relate to the contagious nature of the condition, describing her social situation at school and work. She also continues to describe signs and symptoms as well as elaborate on the myth of the friend:

**Student Quotation (Julie):**

“….Monica’s friend is a part time student at teacher’s college, volunteers at the YMCA children’s daycare and works part time at a clothing boutique to pay for school. Throughout the conversation, Monica begins and continues scratching her hands. This is a clue to the pharmacist that the patient is Monica and not her ‘friend’. Also throughout the conversation, Monica continues to refer to ‘her friend’ but does not mention her friend’s name. She is very embarrassed about her condition and pretends that her friend is the patient when speaking with the pharmacist…”

**Researcher Comments:**

At this point, in the exchange below, the next few students continued to build on the scenario, focused on creating and acquiring more details about the patient. They became interested in exploring details and contributing various ideas about her embarrassment, hiding information and her medical history and medication use that would make solving the mystery and creating a
care plan a challenge. As a result of student efforts at Knowledge Building, the community continued to incorporate the important facts in their problem creation and solving. …

**Student Quotation:**

“…After the pharmacist has confirmed that Monica is the actual patient, there is a challenge in procuring further information because Monica is embarrassed. She will be hesitant to volunteer any information and will not divulge information unless she is in a private counseling area and she is reassured by the pharmacist. She is concerned that her co-workers will find out she has scabies. She also doesn’t want her husband to know about her condition. She will only tell the pharmacist about her volunteering if the pharmacist asks about other close contact with people or activities…”

**Student Quotation:**

“…Her family history consists of breast cancer (her grandmother overcame breast cancer 15 years ago)…”

**Student Quotation:**

“… Her medication history consists of Flonase® for her seasonal allergies (hay fever) and a daily multivitamin fortified with folic acid and iron…”

**Student Quotation:**

“…Has suffered from allergies since age 12…”

**Student Quotation:**

“…Seasonal allergies (hay fever) have worsened since attending a picnic on the weekend. Needs to get her Flonase® refilled – Using Flonase® 50mcg, two sprays in each nostril once a day (total daily dosage of 200mcg)”

**Researcher Comments:**

Caroline then began to build on this discussion and clarify some of the problems that present as issues based on the information so far by addressing the issue of Flonase® and reinforced her elaboration by making constructive use of authority by quoting the literature…”
Student Quotation (Caroline):

“….Flonase® can cause signs of scabies such as skin rash and pruritus, according to the manufacturer’s product information. This should be considered since reinfection or ineffective therapy may be incorrectly identified. Monica should be warned that these symptoms may persist if she continues using Flonase® and that she can choose to stop taking it until the scabies treatment is completed if it is not necessary to control her allergies…”

Researcher Comments:
Ann introduced the idea of pregnancy and some new ideas about how this would affect future development of the case, as well as building on a reason for some of her mediation history already contributed….

Student Quotation (Ann):

“….She is one month pregnant, but does not offer this information to the pharmacist. Since Monica is preparing to become a mother she started taking multivitamins enriched with folic acid and iron, calcium enriched with vitamin D and vitamin B12. She is willing to follow any directives from the pharmacist regarding her medication, since she is pregnant. She does not want to harm her baby and will do as the pharmacist says… “

Researcher Comments:
Joy then returned to the issue of credibility of this patient and how this might affect moving forward with a plan of action.
**Student Quotation (Joy):**

“…..She is dishonest with the pharmacist at the beginning and it is therefore reasonable for the pharmacist to believe that she may not be telling the truth about her history, medications and compliance since she lied about her ‘friend’ requiring treatment…”

**Researcher Comments:**

At this point, John summarized the main idea advances of the community - and then proceeded to identify unexplored territories that need further knowledge and understanding. Having adequately created an authentic patient example, the rest of the panel began to synthesize these established facts and relate them to ideas that need to be considered in integrating and formulating a reasonable solution for her, referring to authoritative references when required, to support their statements…..Some of these unfolding key points follow:

**Student Quotation (John):**

“…..To obtain a complete picture of Monica’s signs and symptoms, the pharmacist should ask if the patient has noticed any pustules, since untreated scabies is often associated with a secondary bacterial infection, according to the Postgraduate Medical Journal, 2004. Monica does not have pustules and thus does not have a secondary bacterial infection…”

**Student Quotation:**

“…One of the risk factors for Norwegian scabies is pregnancy. Her signs and symptoms are not consistent with the clinical manifestations of Norwegian scabies. The pharmacist must nonetheless be aware of the possibility of Norwegian scabies and that although Norwegian scabies may be treated in the pharmacy, some patients required prescription therapy (ie. Ivermectin) and must be referred to a physician. Reference for that is Clinics in Dermatology, 2004….”
Student Quotation:

“…..The pharmacist must respect the confidentiality of Monica’s scabies, but also reinforce that Monica should tell her coworkers, family and friends whom she had close contact with for proper education and treatment…”

Student Quotation:

“…..Monica needs to be educated and counseled about scabies and her treatment. She needs appropriate therapy or she will risk getting a secondary infection or spreading the scabies to others. Since she is pregnant, she will need treatment that is not contraindicated in pregnant women. The pharmacist may either refer her to a physician due to her pregnant status, or counsel her in the pharmacy on the appropriate pharmacological and non-pharmacological measures for treatment and prevention…”

Student Quotation:

“….The pharmacist should counsel Monica on how to apply the appropriate therapy, when, for how long, and possible side effects of the medication. Otherwise, Monica may not take the medication appropriately and re-infection, secondary infection and spreading may occur…”

Researcher Comments:

The idea of allergy that was initiated earlier, was built on and appeared to incorporate all the relevant consequences from the previous comments, namely how allergies might impact treatment of the pregnant patient or children. In this contribution, the contributing student put the community’s knowledge together using as evidence the knowledge they were given and the knowledge they co-constructed.

Student Quotation:
“….Monica has seasonal allergies (hay fever) and successfully uses Flonase® to relieve her allergy symptoms. Although this may not apply to Monica, the pharmacist should be alert to patients who mention that they are allergic to ragweed, chrysanthemum and petroleum since the scabies treatment products permethrin and pyrethrins with piperonyl butoxide are contraindicated in people with these allergies. As well, sulfur is another key allergy to watch out for since the preferred treatment for pregnancy, lactation and children under two months of age is precipitated sulfur in 6% petrolatum…”

Researcher Comments:

The panel further expanded on the initial ideas of transmission and the contagious nature of the condition and elaborated these in attempts to tie in all the ideas generated throughout the discussion such as the impact on the various individuals who had contacted Monica:

Student Quotation:

“….Monica works at the clothing store. The pharmacist must realize that the staff at the store may have been exposed to scabies and may be in need of treatment. If her coworkers do not receive treatment, they risk getting a secondary infection and spreading the scabies to their close contacts. Monica needs to stop working during therapy…”

Student Quotation:

“….Monica works in close contact with children. The pharmacist must realize that Monica temporarily needs to discontinue volunteering at the daycare centre. The children as well as staff at daycare must also be monitored for signs and symptoms of scabies and treated if needed. Her coworkers and the children will risk secondary infections and spreading the disease if not treated as soon as possible…."

Student Quotation:

“…Friends and family who are in close contact with Monica must be informed about the risk of getting scabies and must avoid close contact with Monica until
her therapy is finished. Urge Monica to refrain from any contact with family and friends until she is no longer contagious, and she has undergone 25 hours of effective therapy otherwise, Monica risks unnecessarily infecting additional people…”

**Researcher Comments:**

This led to the generation of community knowledge. This community knowledge was then evaluated internally and expanded by the final panelists who summarized treatment options for Monica, including non-drug and drug measure for prevention and treatment, for example:

**Student Quotation:**

“…mites are able to survive and re-infest the patient. Therefore, it is critical to decontaminate all linens, towels, and clothing used in the previous four days by hot-water washing (60°C) and heated drying. Items that cannot be washed in hot water should be dry cleaned or sealed in a plastic bag for five days…”

**Researcher Comments:**

The high level of engagement of the students, and the ideas they brought to the case, led some students to offer salient final points, synthesizing facts from the beginning of the story, or looking ahead to other problems which might develop if not addressed at this moment, including:

**Student Quotation:**

“.. She should therefore be warned that these symptoms may persist even with effective treatment of her scabies, and are not due to persistence of disease…”

**Student Quotation:**

“….She should not stop the Flonase® since her allergies have worsened and she came in originally to get her prescription refilled. If Monica does not want to continue with the Flonase® due to its potential for causing pruritis,
the pharmacist may refer her to a physician to see if an alternate prescription product is available for her hay fever management. If Monica decides to stick with the Flonase®, the pharmacist should refill her prescription and ensure that Monica is using the Flonase® appropriately by asking her to demonstrate how and when she takes it…”

**Student Quotation:**

“…Currently, Monica is not showing signs of a secondary infection. However, if she does develop an infection, she should see a physician for a prescription for antibiotics…”

In summary, these excerpted field notes from the sample panel discourse suggest that the twelve Knowledge Building principles were evident to various degrees in community creation and elaboration of an authentic patient problem. Epistemic agency and collective responsibility, community knowledge, while inextricably related to the other aspects of Knowledge Building, are evident in the control students took in creating this learning problem and all its intricacies, and joining together in elaborating goals, outcomes, solutions, assessment parameters and insights for their future practice.

### 5.1.1.2 Observer and Student Ratings of Student Engagement in Knowledge Building

To assess students’ Knowledge Building, instruments were developed that incorporated all 12 Knowledge Building principles. As indicated earlier, Knowledge Building principles represent an integrated, interactive system, with each principle is influenced by the others. Thus, it is not easy to differentiate one principle from another. Accordingly, the instruments involve all 12 principles, not just epistemic agency and collective responsibility, community knowledge. Ratings took two forms: pharmacist observer (TAs: teaching assistants) ratings of student engagement in Knowledge Building; students’ self-assessment of their engagement in Knowledge Building.
5.1.1.2.1 Pharmacist observer (TAs) vs. student ratings of student engagement in Knowledge Building

The analysis first examines data from pharmacist observers (TAs: teaching assistants) and students who each submitted Knowledge Building ratings for one panel. The 12 knowledge principles were rated on a 5-point Likert scale by 138 students and 14 pharmacist observers (TAs). For the purpose of analysis, to address the questions as to differences in rating by status, a series of independent-samples $t$-tests were performed to compare ratings from the 138 students and 14 pharmacist observers (TAs).

Table 6 presents the means and results. The two principles of particular interest to the thesis are presented in the sixth row – epistemic agency and in the seventh row - collective responsibility. Means for epistemic agency were 4.18 for student ratings vs. 4.00 for pharmacist observer (TA) ratings. Means for collective responsibility were 4.58 for student ratings and 3.36 for pharmacist observer (TA) ratings.

Table 7 presents the t-test results for significance. An alpha of .01 rather than 0.05 is used for significance for this analysis because there are so many related tests.
**Table 6**

Independent samples t-tests comparing student to pharmacist observer (TA) ratings (Likert 1-5) for panel engagement in each of twelve Knowledge Building principles

<table>
<thead>
<tr>
<th>Knowledge Building Principles</th>
<th>Group</th>
<th>Respondent</th>
<th>N</th>
<th>Mean Likert 1-5</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
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</thead>
<tbody>
<tr>
<td>Real Ideas, Authentic</td>
<td>1.00</td>
<td>Student</td>
<td>138</td>
<td>3.98</td>
<td>.699</td>
<td>.060</td>
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<td>Problems elaborated</td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>3.86</td>
<td>.535</td>
<td>.143</td>
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<td>Knowledge Building Discussion</td>
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<td>Student</td>
<td>138</td>
<td>4.29</td>
<td>.529</td>
<td>.045</td>
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<td></td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>4.07</td>
<td>.475</td>
<td>.127</td>
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<td>Improvement of Ideas</td>
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<td>Student</td>
<td>138</td>
<td>4.32</td>
<td>.592</td>
<td>.050</td>
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<td></td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>4.07</td>
<td>.730</td>
<td>.195</td>
</tr>
<tr>
<td>Diversity of Ideas</td>
<td>1.00</td>
<td>Student</td>
<td>138</td>
<td>3.67</td>
<td>.767</td>
<td>.065</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>3.57</td>
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<td>3.78</td>
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<td>understanding that rises</td>
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<td>TA</td>
<td>14</td>
<td>3.43</td>
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<td>.137</td>
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<td>above previous ideas</td>
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<td>Student</td>
<td>138</td>
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<td>.053</td>
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<td>TA</td>
<td>14</td>
<td>4.00</td>
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<td>Community knowledge as</td>
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<td>4.58</td>
<td>.524</td>
<td>.045</td>
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<td>14</td>
<td>3.36</td>
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<td>4.27</td>
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<tr>
<td></td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>3.29</td>
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<td>.304</td>
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<td>Symmetric Knowledge</td>
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<td>.046</td>
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<td>TA</td>
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<td>Constructive Use of</td>
<td>1.00</td>
<td>Student</td>
<td>138</td>
<td>4.22</td>
<td>.855</td>
<td>.073</td>
</tr>
<tr>
<td>Authoritative Sources</td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>3.29</td>
<td>1.267</td>
<td>.339</td>
</tr>
<tr>
<td>Transformative Assessment</td>
<td>1.00</td>
<td>Student</td>
<td>138</td>
<td>3.80</td>
<td>.827</td>
<td>.070</td>
</tr>
<tr>
<td></td>
<td>2.00</td>
<td>TA</td>
<td>14</td>
<td>3.36</td>
<td>.745</td>
<td>.199</td>
</tr>
</tbody>
</table>
In examining t-test results, Levene’s test for homogeneity of variance was checked first for significance (where confidence limits assume p < .05). When the Levene’s test was not significant, the relevant data reported is the top line of Table 7 (equal variances assumed). If the Levene’s test was significant, the values on the second line are relevant to the report (equal variances not assumed). The second line is a correction, important given the large difference in number of cases in this data set. A p value of <.01 was considered significant for subsequent t-tests.

These results show that there is no statistically significant difference at all on some (real ideas, authentic problems; Knowledge Building discussion; idea improvement; idea diversity; conceptual change; epistemic agency; transformative assessment) and large difference on the others. Examining results for epistemic agency and collective responsibility, the top line is relevant (Levene is not significant). For epistemic agency, there was no significant difference for the ratings of students (4.18) vs for pharmacist observers (TAs) (4.00) (Sig. (2-tailed) = 0.294). For collective responsibility, community knowledge, there was a significant difference for the ratings of students (4.58) vs. pharmacist observers (3.36) (Sig. (2-tailed) = 0.000).

These results suggest that both pharmacist observers (TAs) and students perceived to the same degree that there was demonstration of epistemic agency in the panel (students - 4.18/5; TAs - 4/5). They also indicated that while both groups perceived that the panels showed collective responsibility for community knowledge (students - 4.58/5; TAs- 3.36/5), students felt a sense of community responsibility more strongly than perceived by pharmacist observers (TAs).
Table 7

Independent Samples Test: t-test significance using Levene’s test for homogeneity of variance

<table>
<thead>
<tr>
<th>Knowledge Building Principles</th>
<th>Variances</th>
<th>Levene’s Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
</tr>
<tr>
<td>Real Ideas, Authentic Problems</td>
<td>.243</td>
<td>.623</td>
<td>.629</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.783</td>
<td>17.851</td>
<td>.444</td>
</tr>
<tr>
<td>Knowledge Building Discussion</td>
<td>6.942</td>
<td>.009</td>
<td>1.483</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>1.623</td>
<td>16.465</td>
<td>.124</td>
</tr>
<tr>
<td>Improvement of Ideas</td>
<td>.008</td>
<td>.929</td>
<td>1.458</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>1.228</td>
<td>14.784</td>
<td>.239</td>
</tr>
<tr>
<td>Diversity of Ideas</td>
<td>.029</td>
<td>.865</td>
<td>.438</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>.402</td>
<td>15.220</td>
<td>.693</td>
</tr>
<tr>
<td>Conceptual change</td>
<td>1.377</td>
<td>.242</td>
<td>1.719</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>2.338</td>
<td>19.185</td>
<td>.030</td>
</tr>
<tr>
<td>Epistemic Agency</td>
<td>3.394</td>
<td>.067</td>
<td>1.053</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>1.151</td>
<td>16.466</td>
<td>.286</td>
</tr>
<tr>
<td>Community knowledge, collective responsibility</td>
<td>1.218</td>
<td>.272</td>
<td>8.156</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>6.984</td>
<td>14.862</td>
<td>.000</td>
</tr>
<tr>
<td>Democratizing Knowledge (class and panel)</td>
<td>3.985</td>
<td>.048</td>
<td>4.523</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>3.163</td>
<td>14.105</td>
<td>.007</td>
</tr>
<tr>
<td>Symmetric Knowledge advancement</td>
<td>1.887</td>
<td>.172</td>
<td>2.994</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>2.382</td>
<td>14.560</td>
<td>.031</td>
</tr>
<tr>
<td>Pervasive Knowledge building</td>
<td>23.234</td>
<td>.000</td>
<td>5.886</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>3.799</td>
<td>13.892</td>
<td>.002</td>
</tr>
<tr>
<td>Constructive Use of Authoritative Sources</td>
<td>6.682</td>
<td>.011</td>
<td>3.729</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>2.712</td>
<td>14.225</td>
<td>.017</td>
</tr>
<tr>
<td>Transformative Assessment</td>
<td>.044</td>
<td>.835</td>
<td>1.944</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>2.118</td>
<td>16.430</td>
<td>.050</td>
</tr>
</tbody>
</table>

**p<.01
As noted in the previous chapter, it is not possible to establish inter-rater reliability between this researcher’s and the pharmacist observers’ (TAs) results since only she and no other rated all 15 panels. Alternatively, two instances of this researcher’s vs. pharmacist observers (TAs) ratings are contrasted to provide some descriptive comparisons.

Table 8 reports randomly selected results from two pharmacist observers and the instructor (researcher). Percentage of agreement for means of ratings of the twelve principles (combined) for the same panel is compared for the instructor (researcher) and the pharmacist observer. With the first pharmacist observer (Linda) there were exact agreements on 67% of Knowledge Building principles ratings. With the second pharmacist observer (Debby) there were exact agreements of the judgment on 80%. If the criterion of agreement is used with means rounded to within one point, 92% of agreement is reached with Linda and 100% with Debby. The means are as follows in Table 8 and it can be seen that in both cases the instructor (researcher) ranked higher than the pharmacist observer, although trivially so with Debby (4.17 vs. 3.83 - Linda and 4.17 vs. 4.08- Debby). The ratings, however, are not independent, since independence is important for inferential stats. The instructor (researcher) ratings are not used in statistical analysis.

**Table 8**

Instructor (Researcher - Debra) and Pharmacist Observer Comparative Mean Likert Ratings (1-5):
Student engagement in twelve Knowledge Building principles

<table>
<thead>
<tr>
<th>Rater</th>
<th>Means 12 KB Principles Combined</th>
<th>Number of KB Principles</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel One Eye Irritation</td>
<td>Linda (TA)</td>
<td>3.83</td>
<td>12</td>
<td>.389</td>
</tr>
<tr>
<td>Panel Two Traveler's Diarrhea</td>
<td>Debra (instructor/researcher)</td>
<td>4.17</td>
<td>12</td>
<td>.389</td>
</tr>
<tr>
<td></td>
<td>Debby (TA)</td>
<td>4.08</td>
<td>12</td>
<td>.669</td>
</tr>
<tr>
<td></td>
<td>Debra2 (instructor/researcher)</td>
<td>4.17</td>
<td>12</td>
<td>.577</td>
</tr>
</tbody>
</table>
5.1.1.3 Survey of Student Perceptions of Engagement in Content and Skills through the Panel Design

Upon completion of this study, students were asked to rate their Knowledge Building experience as well as to explain their perceptions of the experience using a Knowledge Building questionnaire. Of the student participants who had been in both the study and the pilot (n=182), 172 completed the online survey.

5.1.1.3.1 Student ratings of their own engagement in content and Knowledge Building processes (Appendix 3)

To assess students’ accomplishments relative to the curriculum mandated 17 content and 8 additional course objectives, the online survey instrument that rated 25 items (scale of 1-5) comparing the panel vs. 3 tasks design features was used. The survey also asked them to rank their preference of the four designs. As described in the previous chapter, the 25 individual items were included to present evidence to the curriculum committee regarding fulfillment of course objectives through the panel vs. the 3 tasks, and not all items are relevant to analyze and report. It is noteworthy to report overall results were impressive to the committee and the panel design was approved officially as part of the course format.

The analysis focuses on the one item most directly related to epistemic agency, (it asks students to rate the design in terms of enabling responsibility for the learning). Results are also reported for the combined 25 test items. In addition to comparative scores for the four designs, results are reported for students’ comments about how the designs affected the way they learned.
5.1.1.3.1.1 Online Survey Ratings: Epistemic Agency

Table 9 reports results for the means of the Likert ratings for each of the four design 4 features for the item most directly related to epistemic agency (item 18). Figure 3 charts these results.

Table 9

Survey One: Student Mean Likert Ratings for Each of Four Design Features (panel vs 3 tasks) – Epistemic Agency

<table>
<thead>
<tr>
<th>Design</th>
<th>Mean (Likert 1-5)</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Panel</td>
<td>4.68</td>
<td>.515</td>
<td>172</td>
</tr>
<tr>
<td>Peer Teaching Task</td>
<td>4.09</td>
<td>.748</td>
<td>172</td>
</tr>
<tr>
<td>Assessment of Case Task</td>
<td>3.94</td>
<td>.781</td>
<td>172</td>
</tr>
<tr>
<td>Completion of an Interactive Online Case (VITAL©)</td>
<td>3.23</td>
<td>.949</td>
<td>172</td>
</tr>
</tbody>
</table>

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 as the assumption of compound symmetry was not met.

Table 10 presents the pair-wise comparisons (Sidak method), which show every feature was reported to be 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).

**Table 10**

Pairwise Comparisons of Means Adjusted for Multiple Comparisons: (Sidak. Method)

<table>
<thead>
<tr>
<th>Design Feature Compared = (I)</th>
<th>Other Designs = (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sidak adjustment for multiple comparisons</th>
<th>Sig.(a)</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Panel</td>
<td>Mean – 4.68</td>
<td>2</td>
<td>.593(*)</td>
<td>.064</td>
<td>.000</td>
<td>.422</td>
</tr>
<tr>
<td></td>
<td>Mean – 4.09</td>
<td>3</td>
<td>.744(*)</td>
<td>.069</td>
<td>.000</td>
<td>.561</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.94</td>
<td>4</td>
<td>1.453(*)</td>
<td>.081</td>
<td>.000</td>
<td>1.237</td>
</tr>
<tr>
<td>Peer Teaching Task</td>
<td>Mean – 4.09</td>
<td>1</td>
<td>-.593(*)</td>
<td>.064</td>
<td>.000</td>
<td>-.764</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.94</td>
<td>2</td>
<td>-.744(*)</td>
<td>.069</td>
<td>.000</td>
<td>-.927</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.23</td>
<td>3</td>
<td>1.453(*)</td>
<td>.081</td>
<td>.000</td>
<td>1.237</td>
</tr>
<tr>
<td>Assessment of Case Task</td>
<td>Mean – 4.09</td>
<td>1</td>
<td>-.151(*)</td>
<td>.053</td>
<td>.028</td>
<td>-.292</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.23</td>
<td>2</td>
<td>.709(*)</td>
<td>.088</td>
<td>.000</td>
<td>.475</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.94</td>
<td>4</td>
<td>-.744(*)</td>
<td>.069</td>
<td>.000</td>
<td>-.927</td>
</tr>
<tr>
<td>Completion of an Interactive Online Case (VITAL©)</td>
<td>Mean – 3.23</td>
<td>1</td>
<td>-1.453(*)</td>
<td>.081</td>
<td>.000</td>
<td>-1.670</td>
</tr>
<tr>
<td></td>
<td>Mean – 3.94</td>
<td>2</td>
<td>-.860(*)</td>
<td>.089</td>
<td>.000</td>
<td>-1.096</td>
</tr>
<tr>
<td></td>
<td>Mean – 4.09</td>
<td>3</td>
<td>-.709(*)</td>
<td>.088</td>
<td>.000</td>
<td>-.943</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.

a Sidak Adjustment for multiple comparisons

These data show the students’ perception of the degree to which the panel vs. 3 tasks designs enabled Knowledge Building for themselves and for their community as measured by the indicators. The mean scores for the panel design exceeded scores for the three tasks for enabling epistemic agency. High panel scores which are statistically significant reflect the progress towards students taking charge of the learning through the panel design feature as an enabler format.
5.1.1.3.1.2 Online Survey Ratings: Overall (25 Items Combined)

For completeness, since the curriculum objectives operated together, a similar analysis was carried out for responses concerning the panel vs. 3 tasks compared features in terms of all 25 knowledge and skills curriculum objectives, combined as a whole (overall).

Results are reported for the means of the Likert ratings for each of the four design features in Table 11, illustrated in Figure 4. The distributions of overall means are similar to those which were reported for epistemic agency. The epistemic agency responses are included in the overall responses. Again, means are highest for the classroom panels, (4.24/5) vs. the 3 tasks (4.05/5; 3.87/5; 3.07/5).

Table 11

Survey One: Student Mean Likert Ratings for Each of Four Design Features (panel vs 3 tasks) – Overall [25 items]

<table>
<thead>
<tr>
<th>Design</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Panel</td>
<td>4.2388</td>
<td>.34715</td>
<td>172</td>
</tr>
<tr>
<td>Peer Teaching Task</td>
<td>4.0521</td>
<td>.41189</td>
<td>172</td>
</tr>
<tr>
<td>Assessment of Case Task</td>
<td>3.8730</td>
<td>.49390</td>
<td>172</td>
</tr>
<tr>
<td>Completion of an Interactive Online Case (VITAL©)</td>
<td>3.0660</td>
<td>.59002</td>
<td>172</td>
</tr>
</tbody>
</table>

A 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 as the assumption of compound symmetry was not met.

Table 12 presents the results for pair-wise comparisons (Sidak method) which showed that every feature was reported 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).
Table 12

Pairwise Comparisons of Means Adjusted for Multiple Comparisons: (Sidak. Method)

<table>
<thead>
<tr>
<th>Design Feature Compared = (I)</th>
<th>Other Designs = (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sidak adjustment for multiple comparisons</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Panel</td>
<td>2</td>
<td>.187(*)</td>
<td>.030</td>
<td>.000</td>
<td>.108 - .266</td>
</tr>
<tr>
<td>Mean – 4.24</td>
<td>3</td>
<td>.366(*)</td>
<td>.036</td>
<td>.000</td>
<td>.269 - .462</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1.173(*)</td>
<td>.044</td>
<td>.000</td>
<td>1.056 - 1.290</td>
</tr>
<tr>
<td>Peer Teaching Task</td>
<td>1</td>
<td>-.187(*)</td>
<td>.030</td>
<td>.000</td>
<td>-.266 - -.108</td>
</tr>
<tr>
<td>Mean – 4.05</td>
<td>3</td>
<td>.179(*)</td>
<td>.034</td>
<td>.000</td>
<td>.090 - .268</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.966(*)</td>
<td>.049</td>
<td>.000</td>
<td>.856 - 1.116</td>
</tr>
<tr>
<td>Assessment of Case Task</td>
<td>1</td>
<td>-.366(*)</td>
<td>.036</td>
<td>.000</td>
<td>-.462 - -.269</td>
</tr>
<tr>
<td>Mean – 3.87</td>
<td>2</td>
<td>-.179(*)</td>
<td>.034</td>
<td>.000</td>
<td>-.268 - -.090</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.807(*)</td>
<td>.055</td>
<td>.000</td>
<td>.661 - .953</td>
</tr>
<tr>
<td>Completion of an Interactive</td>
<td>1</td>
<td>-1.173(*)</td>
<td>.044</td>
<td>.000</td>
<td>-1.290 - -1.056</td>
</tr>
<tr>
<td>Online Case (VITAL©)</td>
<td>2</td>
<td>-.807(*)</td>
<td>.049</td>
<td>.000</td>
<td>-1.116 - -.856</td>
</tr>
<tr>
<td>Mean – 3.06</td>
<td>3</td>
<td></td>
<td>.055</td>
<td>.000</td>
<td>-.953 - -.661</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.
a Sidak Adjustment for multiple comparisons

Legend
C.Overall = Class Panel
P.Overall = Peer Teaching Task
A.Overall = Assessment of Case Task
V.Overall = Completion of an Interactive Online Case (VITAL©)

Likert scale – 1-5

Figure 4. Survey One: Means and Standard Deviations For Panel vs 3 Tasks - Overall [25 items]
In summary, these quantitative statistics report that students rated classroom panels highest for relation to epistemic agency, compared to the three task designs. The panels were also perceived to be most significant for demonstration of overall curriculum designated learning objectives for knowledge and skills. This lends support that the panel design was preferred by students in the delivery of broad terms as well as the individual principle.

A closer look is now taken qualitatively at the commentary students contributed on the same survey.

### 5.1.1.3.2 Survey One: Analysis of Student Commentary Themes

In addition to these relative scores, students were also asked to comment about how the designs affected the way they learned. Ratings and comments were collected after completion of the course in the study year, and were analyzed according to the approach outlined in the previous chapter.

One rater rated all notes. An additional rater rated twenty percent, with an inter-rater reliability of $r = .90$.

The content of free-response notes were rich with comments relevant to Knowledge Building indicators, with 78 comments indicating the students found the panel activity very useful. Qualitative analysis revealed eleven overall themes including supports for epistemic agency and collective responsibility. Epistemic agency was coded as a theme in 69 comments. The collective responsibility theme was recorded as a theme in 46 comments. Other themes related to Knowledge Building principles included democratizing knowledge ($n = 29$); pervasive knowledge building ($n = 33$); authentic problems ($n = 26$); authoritative resources ($n = 17$) and idea diversity ($n = 7$). Other themes coded included self-direction ($n = 67$) and self-assessment ($n = 28$).
5.1.1.3.2.1 Qualitative Analysis of the Theme: Epistemic Agency

A closer examination of the 69 samples of the epistemic agency theme highlights student reflections on setting their own agendas for learning, and so forth, within the context of the panel design. Commentary suggests students were consistently engaged in trying to control depth of understanding.

Following are a few examples for this theme in this regard. Appendix 10 contains all of the quotations which demonstrate similar perceptions of the value of the panel in terms of student control:

Quotations from Online Survey Access Database recorded January 22, 2006:

“…by having the opportunity to do these things, I felt like we, the students, controlled what we learned, so it pushed me to be more responsible with what we learn in class and to learn; …made me more active in my learning. I found I wasn't just reviewing the information as in previous years, but trying to come up with other potential situations and applying the information to them….”

“…It helped me acquire knowledge about self-limited conditions at my own initiative, with further reinforcement or clarity provided during class panels/discussions. It is more helpful in this respect than simple didactic lectures. Panel forced me to familiarize myself with the material prior to the panel…. panels helped me to learn independently and assess my level of familiarity of disease conditions and their treatment approaches in a "safe" environment…”
5.1.1.3.2.2 Qualitative Analysis of the Theme: Collective Responsibility, Community Knowledge

The collective responsibility theme contained 46 quotations which reflected peer and community responsibility for learning and an engendered sense of community identity. Two selected examples follow, and all quotations are found in Appendix 11.

Quotations from Online Survey Database recorded January 22, 2006:

“…enabled to do my own studying and research first, preparing in advance, then collaborate with peers and classmates to discuss issues and develop ideas and solutions further;…deepened understanding of each topic;… opportunity to clarify confusing concepts and simultaneously evaluate our understanding;… retaining the information better;… through studying more carefully and paying more attention to detail, with the motivation that we would be sharing information with others….”

“…provided me with multiple perspectives on a topic because each panel member usually had something insightful to impart to the rest of the class…It provided an active learning experience. Instead of trying to memorize the information, it needed to be understood to explain the information to others...”

Additional and more broadly ranged panel extracted comments are reported in Appendix 12. Comments indicating areas for improvement were not specific for the panel design but noted time constraints for curriculum course load (n=9) and are recorded in Appendix 13.

In summary, responses from students indicated many ways in which the first Knowledge Building design feature, classroom panels, resulted in students attributing to them a broad array of feelings and behaviors consistent with epistemic agency and collective responsibility and in line with other Knowledge Building principles.

Next are reports of the analyses of the second Knowledge Building design feature, student-generated self-assessment exam questions.
5.2 Student-Generated Self-Assessment Exam Questions

5.2.1 Results

As outlined previously, the second design feature consisted of a system of pre and post panel student-generated self-assessment exam questions, linking learning and assessment to the classroom panels. For each panel, a subset of students created and contributed examination questions to the instructor (researcher). Each student submitted one set (n = 182).

Three approaches to analysis of the student-generated self-assessment exam questions were taken. First, a qualitative narrative account of sample student questions is presented. From this follow two sets of quantitative ratings. First, questions are scored for the level of idea improvement by the researcher and one cross-checker, using the solo taxonomy scale (1-5) of Collis and Biggs. As well, the quality of student-generated test questions is compared to test questions created by instructors in a randomly ordered and blinded survey completed by faculty professor raters. Inter-rater reliability is reported. Following is the corresponding portion of Table 4, from the previous chapter:

Table 13

Extracted Portion of Table 4, Chapter 4: Student Generated Self-Assessment Exam Questions

<table>
<thead>
<tr>
<th>DESIGN FEATURE</th>
<th>DATA ANALYSES</th>
<th>DATA SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-Generated Self-Assessment Exam Questions</td>
<td></td>
<td>Narrative account; qualitative analysis</td>
</tr>
<tr>
<td>Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions</td>
<td>Samples of student questions and their reflections on those questions, recorded in Knowledge Forum.</td>
<td>T-test of pre vs. post scores – Solo Taxonomy (1-5)</td>
</tr>
<tr>
<td>Comparison of Student vs Instructor Generated Questions</td>
<td></td>
<td>Inter-rater reliability – Pearson correlation coefficient</td>
</tr>
<tr>
<td>Survey Instrument</td>
<td></td>
<td>Estimation of Student vs Instructor author</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Friedman test (authorship vs percentage correct)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Wilcoxon paired test (percentage correct for student items vs. all others)</td>
</tr>
</tbody>
</table>
5.2.1.1 Samples of Student Questions (Narrative Account)

A qualitative narrative account of sample student questions is presented. The first example uses the same topic previously recounted for the panel narrative account (i.e. scabies), for continuity. The following are exact excerpts taken from the confidential website submissions to the instructor (researcher) via phm.320@utoronto.ca as well as from the community discussion view on Knowledge Forum. A sample test question with the pre and post panel versions, from a student, Sari, and the contributions of the class, follows. Student names are fabricated.

Pre-Panel Patient Case and 5 Answer Options: (as submitted to researcher/instructor - phm.320@utoronto.ca September 30, 2005).

“Sophia, a 1st year university student, comes into your pharmacy complaining that she is itchy and it is keeping her up at night. She went to the doctor almost 2 weeks ago because she had this terrible rash on her hands, elbows and in her groin area. After learning that she in fact had scabies, she bought permethrin cream and applied it as directed on the bottle. That was almost 2 weeks ago and she is still itchy! What should you tell her?

a) Tell her to go back to her doctor for a follow-up examination.

b) Tell her to wait it out, as it may take a few weeks for her itch to subside.

c) Tell her that it may take a few weeks for her itch to subside, and suggest that she use an antihistamine for relief in the meantime.

d) Tell her to buy a second bottle of permethrin cream and apply it again.

e) Tell her to buy a different scabies treatment, such as lindane, because it is likely that she is resistant to permethrin.”

Sari’s Test Answer and explanation to researcher/instructor = c: (as submitted to researcher/instructor - phm.320@utoronto.ca September 30, 2005)
“Itch due to scabies infestation may last 2-6 weeks after successful treatment. Supportive therapy is an important part of treating an individual with scabies, and antihistamines are a suitable option for treating night time itch.”

**Researcher Comments:**
Sari reflected and decided to improve her test item.

**Post Panel Patient Case and 5 Answer Options:** (as submitted to researcher/instructor - phm.320@utoronto.ca September 30, 2005)

“Sophia, a 1st year university student, comes into your pharmacy complaining that she is itchy and it is keeping her up at night. She went to the doctor almost 2 weeks ago because she had this terrible rash on her hands, elbows and in her groin area. Her doctor noticed that she had small snake-like silvery lines in these areas. After learning that she in fact had scabies, she bought permethrin cream and applied it as directed on the bottle. That was almost 2 weeks ago and she is still itchy! What should you tell her?

a) Tell her to go back to her doctor for a follow-up examination.

b) Tell her to wait it out, as it may take a few more weeks for her itch to subside.

c) Tell her that it may take a few more weeks for her itch to subside, and suggest that she use an antihistamine for relief in the meantime.

d) Tell her to buy a second bottle of permethrin cream and apply it again.

e) Tell her to buy a different scabies treatment, such as lindane, because it is likely that she is resistant to permethrin.”

*Sari's Test Answer and explanation of improved version to researcher/instructor = c (as submitted to researcher/instructor - phm.320@utoronto.ca September 30, 2005)*
“I wanted to make the question more accurate. In option 2 and 3, it stated that “it may take a few weeks” for her itch to subside. I thought that it would be more accurate to state “a few more weeks”. This indicates that it will take a few weeks from the time she is speaking to you, rather than a few weeks from the time she used permethrin.

As well, I added a sentence about the appearance of silvery lines on her skin. This sign is descriptive of scabies, and it gives the reader a better picture of the patient’s condition.”

Researcher Comments:

This version without the answer strategy was then posted as ‘Scabies mcq by testposter’ on Knowledge Forum on September 30. (Note from Knowledge forum, September 30 (09:08:44))

On October 4, a student, Cathryn, asked for clarification from the class. Due to a lack of clarity in the test item, Cathryn was unsure of whether the signs and symptoms were due to incorrect application requiring one more treatment, correct application but lingering symptoms not needing treatment, or incorrect treatment and time lag, requiring two more treatments....

Clarification? (Note from Knowledge Forum: 2005, October 04 (16:42:18) by cathryn)

“I am a little confused by this question... when it says that Sophia applied the cream as per bottle instructions, would she have reapplied in a week? Because if she reapplied, then it could be just residual itch but if she only used it once, she would need to retreat. Also, if she failed to reapply after 1 week and it's been 2 weeks, I'm guessing she would need two additional applications (one now and one in a week). Does anyone have any ideas??”
Researcher Comments:

By specifically asking the class for new ideas, Cathryn calls on the class to contribute to the understanding, exhibiting the collective responsibility required of the community.

Later the same day, another student, Baharuk, agrees that this clarification is necessary, and also asks for bottle instructions…

Clarification also (Note from Knowledge Forum: 2005, October 04 (17:35:49) by baharak)

“I agree that some clarification is needed. If she did not re-apply 7 days after the first treatment then she would need to do 2 new treatments one immediately and one in a week when the eggs hatch and produce new mites. I guess we would need to know what the bottle instructions are.”

Researcher Comments:

Eight days later, Matt further explores the issues, referring to Cathryn’s postulation that lingering symptoms are normally seen, agreeing they are nothing to worry about. This implies only one treatment would be required if correctly applied. He then wonders about a gap in his understanding, and asks if two treatments are always necessary.

Question about the clarification comment (Note from Knowledge Forum: 2005, October 12 (20:38:02) by matt)

“Isn’t a residual itch 2 weeks later nothing to be too concerned about? I was under the impression that this may be seen for 4-6 weeks? Or are we always suppose to give them 2 treatments of permethrin (1 week apart)’’

Researcher Comments:

Two days later, Cathryn, the first student to ask for clarification, reflected on this discussion and the answers to her need for clarification. She decided to resubmit an improved version of the anonymous testposter’s question, which synthesized all the issues elaborated by the class. She
had to post this improved version of the test question anonymously as well, as ‘testposter’, according to class instructions to protect academic integrity, so that the author of test questions would never be identified. The synthesized changes are below, as they appeared (underscored) in the next threaded note.

Improved scabies MCQ #2 by testposter (Note from Knowledge Forum: 20052005, October 10 (20:25:42) by testposter)

“Sophia, a 1st year university student, comes into your pharmacy complaining that she is itchy and it is keeping her up at night. She went to the doctor almost 2 weeks ago because she had this terrible rash on her hands, elbows and in her groin area. Her doctor noticed that she had small snake-like silvery lines in these areas. After learning that she in fact had scabies, she bought permethrin cream and followed the directions on the bottle: she applied it once to her entire body (neck down) and left it on for 8 hours. That was almost 2 weeks ago and she is still itchy! What should you tell her?

a) Tell her to go back to her doctor for a follow-up examination.
b) Tell her to wait it out, as it may take a few more weeks for her itch to subside and suggest that she use an antihistamine for relief in the meantime.
c) Tell her to buy a second bottle of permethrin cream and apply it again today to catch any eggs that weren’t killed with the first application.
d) Tell her to buy a second bottle of permethrin cream and apply it again in the same way and to repeat this again one week from now, since she likely has full grown mites as well as nits present.

e) Tell her to buy a different scabies treatment, such as lindane, because it is likely that she is resistant to permethrin."
Researcher Comments:

As instructed, she also submitted her improved question to the instructor, including the answer and the reason she had improved it. While the original testposter, Sari, had indicated option ‘c’ to be the correct answer, Cathryn’s improved question now indicated option ‘d’ was the correct answer.…

Cathryn’s Test Answer and explanation of improved version to researcher/instructor = d (as submitted to researcher/instructor - phm.320@utoronto.ca October 10, 2005)

“Answer with reason: d) because although correctly, she failed to retreat and therefore the nits that weren’t killed have hatched and matured and laid new nits so there are two new generations that need to be treated.

Reason for editing: Poorly worded description in the first question didn’t indicate whether or not she has retreated after a week.”

Researcher Comments:

This ultimate version, with all its improvements, was included on the students’ examination in late October.

This example reflects epistemic agency, in the sense that students created their own test measures, reflected on their adequacy in light of feedback and interactions and improved their contribution. It exemplifies the community responsibility of collectively ensuring through online discussion in Knowledge Forum, that their ideas are presented with clarity and necessary specific detail. Epistemic agency is also demonstrated in the empowerment of Cathryn, who was able to take ownership of Sari’s original question by improving it and changing the correct response. The rest of the class then had a week to ponder this final version of the question as a potential test item, review their understanding and prepare an answer in case it appeared on the midterm examination. This demonstrates community knowledge and democratizing knowledge to all students. A sense of collective responsibility is apparent in this discourse.

A second example, generated by the student, Lisa, is on the topic eye irritation:
“SK went to JC’s party last night. She drank way too much and it was so smokey that she couldn’t even find her friend JC. She woke up the next morning and had a slightly difficult time separating her eyes. She noticed a whitish substance on her eyelashes which she had never experienced before. As the day progressed she experienced irritation in her left eye like a foreign body was in it. During her lunch break she enters your pharmacy for advice. Based on the information provided SK:

a) is experiencing an infestation of pubic lice and should remove the nits and treat with petrolatum

b) is experiencing irritation due to a contact lens that she slept in and forgot to remove

c) likely has bacterial conjunctivitis and should use polysporin ointment

d) likely has dry eyes and should use a cool moist compress over the eyelid

e) likely had allergic conjunctivitis and should use an antihistamine”

Lisa’s Test Answer and explanation to researcher/instructor = d (as submitted to researcher/instructor - phm.320@utoronto.ca October 21, 2005)

“Answer is d since SK was exposed to smoke, and drank alcohol which may have contributed to her dry eyes.

Answer c is a possibility, however is likely not most appropriate answer as the factors described were for eye dryness and polysporin drops would be a better choice since it is lunch and KC would have to return to work and would probably prefer clear vision.”
Researcher Comments:
Lisa reflected and decided to improve her test item. She decided to remove the option which included lice as a cause, and added another option which offered a decongestant as a second alternative to an oral antihistamine treatment for allergic rhinitis.

Post Panel Patient Case and 5 Answer Options: (as submitted to researcher/instructor - phm.320@utoronto.ca October 21, 2005)

“SK went to JC’s party last night. She drank way too much and it was so smokey that she couldn’t even find her friend JC. She woke up the next morning and had a slightly difficult time separating her eyes. As the day progressed she experienced irritation in her left eye like a foreign body was in it and as well as tearing. During her lunch break she enters your pharmacy for advice. Based on the information provided SK:

a) is experiencing irritation due to a contact lens that she slept in and forgot to remove

b) likely has bacterial conjunctivitis and should use polysporin ointment

c) likely has dry eyes and should use a cool moist compress over the eyelid

d) likely had allergic conjunctivitis and should use an oral antihistamine

e) likely has allergic conjunctivitis and should use a decongestant”

Lisa’s Test Answer and explanation of improved version to researcher/instructor = c (as submitted to researcher/instructor - phm.320@utoronto.ca October 21, 2005)

“Based on the information provided, the most appropriate answer is (c) since the symptoms of dry eyes are described and a cool moist compress over the eyelid is a suitable non-pharmacological
The question was changed, the “whitish substance” description was taken out as it could be a symptom of viral infection. Therefore to make the MCQ more clear and accurate, I took this out and changed one of the multiple choice options regarding pubic lice since it related to the “whitish substance” description.”

Researcher Comments:

This improved version without the answer strategy was then posted as ‘Eye Irritation #8 by testposter’ on Knowledge Forum on October 21. (Note from Knowledge forum, October 21 (17:10:03)

On December 8, a student, Marian, asked for clarification from the class.

Is there a correct option? (Note from Knowledge Forum: 2005, December 08 (22:29:43) by marina)

“According to her signs & symptoms she should have viral conjunctivitis. One of the key markers of bacterial conjunctivitis is a white purulent discharge! It can't be allergic conjunctivitis because then both eyes would be affected, and the option of her sleeping in her contacts doesn't explain the foreign body sensation does it?”

Researcher Comments:

Over the next few days, four notes indicate the confusion and gaps in understanding about the common signs and symptoms as they relate to the appropriate diagnosis.

I'm not too sure either (Note from Knowledge Forum: 2005, December 09 (14:14:05) by becky)

“I agree w/ you that it can't be allergic conj or contact lens due to the unilateral nature. It could be bacterial conj but it doesn't say anything about pus-like discharge. Could she be tearing as a reflex to dry eyes”?
Contact lenses? (Note from Knowledge Forum: 2005, December 10 (21:26:16) by nermin)

“I think excessive tearing is associated with contact lens irritation (excessive watery eyes) so if she forgot her contact lenses in that could result in her symptoms. I am not 100% sure if this is right, let me know what you think. Thanks”

Contact lenses (Note from Knowledge Forum: 2005, December 11 (11:44:46) by lee)

“Forgetting her contacts in would also explain the foreign body sensation... I agree with Nermine!”

Option a over b? (Note from Knowledge Forum: 2005, December 11 (15:10:27) by Amanda)

“I agree w/ Marina that the discharge in bacterial conjunctivitis would be more mucopurulent and am more inclined to select a...”

Researcher Comments:

Following these comments, Mike decides to clarify by consulting an authoritative source, the textbook, and then share his findings with his class community. This resulted in a change of opinion as to the correct response which is different from the incorrect choices previously considered.


“I think it's dry eye now...p. 157-158 of the book...the s&s are consistent, as is the cool moist compress...

confusing questions nonetheless...”
**Researcher Comments:**

Another student considers this chain of arguments the next day and agrees with the last comment, based on the authoritative source.

**Sounds like dry eye (Note from Knowledge Forum: 2005, December 12 (00:33:26) by baharak)**

“I agree with dry eye and reflex tearing.”

**Researcher Comments:**

This stops further discussion, as consensus and synthesis seems to have occurred. This test question version was included on the students’ examination in December.

This example reflects epistemic agency, as Lisa, as with the previous example, created her own assessment test measure, reflected and improved her contribution. It also demonstrates the community responsibility of collectively reflecting through online discussion in Knowledge Forum, on the testing elements related to specific details, with attention to enhancing understanding and addressing gaps in knowledge. Epistemic agency is also demonstrated in the feeling of empowerment evident in the class in giving their opinion of the accuracy of the answer options, coming to consensus despite some confusion and accepting the item be considered as a reasonable test item. The class as a whole benefitted from reviewing the comments about the question, reviewing their understanding and preparing an answer in case it appeared on the examination. This demonstrates community knowledge, collective responsibility.

The above descriptive profiles suggest students engage in epistemic agency and responsibility for community knowledge. Next, quantitative measures are reported.
5.2.1.2 Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions

The first analysis involves the solo taxonomy scale (1-5) of Collis and Biggs instrument used to assess students’ idea improvement (Appendix 4). It may be recalled that the instructor (researcher) assessed all pre and post submissions. Of 182 submissions, 178 were included for analysis. An additional assessor rated twenty percent. Inter-rater reliability data is reported following distribution results.

The basic question addressed is whether pre to post improved significantly. The frequency and percent distributions of the Solo taxonomy scores are reported for the pre-panel and post-panel questions in Table 14.

Table 14

<table>
<thead>
<tr>
<th>Solo Taxonomy Score 1-5</th>
<th>Pre-panel</th>
<th></th>
<th>Post-panel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Valid Percent Rated by Researcher</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td>3</td>
<td>74</td>
<td>41.6</td>
<td>41.6</td>
</tr>
<tr>
<td>4</td>
<td>55</td>
<td>30.9</td>
<td>30.9</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>3.4</td>
<td>3.4</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

5.2.1.2.1 Inter-rater Reliability

Inter-rater reliability in this situation is assessed with a Pearson correlation coefficient. Results are reported for the second rater’s (peer pharmacist) 20% crosschecked questions. The frequency and percent distributions of the Solo taxonomy scores are presented for the pre-panel and post-panel questions in Table 15.
Table 15

Frequency and Percent Distributions of Pre / Post-panel Scores: Second Rater (20%) vs. Researcher Rater (100%)

<table>
<thead>
<tr>
<th>Question Inclusion</th>
<th>Score 1-5</th>
<th>Frequency</th>
<th>Percent by 2nd rater</th>
<th>Valid Percent by 2nd rater</th>
<th>Cumulative Percent</th>
<th>Valid Percent Rated by Researcher</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>2</td>
<td>14</td>
<td>7.9</td>
<td>22.2</td>
<td>22.2</td>
<td>5.6</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25</td>
<td>14.0</td>
<td>39.7</td>
<td>61.9</td>
<td>13.5</td>
<td>38.1</td>
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<tr>
<td></td>
<td>4</td>
<td>24</td>
<td>13.5</td>
<td>38.1</td>
<td>100.0</td>
<td>16.3</td>
<td>46.0</td>
</tr>
<tr>
<td>Total</td>
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<td>63</td>
<td>35.4</td>
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<td>Missing System</td>
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<td>115</td>
<td>64.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>178</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the pre, the correlation is .90 (p = .006); for the post the correlation is .93 (p = .001). This indicates a high level of consistency. Table 16 results show that 102 students (57%) changed.

Table 16

Frequency and Percent of Post-Panel Student Questions Changed

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>76</td>
<td>42.7</td>
<td>42.7</td>
<td>42.7</td>
</tr>
<tr>
<td>1</td>
<td>102</td>
<td>57.3</td>
<td>57.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

The data are well-distributed over the 5-point scale. Therefore a t-test was performed to compare pre and post. Table 17 shows that students who changed scored significantly higher on the post-test (3.14 - pre-panel; 4.34 - post-panel). Table 18 reports the paired differences for significance (Sig. (2-tailed) p=0.000).
Table 17

Paired Samples Statistics: t-test for Pre-panel and Post-panel Comparisons of Mean Solo Taxonomy Scores

<table>
<thead>
<tr>
<th></th>
<th>Mean Solo Taxonomy Scores 1-5</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>prepanel</td>
<td>3.14</td>
<td>102</td>
<td>.771</td>
</tr>
<tr>
<td></td>
<td>postpanel</td>
<td>4.34</td>
<td>102</td>
<td>.738</td>
</tr>
</tbody>
</table>

Table 18

Paired Differences of Pre-Post Solo Taxonomy Mean Scores for Significance:

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>T</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-post</td>
<td>-1.21</td>
<td>0.57</td>
<td>0.06</td>
<td>-21.41</td>
<td>101</td>
<td>.000</td>
</tr>
</tbody>
</table>

The t-test results demonstrate that it is not the case that people who changed most scored higher at pre, as presented in Table 19 (3.09 - no change vs. 3.14 - changed; Sig. (2-tailed = 0.728).

Table 19

t-test Comparing Changed Questions and Higher Pre-panel Scores and Sig. (2-tailed)

<table>
<thead>
<tr>
<th>Status</th>
<th>changed</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>prepanel</td>
<td>0</td>
<td>76</td>
<td>3.09</td>
<td>.95</td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>102</td>
<td>3.14</td>
<td>.77</td>
<td>.08</td>
<td>-0.35</td>
<td>176</td>
<td>0.728</td>
</tr>
</tbody>
</table>

In summary, these data confirm that 57% of case study student participants reflected on their level of understanding following the panel community discussion and improved their test questions based on this increased knowledge. Results show that after reflection and reconsidered versions, students who changed scored significantly higher on the post-test (4.34 vs. 3.14) despite the fact that their pre-test submissions were not higher than peer submissions.
5.2.1.3 Comparison of Student vs. Instructor Generated Questions

The second set of quantitative analysis assesses the quality of student created questions compared to instructor generated questions. Analysis were conducted by a saturated sample of qualified content experts (n=16).

A calculation of the percentage of times content experts could identify authorship (student vs. instructor) of the question was determined. Percentages were compared using a Friedman test to compensate for the fact that the data are abnormally distributed.

The results, in Table 20, show that content experts are approximately equally likely to attribute a response to student or instructor. The case study students, listed as ‘undergrads’ (to use the terminology familiar to content experts), were not selected out as easily identifiable compared to the other groups (mean of 32.14). Graduate pharmacists were slightly more identifiable (mean of 39.68) compared to other groups (32.14 - undergrad; 28.57 – Pharm D; 27.89 - faculty).

<table>
<thead>
<tr>
<th>Authorship</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrad</td>
<td>21</td>
<td>0</td>
<td>75</td>
<td>32.14</td>
<td>23.90</td>
</tr>
<tr>
<td>BScPhm</td>
<td>21</td>
<td>0</td>
<td>100</td>
<td>39.68</td>
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<tr>
<td>PharmD</td>
<td>21</td>
<td>0</td>
<td>100</td>
<td>28.57</td>
<td>29.88</td>
</tr>
<tr>
<td>Faculty</td>
<td>21</td>
<td>0</td>
<td>100</td>
<td>27.89</td>
<td>23.68</td>
</tr>
</tbody>
</table>

The Friedman test results showed that the percentage correctly identified was independent of authorship ($\chi^2(3, N=21)=1.63$, that is, non significant.

When percentage of correct items identified as authored by undergraduates versus all others was compared, there also was no significant difference, using the Wilcoxon paired test ($Z = -0.44$, non significant). They were about equally likely to be correct irrespective of authorship. This is presented in Table 21 (student - 32.14; all others - 30.95).
Table 21

Wilcoxon paired test: percent items correctly identified as authored by undergraduates versus all others

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>21</td>
<td>.00</td>
<td>75.00</td>
<td>32.14</td>
<td>23.90</td>
</tr>
<tr>
<td>All others</td>
<td>21</td>
<td>8.33</td>
<td>100.00</td>
<td>30.95</td>
<td>19.57</td>
</tr>
<tr>
<td>Valid Number</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In summary, these data indicate that content experts were not able to differentiate the authorship of student created vs. instructor created test questions. Case study student participants, in generating their self-testing items, achieved quality levels of assessment that were of the same caliber of teacher controlled evaluation.

5.3 Student Evaluation of Designs to Facilitate Knowledge Building Activity

5.3.1 Results

In addition to classroom panels, and student-generated self-assessment exam questions, student discourse occurred in three views in Knowledge Forum (in addition to the view to discuss self-testing questions reported above). Two related to their classroom panel work were plans for the panel, in advance of serving on the panel; and then reflections on plans after the panel. They also created a view that they used for preparation for their Objective Structured Clinical Exam (oral) which occurs two months after course completion.
5.3.1.1 Student Online Survey Two: Study Design Features

To assess students’ perceptions of Knowledge Building through these designs, a survey instrument was developed that incorporated all 12 Knowledge Building principles (Appendix 4, Survey Two) for each design as well as their comments about the features.

Of the student participants in the study (n=182), 177 completed the survey. Ratings and comments were collected after completion of the course in the study year. Following is the corresponding portion of Table 4, from the previous chapter:

Table 22

Extracted Portion of Table 4, Chapter 4: Student Evaluation of Designs to Evaluate Knowledge Building Activity

<table>
<thead>
<tr>
<th>DESIGN FEATURE</th>
<th>DATA ANALYSES</th>
<th>DATA SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Evaluation of Designs to</td>
<td>Student survey results will be used to evaluate all study design features</td>
<td>Survey Two (online)</td>
</tr>
<tr>
<td>Evaluate Knowledge Building Activity</td>
<td>from the students’ perspective including classroom panels, student generated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>exam questions and discourse in an online Knowledge Building environment</td>
<td>- epistemic agency</td>
</tr>
<tr>
<td></td>
<td>(Knowledge Forum™)</td>
<td>- collective responsibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 12 principles combined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mean Likert scores</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Repeated-measures ANOVA (means for each design feature compared: GG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>correction for significance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pair-wise comparisons - Sidak method (response for each feature compared to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>others for difference in significance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Repeated-measures ANOVA (means for each design feature compared)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pair-wise comparisons - Sidak method (response for each feature compared</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to others for difference in significance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analysis of student commentary themes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- qualitative analysis of epistemic agency, collective responsibility</td>
</tr>
</tbody>
</table>

5.3.1.1.1 Mean Likert Scores for Study Design Features

As may be recalled, students were asked to complete an online survey (Survey Two) rating on a 5-point Likert scale, their preferences for five design features in terms of each Knowledge Building principle. Repeated-measures ANOVAs were used to compare their responses among the design features for the two knowledge principles of particular focus in this thesis: epistemic agency and collective responsibility, community knowledge.
5.3.1.1.1.1 Scores: Epistemic Agency

Table 23 reports the results: highest means were 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, which are charted in Figure 5. Ratings given the five design features for epistemic agency were significantly different ($F(3.53,627.49)=43.43$, $p <.001$, partial $\eta^2=.20$). Because the assumption of compound symmetry was not met, the Greenhouse-Geisser correction was used to assess significance.

Table 23

Survey Two: Student Mean Likert Scores for Five KB Designs - Epistemic Agency

<table>
<thead>
<tr>
<th>Design Features Compared for Epistemic Agency</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>classroom panels</td>
<td>4.08</td>
<td>.753</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: pre panel KF view</td>
<td>3.20</td>
<td>1.002</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: post panel KF view</td>
<td>3.53</td>
<td>.866</td>
<td>177</td>
</tr>
<tr>
<td>student-generated self-assessment exam questions</td>
<td>4.08</td>
<td>.888</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: OSCE KF view</td>
<td>3.84</td>
<td>.803</td>
<td>177</td>
</tr>
</tbody>
</table>

Figure 5. Survey Two: Means and Standard Deviations (Five KB Designs) - Epistemic Agency
Table 24 presents the results of pair-wise comparisons. Responses were compared pair-wise using the Sidak correction to protect the family-wise error rate.

### Table 24

Pair-wise Response Comparisons with Correction for Family-wise Error: (Sidak, Method) for Epistemic Agency

<table>
<thead>
<tr>
<th>Design Feature Compared = (I)</th>
<th>Other Designs = (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.(a)</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>classroom panels</td>
<td>2</td>
<td>.888(*)</td>
<td>.083</td>
<td>.000</td>
<td>.653, 1.124</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.564(*)</td>
<td>.083</td>
<td>.000</td>
<td>.328, .810</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.000</td>
<td>.087</td>
<td>1.000</td>
<td>-.247, .247</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.229(*)</td>
<td>.079</td>
<td>.042</td>
<td>.005, .453</td>
</tr>
<tr>
<td>student discourse: pre panel KF view</td>
<td>1</td>
<td>-.888(*)</td>
<td>.083</td>
<td>.000</td>
<td>-1.124, -.653</td>
</tr>
<tr>
<td>Mean  = 3.20</td>
<td>3</td>
<td>-.324(*)</td>
<td>.068</td>
<td>.000</td>
<td>-.515, -.133</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.888(*)</td>
<td>.093</td>
<td>.000</td>
<td>-1.153, -.624</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-.659(*)</td>
<td>.094</td>
<td>.000</td>
<td>-.925, -.393</td>
</tr>
<tr>
<td>student discourse: post panel KF view</td>
<td>1</td>
<td>-.564(*)</td>
<td>.083</td>
<td>.000</td>
<td>-.801, -.328</td>
</tr>
<tr>
<td>Mean  = 3.53</td>
<td>2</td>
<td>.324(*)</td>
<td>.068</td>
<td>.000</td>
<td>.133, .515</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.564(*)</td>
<td>.080</td>
<td>.000</td>
<td>-.791, -.337</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-.335(*)</td>
<td>.081</td>
<td>.001</td>
<td>-.564, -.106</td>
</tr>
<tr>
<td>student-generated self-assessment exam questions</td>
<td>1</td>
<td>.000</td>
<td>.087</td>
<td>1.000</td>
<td>-.247, .247</td>
</tr>
<tr>
<td>Mean  = 4.08</td>
<td>2</td>
<td>.888(*)</td>
<td>.093</td>
<td>.000</td>
<td>.624, 1.153</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.564(*)</td>
<td>.080</td>
<td>.000</td>
<td>.337, .791</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.229(*)</td>
<td>.075</td>
<td>.027</td>
<td>.015, .443</td>
</tr>
<tr>
<td>student discourse: OSCE KF view</td>
<td>1</td>
<td>-.229(*)</td>
<td>.079</td>
<td>.042</td>
<td>-.453, -.005</td>
</tr>
<tr>
<td>Mean  = 3.84</td>
<td>2</td>
<td>.659(*)</td>
<td>.094</td>
<td>.000</td>
<td>.393, .925</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.335(*)</td>
<td>.081</td>
<td>.001</td>
<td>.106, .564</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.229(*)</td>
<td>.075</td>
<td>.027</td>
<td>-.443, -.015</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.

a Sidak Adjustment for multiple comparisons

5.3.1.1.1.2 Scores: Collective Responsibility, Community Knowledge

A similar analysis was carried out for responses concerning the community knowledge, collective responsibility principle, reported in Table 25 and charted in Figure 6. Highest means were 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 η²=.20).
Table 25

Survey Two: Student Mean Likert Scores for Five KB Designs - Community Knowledge, Collective Responsibility

<table>
<thead>
<tr>
<th>Design Features Compared for Community Knowledge, Collective Responsibility</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>classroom panels</td>
<td>4.23</td>
<td>.719</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: pre panel KF view</td>
<td>3.20</td>
<td>1.023</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: post panel KF view</td>
<td>3.51</td>
<td>.867</td>
<td>177</td>
</tr>
<tr>
<td><strong>student-generated self-assessment exam questions</strong></td>
<td><strong>3.85</strong></td>
<td><strong>.950</strong></td>
<td>177</td>
</tr>
<tr>
<td>student discourse: OSCE KF view</td>
<td>3.68</td>
<td>.840</td>
<td>177</td>
</tr>
</tbody>
</table>

Legend

C7 = Classroom panels
P7 = panel KF view
T7 = post panel KF view
M7 = student-generated self-assessment exam questions
O7 = student discourse: OSCE KF view

Where 7 = row 7 of survey two, community knowledge, collective responsibility

Likert scale 1-5

Figure 6. Survey Two: Means and Standard Deviations (Five KB Designs) - Community Knowledge

Table 26 presents the results of pair-wise comparisons using the Sidak correction.
Table 26

Pair-wise Response Comparisons with Correction for Family-wise Error: (Sidak. Method) for Community Knowledge, Collective Responsibility

<table>
<thead>
<tr>
<th>Design Feature Compared = (I)</th>
<th>Other Designs = (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.(a)</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>classroom panels mean = 4.23</td>
<td>2</td>
<td>1.028(*)</td>
<td>.087</td>
<td>.000</td>
<td>.781 - 1.275</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.712(*)</td>
<td>.080</td>
<td>.000</td>
<td>.486 - .938</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>.379(*)</td>
<td>.088</td>
<td>.000</td>
<td>.128 - .629</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.542(*)</td>
<td>.081</td>
<td>.000</td>
<td>.313 - .772</td>
</tr>
<tr>
<td>student discourse: pre panel KF view mean = 3.20</td>
<td>1</td>
<td>-1.028(*)</td>
<td>.087</td>
<td>.000</td>
<td>-1.275 - -.781</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-.316(*)</td>
<td>.061</td>
<td>.000</td>
<td>-.488 - -.145</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.650(*)</td>
<td>.099</td>
<td>.000</td>
<td>-.930 - -.370</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-.486(*)</td>
<td>.086</td>
<td>.000</td>
<td>-.731 - -.241</td>
</tr>
<tr>
<td>student discourse: post panel KF view mean = 3.51</td>
<td>1</td>
<td>-.712(*)</td>
<td>.080</td>
<td>.000</td>
<td>-.938 - -.486</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.316(*)</td>
<td>.061</td>
<td>.000</td>
<td>.145 - .488</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.333(*)</td>
<td>.080</td>
<td>.000</td>
<td>-.560 - -.107</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-.169</td>
<td>.075</td>
<td>.230</td>
<td>-.383 - .044</td>
</tr>
<tr>
<td>student-generated self-assessment exam questions mean = 3.85</td>
<td>1</td>
<td>-.379(*)</td>
<td>.088</td>
<td>.000</td>
<td>-.629 - -.128</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.650(*)</td>
<td>.099</td>
<td>.000</td>
<td>.370 - .930</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.333(*)</td>
<td>.080</td>
<td>.000</td>
<td>.107 - .560</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>.164</td>
<td>.082</td>
<td>.386</td>
<td>-.069 - .397</td>
</tr>
<tr>
<td>student discourse: OSCE KF view mean = 3.68</td>
<td>1</td>
<td>-.542(*)</td>
<td>.081</td>
<td>.000</td>
<td>-.772 - -.313</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>.486(*)</td>
<td>.086</td>
<td>.000</td>
<td>.241 - .731</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>.169</td>
<td>.075</td>
<td>.230</td>
<td>-.044 - .383</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-.164</td>
<td>.082</td>
<td>.386</td>
<td>-.397 - .069</td>
</tr>
</tbody>
</table>

Based on estimated marginal means
* The mean difference is significant at the .05 level.
aSidak Adjustment for multiple comparisons

5.3.1.1.1.3 Scores: Twelve Knowledge Building Principles Combined

Finally, for completeness, since the principles operate as a complex entity, a similar analysis was carried out for responses concerning the five compared features in terms of all twelve Knowledge Building principles combined as a whole (overall).
Table 27 reports the means, illustrated by Figure 7. The graph is similar to those of epistemic agency and collective responsibility, community knowledge. The epistemic agency and community knowledge responses are included in the overall responses, which may account for that redundancy. Again, means are highest 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.

Table 27
Survey Two: Student Mean Likert Scores for Five KB Designs - Combined Knowledge Building Principles (Overall)

<table>
<thead>
<tr>
<th>Design Features Compared for Combined Knowledge Building Principles</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>classroom panels</td>
<td>4.2444</td>
<td>.41852</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: pre panel KF view</td>
<td>3.1191</td>
<td>.82676</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: post panel KF view</td>
<td>3.5009</td>
<td>.67256</td>
<td>177</td>
</tr>
<tr>
<td>student-generated self-assessment exam questions</td>
<td>3.8145</td>
<td>.60338</td>
<td>177</td>
</tr>
<tr>
<td>student discourse: OSCE KF view</td>
<td>3.6780</td>
<td>.59008</td>
<td>177</td>
</tr>
</tbody>
</table>

Legend
C.Overall = Classroom panels
P.Overall = panel KF view
T.Overall = post panel KF view
M.Overall = student-generated self-assessment exam questions
O.Overall = student discourse: OSCE KF view

Figure 7. Survey Two: Means and Standard Deviations (Five KB Designs) – Overall KB Principles
As for the foregoing a repeated measures ANOVA was conducted to compare responses concerning the 5 design elements over the 12 knowledge principles. The results were very significant, again with the Greenhouse-Geisser correction \((F(3.21,565.45)=121.34, p < .001, \text{partial } \eta^2=.41)\). Table 27 reports the results of pairwise comparisons.

### Table 28

Pair-wise Response Comparisons with Correction for Family-wise Error; (Sidak. Method) for Overall KB Principles

<table>
<thead>
<tr>
<th>Design Feature Compared = (I)</th>
<th>Other Designs = (J)</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.(a)</th>
<th>95% Confidence Interval for Difference(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>classroom panels</td>
<td>Mean = 4.24</td>
<td>2</td>
<td>1.125(*)</td>
<td>.062</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>.743(*)</td>
<td>.051</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>.430(*)</td>
<td>.047</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>.566(*)</td>
<td>.044</td>
<td>.000</td>
</tr>
<tr>
<td>student discourse: pre panel KF view</td>
<td>Mean = 3.12</td>
<td>1</td>
<td>-1.125(*)</td>
<td>.062</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>- .382(*)</td>
<td>.046</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>- .695(*)</td>
<td>.067</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>- .559(*)</td>
<td>.059</td>
<td>.000</td>
</tr>
<tr>
<td>student discourse: post panel KF view</td>
<td>Mean = 3.50</td>
<td>1</td>
<td>- .743(*)</td>
<td>.051</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>.382(*)</td>
<td>.046</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>- .314(*)</td>
<td>.050</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>- .177(*)</td>
<td>.047</td>
<td>.002</td>
</tr>
<tr>
<td>student-generated self-assessment exam questions</td>
<td>Mean = 3.81</td>
<td>1</td>
<td>- .430(*)</td>
<td>.047</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>.695(*)</td>
<td>.067</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>.314(*)</td>
<td>.050</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>.137</td>
<td>.052</td>
<td>.094</td>
</tr>
<tr>
<td>student discourse: OSCE KF view</td>
<td>Mean = 3.68</td>
<td>1</td>
<td>- .566(*)</td>
<td>.044</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>.559(*)</td>
<td>.059</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>.177(*)</td>
<td>.047</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>- .137</td>
<td>.052</td>
<td>.094</td>
</tr>
</tbody>
</table>

* Based on estimated marginal means
* The mean difference is significant at the .05 level.
  aSidak Adjustment for multiple comparisons

In summary, these quantitative statistics indicate that students rated classroom panels and self-testing questions highest for demonstration of epistemic agency. Classroom panels were rated highest for community knowledge, collective responsibility, followed by self-testing questions. These two design features were also perceived to be most significant for demonstration of all Knowledge Building principles operating as a whole, with classroom panels rated highest, followed by self-testing questions.
A closer look is now taken qualitatively at the commentary students contributed on the same survey.

5.3.1.1.2 Survey Two: Analysis of Student Commentary Themes

It may be recalled that in addition to rating the preceding relative scores, students were also asked to comment from 177 anonymous students. Qualitative analysis revealed twelve overall themes which were examined for degree of epistemic agency and collective responsibility.

Epistemic agency was coded as a theme in 68 comments. Collective responsibility was recorded as a theme in 112 comments. Other themes related to Knowledge Building principles included democratizing knowledge (n = 48); Knowledge Building discourse (n = 36); pervasive knowledge building (n = 31); authentic problems (n = 38); authoritative resources (n = 19) and idea diversity (n = 19). Other comments were coded as themes of self-assessment (n = 37) and self-direction (n = 10).

5.3.1.1.2.1 Qualitative Analysis of the Theme: Epistemic Agency

A detailed exploration of the 68 samples of the theme of epistemic agency spotlight individual accountability, and setting their own agenda for controlling their learning, etc. through the design features. Responses confirm students were constantly attentive to increasing their degree of understanding:

Following are a few examples for this theme in this regard. Appendix 14 contains all of the quotations which demonstrate similar perceptions of the value of all the design features in terms of student control:
Quotations from Online Survey Access Database recorded March 3, 2006:

“…students were held accountable for their own learning goals and there were multiple venues for students to explore their own styles of learning…panels were particularly a very creative and original way to permit and encourage students to do their own self-directed learning, self-study and to participate…by learning using this problem-based approach, we actively remember the material because we take initiative for our learning…class panels motivates me to study and prepare for the topics well before each class…”

“… The class panels helped to encourage student-controlled learning which I found was very effective…but these course features were all self-directed, thus they had to make me learn the pertinent information in such a way so that it could be applied to any patient case; it's not just knowing the material that is important but the ability to apply it to various patients, in order to grasp a more thorough understanding…”

5.3.1.1.2.2 Qualitative Analysis of the Theme: Collective Responsibility, Community Knowledge

The collective responsibility theme contained 112 quotations which reflected peer and community responsibility for learning and an engendered sense of community identity. A few selected examples follow, and all quotations are found in Appendix 15.

Quotations from Online Survey Access Database recorded March 3, 2006:

“…the panel is the most important part. This is where we find out what we cannot get from a textbook…contributing and listening during the panels to be the most effective in helping me learn because the pre-readings provided a lot of
general knowledge while the panels reinforced the important points, excellent to develop information being learned. It allowed evaluation of knowledge and immediate validation/rejection of ideas submitted by students, which made it easier later on to remember which points were valid. More systematic organization of thoughts allowed these questions to be addressed openly and by all class members...."

“... They facilitated interaction with classmates. The preparation for class panel made me actually learn things better than simply trying to memorize didactic lectures... students feel that preparing and participating in the panel actually makes them learn differently (not memory) and they feel that this improves learning - they learn better... forced me to learn differently. Instead of didactically, I learned from other students' responses as well...”

“... It was good having others respond to questions... the various forums was provided a double check station, when I came across questions that were not clearly answered in the textbook. Going through the decision making process on what is right and wrong with fellow students allowed one to have personal questions answered. I really liked the fact that students were able to help one another learn, it was helpful whenever questions arose, or to see what problems/concerns I had missed or didn't think of...”

In summary, these sample remarks are only a small selection of a large number of student notations (n = 177) in the online survey which were anonymous and freely submitted in response to a general solicitation for comments. They provided strong approval of all study designs, in particular the panel and student-generated self-assessment exam questions features, which corroborated the quantitative ratings reporting preference for these activities. Their observations indicated perceptions that the two principles of epistemic agency and collective responsibility were meaningfully facilitated by participation in the combination of primary study design features in the course layout, with particular appreciation for the two preferred formats.
Survey One reported comments specific to the panel design feature, which in Survey Two, was rated the most preferred design. Similarly, there were comments in Survey Two specific to the feature of student-generated self-assessment exam questions which was rated the second most preferred design, and are contained in Appendix 16. Comments indicating areas for improvement were not specific for the preferred designs but noted time constraints due to curriculum course load curtailed time available for online discourse (n=13). These are recorded in Appendix 17.

5.4 Idea Improvement

5.4.1 Results

The quantitative analysis reported previously for the student-generated self-assessment exam questions showed significant differences between pre and post test scores for student-created exam questions. This can be taken as documentation of idea improvement in that design feature. However, given that the course is embedded in a curriculum with multiple interacting influences, it is more difficult to quantitatively examine other measures of student improvement. One could not report that other markers of increased attainment reflect solely on the design features. For completeness, and to understand more dimensions of the case study, it is interesting to examine in further detail some of the other scores for these students compared to previous sessions (pre study 3rd year iterations or second year pilot) or concurrent third year courses.

As previously noted, idea improvement is inextricably related to epistemic agency and collective responsibility, community knowledge. The goals of following analyses will be to provide indication that the designs leading to greater engagement in Knowledge Building also led to more idea improvement, as reflected in course scores and independent assessments of knowledge growth. Following is the corresponding portion of Table 4, from the previous chapter:
Table 29

Extracted Portion of Table 4, Chapter 4: Idea Improvement

<table>
<thead>
<tr>
<th>DESIGN FEATURE</th>
<th>DATA ANALYSES</th>
<th>DATA SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea Improvement</td>
<td>Comparison of Student-Generated Questions, Pre vs. Post Panel Submissions (described previously under section 4.5.4.2)</td>
<td>• T-test of pre vs post scores – Solo Taxonomy (1-5)</td>
</tr>
<tr>
<td>Course Scores F2004: pre KB vs F2005: all KB Designs</td>
<td>• T-test of equality of course score means</td>
<td>• - Sig. (2-tailed)</td>
</tr>
<tr>
<td>Course scores 220 (S2005: KB Panel) vs 320 (F2005: all KB Designs) and second year (2004-5) vs third year (2005-6) GPAs</td>
<td>• T-test for equality of course score means vs means for 2nd &amp; 3rd year AGPAs -Sig. (2-tailed)</td>
<td></td>
</tr>
<tr>
<td>Course scores 220 (S2005: KB Panel) vs 320 (F2005: all KB Designs)</td>
<td>• T-test of equality of means</td>
<td>- Sig. (2-tailed) - size effects</td>
</tr>
</tbody>
</table>

5.4.1.1 Course Scores: F2004: pre KB vs. F2005: all KB Designs

A different cohort of third year students (0T6s) completed the course in the previous year. As such, many of the course components remained the same, in terms of kind of content, knowledge and skills required for the self-care context. Each year had the same content of fifteen topics. The differences for the two course sessions, apart from other uncontrolled variables, were the addition of the design features, as previously indicated in Table 3. Therefore a closer look can be taken at the difference in the individual course scores for the two cohorts (0T6 vs. 0T7) averages.

Table 30 presents the following results. Means for the third year course completed without the full design features are compared to the means for the third year course with the combined study designs to reflect community Knowledge Building. The analysis reports the PHM 320 course marks: final overall course averages, midterm exam averages, December exam averages and (OSCE comprehensive oral) exam averages for the 0T7s (study cohort n = 182) vs. the 0T6s (pre-study cohort; n = 174).
Table 30


<table>
<thead>
<tr>
<th>Item Scored</th>
<th>Class</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Combined Exams Scores</td>
<td>F2004</td>
<td>174</td>
<td>78.53</td>
<td>4.83</td>
<td>.37</td>
</tr>
<tr>
<td></td>
<td>F2005</td>
<td>182</td>
<td>80.83</td>
<td>5.57</td>
<td>.41</td>
</tr>
<tr>
<td>Midterm Exam portion</td>
<td>F2004</td>
<td>174</td>
<td>74.11</td>
<td>8.13</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>F2005</td>
<td>182</td>
<td>79.50</td>
<td>8.13</td>
<td>.60</td>
</tr>
<tr>
<td>December Exam portion</td>
<td>F2004</td>
<td>175</td>
<td>74.65</td>
<td>6.19</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>F2005</td>
<td>182</td>
<td>79.66</td>
<td>6.52</td>
<td>.48</td>
</tr>
<tr>
<td>OSCE Exam portion</td>
<td>F2004</td>
<td>174</td>
<td>77.86</td>
<td>7.60</td>
<td>.58</td>
</tr>
<tr>
<td></td>
<td>F2005</td>
<td>182</td>
<td>76.98</td>
<td>8.32</td>
<td>.62</td>
</tr>
</tbody>
</table>

Table 31 reports the results of the 2-tailed test for significance.

Table 31

Significance of Results for Equality of Course Means: Sig. (2-tailed)

<table>
<thead>
<tr>
<th>Item Scored</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final*</td>
<td>-4.15681</td>
<td>350.71</td>
<td>0.000</td>
<td>-2.29</td>
<td>0.55</td>
<td>-3.38 -1.21 0.44</td>
</tr>
<tr>
<td>Midterm</td>
<td>-6.25388</td>
<td>354</td>
<td>0.000</td>
<td>-5.39</td>
<td>0.86</td>
<td>-7.08 -3.69 0.66</td>
</tr>
<tr>
<td>December</td>
<td>-7.44251</td>
<td>355</td>
<td>0.000</td>
<td>-5.01</td>
<td>0.67</td>
<td>-6.34 -3.69 0.79</td>
</tr>
<tr>
<td>OSCE</td>
<td>1.033983</td>
<td>354</td>
<td>0.302</td>
<td>0.87</td>
<td>0.85</td>
<td>-0.79 2.54 0.11</td>
</tr>
</tbody>
</table>

* This test has been adjusted due to lack of homogeneity of variance.

***p<.001

The written multiple choice exams, which reflect content knowledge, were significantly better in F2005 (midterm 79.5 vs. 74.11); December (79.66 vs. 74.65), but the OSCE results, which reflect skill competencies, were not significantly different for F2004 (77.86) vs. F2005 (76.98). The overall course score, labeled ‘final’, combined all these assessments, and was also significantly better for the study cohort, F2005 (80.83 vs. 78.53).
5.4.1.2 Course scores: 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs) and second year (2004-5) vs. third year (2005-6) GPAs

Means for the second year course completed with the panel only (220 -S2005: KB Panel) and means for the third year course with all combined study designs (320 -F2005: all KB Designs) are compared to the second and third year GPAs. The performances for the year are reported as overall GPA aggregate scores for all the courses in the curriculum that year. For purposes of analysis, all courses score means (usually reported as weighted averages eg. above in Table 30) are reported using a GPA scale for the courses, since overall second and third year scores are only recorded using the GPA scale.

Table 32

<table>
<thead>
<tr>
<th>Pairs</th>
<th>Score</th>
<th>Date</th>
<th>Mean</th>
<th>N</th>
<th>SD</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>GPA 3rd year overall</td>
<td>2005-6</td>
<td>2.96</td>
<td>178</td>
<td>0.53</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>GPA 320 course only</td>
<td>F2005</td>
<td>3.53</td>
<td>178</td>
<td>0.44</td>
<td>0.03</td>
</tr>
<tr>
<td>Pair 2</td>
<td>GPA 2nd year overall</td>
<td>2004-5</td>
<td>3.21</td>
<td>178</td>
<td>0.48</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>GPA 220 course only</td>
<td>S2005</td>
<td>3.45</td>
<td>178</td>
<td>0.44</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table 33 reports the results of the 2-tailed test for significance.

Table 33

<table>
<thead>
<tr>
<th>Course Score</th>
<th>Paired Differences</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA 3rd year - GPA 320 course only</td>
<td>-0.57 0.48 0.04</td>
<td>-16.06 177</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>GPA 2nd year - GPA 220 course only</td>
<td>-0.24 0.42 0.03</td>
<td>-7.70 177</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

***p<.001
For both years, the course has a significantly higher mean than the overall GPA (3rd year- 3.53 vs. 2.96; and 2nd year - 3.45 vs.3.21). As tested by paired t-tests, the differences are significant with p<.001. Since the course scores are included in the GPAs, this comparison reflects that students performed better in the 220 and 320 courses than in other courses in that respective year. Again, it is acknowledged that differences in course scores and GPAs cannot be interpreted as a de facto measure of "Idea Improvement", but are reported as a reflection of total and broader effects.

Figure 8 charts show the distribution of the overall and course marks. Only 7 or 8 different marks were given in the course, while there is a full distribution for the overall mark.

---

**Figure 8.** Distribution of 2nd and 3rd Year Overall Marks and 2nd and 3rd Year Course Marks
While the overall GPAs for second vs. third year decreased (3.21 vs. 2.96), the study course means increased 3.45 (S2005: KB Panel) vs. 3.53 (F2005: all KB Designs), despite a more difficult third year program. Out of interest, the next set of analysis examines whether the increase in the course scores from second to third year, is significant.

5.4.1.3 Course scores: 2nd year (S2005: KB panel) vs. 3rd year (F2005: all KB Designs)

Means for the second year course completed with the panel only (220 -S2005: KB Panel) and means for the third year course with all study designs (320 -F2005: all KB Designs) will be compared. The goal of this analysis was to provide indication that the full set of KF designs in 320 -F2005 vs. the panel only design in 220 -S2005, led to greater engagement in Knowledge Building and thereby also led to more idea improvement, as reflected in improved course scores despite increasing difficulty of the course content.

Table 34 reports the means. The means of the 320 (F2005: all KB Designs) group are somewhat higher than the 220 (S2005: KB Panel) group (80.83 vs. 79.71), and the difference is significant.

Table 34

<table>
<thead>
<tr>
<th>Final Marks</th>
<th>Course</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final marks</td>
<td>Final 320</td>
<td>182</td>
<td>80.83</td>
<td>5.57</td>
<td>.41</td>
</tr>
<tr>
<td>Final 320</td>
<td>Final 220</td>
<td>179</td>
<td>79.71</td>
<td>4.96</td>
<td>.37</td>
</tr>
</tbody>
</table>

Since the Levene test for equality of variance was not significant Table 35 reports the usual t-test.
Table 35

<table>
<thead>
<tr>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
<th>95% Confidence Interval of the Difference</th>
<th>d Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.01</td>
<td>359</td>
<td>0.04</td>
<td>1.12</td>
<td>0.56</td>
<td>0.03 2.21</td>
<td>0.21</td>
</tr>
</tbody>
</table>

*p<.05

To address effect sizes, Cohen’s d (Cohen, 1988), is reported as a column in the t-test Table 35. This divides the difference in effect by the average of the standard deviations (also obtained by analysis) in order to be interpreted. The effect size of the difference obtained is 0.21. (The usual guidelines for interpreting the d statistic are 0.2 small effect, 0.5 medium effect, 0.8 or more large effect.) It is acknowledged that Cohen’s d is a guideline only (Cohen, 1988).

5.5 Summary

This chapter has reported quantitative and qualitative results for the design features of the case study. Given the relatively short duration of the study (thirteen weeks) and the pragmatic constraints of the heavy curricular load and large size class, it is impressive that there was change across the various dimensions measured. Caution must be exercised in interpreting the quantitative data, as described in Chapter Four. Testing separately may give rise to overly impressive results or hide differences, despite corrections for multiple comparisons. In this case, the results suggest the reciprocal nature of Knowledge Building principles.

The next chapter will interpret the significance of these reported results in terms of advances in design methodologies and advances in the conceptual framework principles of epistemic agency and community knowledge, collective responsibility.
Chapter 6
Discussion

6 Introduction

This chapter begins with a summary of the research, its challenges and design; followed by a general discussion of the relevance of reported results to literature reviewed in previous chapters; and then narrows the focus to consideration of the importance of results for each design feature in terms of advances in design methodology and implementation of Knowledge Building principles.

6.1 Summary of the Research

This research investigated design interventions in a 13 week PHM 320F course commencing in September, 2005 with 182 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.

6.2 Research Challenges and Design

The challenges of this research were complex. Investigating efforts to shift from a traditional lecture-style training method, which gives the responsibility to teachers and not learners, to a Knowledge Building community in a Pharmacy undergraduate course were situated in a context
of obstacles with multiple dependent variables: the classroom was large size, the educational agenda pre-determined and the social orientation of students in prior classes indicated a preference to learn in isolation without benefit of peer support or interaction.

The design challenge in engaging students in elements of the course which could be altered was to build understanding about what would be most effective in advancing epistemic agency and community responsibility. What would create an environment conducive to a student-driven community-united inquiry process, fostering skills such as self-assessment, to best serve the standards of practice for self-regulation and maintenance of competency in pharmacy in Canada, and in particular, the self-care context?

The design of this research, therefore, was to use a case study approach to explore Knowledge Building interventions in a large enrolment Pharmacy class. This research addresses these challenges through design features which create a dynamic, practice-based classroom and enable self-assessment, advancing methodology and Knowledge Building.

6.3 Significance of Research Results in light of Literature on Large-Class Sizes and Pharmacy Practice:

This case study research was guided by literature regarding large class size, summarized in Chapter Two, and pharmacy self-care practice, described in Chapter Three, with consideration of issues relevant to Knowledge Building theory pedagogy and technology. What is the significance of the outcomes of the case study in terms of this broader picture? How and why does the reported research matter?

A case study was conducted to assess environmental boundaries for Knowledge Building pedagogy in light of the following.
6.3.1 Knowledge Building Literature and the Large Class Size Dilemma:

To achieve Knowledge Building, it is important to engage students in deeper approaches to higher level cognitive processes. Literature calls for increased research aligned to successful approaches such as fostering collective multiple problem-solving approaches within a community (Stevenson & Sigler, 1992; Robison, 2007); peer collaboration and formative assessment (Druger & Crow, 2004); enabling self-regulation for students to affect class goals and outcomes; (Robinson, 2007; Van den Berg, Admiraal & Pilo, 2006); and finally, encouraging autonomy and relinquishing control to students (Gedalof, 2006; Gibbs & Jenkins, 1992; Lewis, 1990; Bauer & Snizek, 1989; Monk, 1983).

As reported in Chapter Two, Regehr and Eva noted deficiencies in the literature with respect to both the practitioner's ability to self-assess gaps in competence and also the willingness of practitioners to seek out opportunities to redress these gaps. (Regehr & Eva, 2006). They called for new strategies to address these personal learning issues as an educational step towards effective individual self-regulation and maintenance of competency. As a step towards their recommendations, this research is unique in allowing fifty percent of examinations to be composed of student test-questions, unmodified by the teacher, and reviewed and improved by student efforts.

The literature reviewed in Chapter Two and results from Chapter Five confirmed that improved designs were empowering to students and they perceived that their motivation and productivity increased through the course features. As suggested by one student:

**Student Quotation:**

“… I enjoyed the panel set-up the most, because it forces students to learn topics well during the semester instead of just for an exam, and builds students confidence when they are able to competently participate in discussions…”
Students further reported that writing questions for their own examinations increased confidence during exam periods and increased their reflective learning.

The case study design implemented in this research aimed to address these issues. Design features include classroom panels, student-generated self-assessment exam questions and online discourse opportunities afforded by Knowledge Forum. Results confirm the success of the designs. As one student stated:

**Student Quotation:**

“…these activities changed the way I learned …I had to prepare in advance, doing my own studying and research first, then collaborate with classmates to discuss develop ideas further.. they deepened understanding of each topic through chances to clarify concepts and simultaneously evaluate our knowledge. We retained the information better because we studied more carefully and paid more attention to detail, because we would be sharing information with others….”

### 6.3.2 Pharmacy Practice Implications

In Chapter Three, the current status and future vision of the profession of Pharmacy in Canada was reviewed in order to consider how the concepts of epistemic agency and collective responsibility might be important to undergraduates preparing for and entering into practice. Increases in student population and volume of information were addressed through designs to vitalize a dynamic classroom within and beyond face to face encounters. It aimed to craft
reforms which would meet pharmacy practice educational outcomes with expediency, efficiency and quality, bearing in mind the continually changing landscape of guidelines and competencies from a number of different educational and regulatory standard-setting organizations. Promoting student involvement, capacity for self-direction, critical thought and evaluation of evidence are critical for a self-regulating profession with ongoing, lifelong and mandated maintenance of competency. These proficiencies are supported by a Knowledge Building theoretical framework that espouses agency and collective responsibility.

The participants required competencies to practice within the domain of self care. The FIP statement on self-care principles outlined in Chapter Three, stressed education which emphasized communication skills, and social and behavioural aspects of self care (FIP, 1996). It also clearly noted the imperative that pharmacists in self care contexts take responsibility to extend and update their knowledge on medicines and symptom recognition throughout their professional careers.

The research took notice of these FIP ability guidelines and also to Abrahamson’s recommendation’s to train students to develop translatable skills to satisfy problem-solving and clinical competency in the workplace (Abrahamson, 1996). Regehr and Eva suggest that self-assessment ability is not a universal skill, but is tied to ability in specific domains, calling for educators to enact mechanisms to hone context-situated self-testing training (Regehr & Eva, 2006). Thus, combined study designs fostered self-assessment skills grounded in experiential realities, and encouraged communication in panels and online discourse elaborating valid patient problems. Case study results show movement towards the challenge of designing and providing teaching strategies and methodologies within the undergraduate curriculum and university system to support these theories and deliver the required outcomes considering local constraints and resource implications.

This research attempted to address general standards for both educational and pharmacy practice in delivering a context-specific specialty course ie self-care, through creation of authentic, realistic panel and self-testing case questions, postulated by the students themselves as a foundation for knowledge creation and problem solving. This effort was to create a link to and awareness of experiential practice which would engender not only knowledge and skills of value in the workplace, but a sense of motivation and confidence that would germinate in each
individual. As well, through solving these bona fide situations together as a community of Knowledge Builders, it was intended to spark an entrée into a community of practitioners.

“I hear and I forget
I see and I remember
I do and I understand”

Anonymous

Excerpts from student survey responses attest to a move in this direction in the minds and experiences of participants. Consider these heartfelt and voluntary comments regarding their growth towards clinical competency:

**Student Quotations:**

“…help you identify what is important (key) for patient education and assisting them with their health concerns…”

“…how much I really understand the topic, beyond the text book, and applying it to different types of patients….”

“…apply that knowledge that I learned to real life situations. …”

“ allowed me to learn all of the material and to think about how the information applies to different populations...”

“...multiple choice questions really helped me apply that knowledge that I learned to real life situations…”

“…really seems to help you identify what is important (key) for patient education and assisting them with their health concerns…”

..MCQ activities helped me to allow me to know how much I really understand the topic, beyond the text book, and applying it to different types of patients….“
“… The class panels helped to encourage student-controlled learning which I found was very effective…but these course activities were all self-directed, thus they had to make me learn the pertinent information in such a way so that it could be applied to any patient case; it's not just knowing the material that is important but the ability to apply it to various patients, in order to grasp a more thorough understanding…”

“… panels challenged me to apply readings to real life situations and to real life patients… to look at patients as individuals…”

“…class panels give me a real life perspective on what situations we can encounter…”

“…the activities definitely helped me learn the material in such a way that I could pick out the information relevant to pharmacists and patient care. …”

As a researcher, teacher, and self-care pharmacist, the investigator attempted to refine educational methods guided by theoretical principles, in order to meet practice requirements for self-regulating professionals. The Knowledge Building frameworks of epistemic agency and collective responsibility appear to prepare students to care for patients as complex and unique individuals and sustain proficiency as practitioners as the profession evolves.

6.4 Significance of Research Results for Each Design Feature:

A variety of data analysis tools and measures were used to assess the impact of new design features on Knowledge Building, especially epistemic agency and community knowledge, collective responsibility. Descriptive narrative accounts, coding from survey responses and quantitative ratings of various instruments provided insights into how the student participants responded to attempts to make progress. Design features related to Knowledge Building principles, as summarized in Table 36.
Table 36

Advances in Design Methodology and Implementing Knowledge Building Principles

<table>
<thead>
<tr>
<th>DESIGN FEATURE</th>
<th>ADVANCES IN DESIGN METHODOLOGY</th>
<th>ADVANCES IN IMPLEMENTING KB PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom Panels</td>
<td>• 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.</td>
<td>• 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.</td>
</tr>
<tr>
<td>Student-Generated Self-Assessment Exam Questions</td>
<td>• 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.</td>
<td>• 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).</td>
</tr>
<tr>
<td>Student Evaluation of All Designs to Facilitate Knowledge Building Activity</td>
<td>• 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.</td>
<td>• 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</td>
</tr>
<tr>
<td>Idea improvement</td>
<td>• Combined design features contributed in part to significantly enhanced student outcomes (see right column)</td>
<td>• Student outcomes demonstrated idea improvement through designs leading to epistemic agency and collective responsibility, community knowledge. This was evident in significantly higher scores for o F2005:all KB Designs vs. F2004:preKB (t-test for equality of course means: sig (2-tailed)) o 220 (S2005: KB Panel) vs. 320 (F2005: all KB Designs) and second year (April 2005) vs. third year (April 2006 GPA) Class 0T7 (t-test for equality of course means vs. Means for AGPA; sig (2-tailed)) o S2005: KB Panel) vs. 3rd year (F2005: all KB Designs) (t-test for equality of course means: sig (2-tailed)) effect size</td>
</tr>
</tbody>
</table>
6.4.1 Classroom Panels

As described in Chapter Four, the classroom panel was a key feature in the case study design. Methodologically, the goal was to create a more dynamic environment involving all students in a large size classroom environment, structured to advance theoretical principles of epistemic agency and collective responsibility by fostering discussion and collaborative building of new ideas. To be effective Knowledge Builders, students should contribute idea, problems of interest, and possible solutions to support continual improvement of knowledge for the group.

The narrative description of the scabies panel discourse set out for the reader how the multifaceted Knowledge Building principles operated in an interconnected, interdependent reciprocal manner as the community created and elaborated goals and an authentic patient problem and care plan.

Faculty observers (TAs) of the panels, the students themselves, and the instructor (researcher) confirmed these observations in documented results. Observers and participants alike perceived approximately to the same degree epistemic agency with students assuming control of many high level components of the work normally handled by the teacher exclusively.

Noteworthy is that while both groups perceived that the panels ‘showed’ collective responsibility for community knowledge, students ‘felt’ the sense of community responsibility more strongly. Faculty observers (TAs) can at best perceive a sense of community without being able to experience it personally. The involved students, who were used to working in isolation, acknowledged and felt community responsibility which they reported as a new and desirable form of engagement.

The instructor (researcher) ratings were not used for statistical analysis. A few instances of instructor (researcher) vs. pharmacist observer (TA) ratings showed the researcher ranked principles similarly or slightly higher than the pharmacist observer (TA) in some cases. The instructor (researcher) is connected to the group with greater investment in outcomes than pharmacist observers (TAs). This may account for slightly higher ratings. But the results are consistent with those of the pharmacist observers (TAs), and her perspective was additionally
based on contrasts she noted over the years, as she had taught the same cohort in the pre-study format. She was alert to redirections in behaviour, particularly in terms of control, accountability and community responsibility. She noted a surprising change between the F2005: all KB designs cohort and previous course iterations (S2005: KB panel; F2004: pre KB). Whereas in F2004 and S2005, attendance in class was slight, during F2005 attendance rose to almost complete with every session. This suggests a sense of engagement, while not captured statistically. It nevertheless was an important result that seems attributable, at least in part, to the enticement of the panel over lecture format.

The advances in both design method and the principles of agency and community knowledge engendered by the panel are born out with data derived from the students’ anonymous survey responses. Quantitative analyses showed that students felt the panel contributed significantly to their sense of engagement in all curricular required learning objectives. Of significance is the evidence that students preferred the panel design method to pre-study designs in terms of enabling epistemic agency evidenced in students taking responsibility for knowledge advances.

Student survey comments were solicited by asking for their opinion regarding methods that affected their learning. Themes identified provided evidence from the perspective of the students regarding the value of each design feature.

The following comment is suggestive of epistemic agency:

**Student Quotation:**

“…by having the opportunity to do these things, I felt like we, the students, controlled what we learned, so it pushed me to be more responsible with what we learn in class and to learn with and from others; …made me more active in my learning. I found I wasn't just reviewing the information as in previous years, but trying to come up with other potential situations and applying the information to them…."

The following comment is suggestive of collective advance in understanding:
Student Quotation:

“…enabled to do my own studying and research first, preparing in advance, then collaborate with peers and classmates to discuss issues and develop ideas and solutions further;…deepened understanding of each topic;… opportunity to clarify confusing concepts and simultaneously evaluate our understanding;… retaining the information better;… through studying more carefully and paying more attention to detail, with the motivation that we would be sharing information with others.…”

These remarks were similar to those of many students, and are suggestive of the advantages students attribute to the change in approach to the course, as evidenced by their perceived capacity, willingness and desire to take on increased levels of agency and collective responsibility for community knowledge. The panel not only was valued by students for enabling their control of learning and ability to fit ideas together with others, but as a design that built motivation and confidence.

6.4.2 Student-Generated Self-Assessment Exam Questions

As described in Chapter Four, the self-assessment exam questions address course design features aimed at innovative ways to foster Knowledge Building. The exam question blueprint was planned to address self-reflective evaluation, and meta-cognition. Sustaining the process through online discourse with the class community was directed toward providing mutual support, constructive criticism and continuous effort at idea improvement to further community understanding, hoping for gains toward epistemic agency and collective responsibility.

The excerpts from the Knowledge Forum view described in the Chapter Five open a window into the world of the student’s progress towards self-assessment, reflection and synthesis. They help
substantiate quantitative results suggesting the design provides a forum for encouraging control of self and peer assessment from the micro to the macro level. First, it links the learner to the panel activity, through the formulation of an individual pre-panel question. Next, it allows for reflection and synthesis through the individual’s modified post panel version. It stimulates collective responsibility to improve the question through the forum discussion. Students are empowered to build on another’s question, to restructure the content and advance the ideas presented. The community knows that if they work together to amalgamate a better version, the question will become part of the formal course examination. Excerpts were presented in Chapter Five to demonstrate the enactment of epistemic agency, and collective responsibility, embedded in a broad network of Knowledge Building principles.

The analysis that compared student pre and post test scores showed that 102 students (57%) reflected, reconsidered and changed their version of the test item to be used. This is important in light of the literature cited that health care practitioners often fail to remedy deficiencies in understanding. Students who revised their item scored significantly higher on the post-test (4.34) vs. pre-test (3.14) (As you may recall, their pre-test submissions were not higher than peer submissions). Results suggest progress towards idea improvement and self-assessment, with results indicating quality production in line with professional practitioners as indicated by the fact that raters were not able to differentiate the authorship of student created vs. instructor created test items.

The data indicate that the instrument itself is an innovative tool for advancing self-regulatory behaviours. The majority of participants, in generating their self-testing items, took control of the opportunity to reflect and improve their ideas, and the results of these revisions led to quality levels of the same caliber as teacher developed evaluation.

6.4.3 Student Evaluation of All Designs to Facilitate Knowledge Building Activity

The aim of advancing principles of epistemic agency and community responsibility was constrained by a strictly pre-determined curriculum structure, but as results indicated, this was
not an overwhelming constraint, as it was possible to involve students as co-designers and all
design changes were reviewed, altered and ultimately approved by a unanimous class vote.
Carrying forward with this concept of student voice, the third set of data analysis focused on
eliciting the opinions of the students who participated regarding their rank ordering of design
features and an anonymous survey that elicited student comments. Students were aware of the
importance of their input in evaluating the designs and were reassured that the results of the
survey would be instrumental in refining the course, emphasizing the degree of influence they
could bring to bear on course improvements. Of the 182 student participants in the study, 177
completed the survey.

The quantitative results in Chapter Five suggest development of both epistemic agency and
collective responsibility, and preference for two designs, the panels as first choice, and the
student generated self-assessment exam questions as second. This was confirmed in the themes
derived from qualitative analysis of student comments.

In terms of advances in methodology, significant difference in means reported for the classroom
panels (4.24) and for student-generated self-assessment exam questions (3.81) emphasize that
these designs were preferred to other features (pre-panel view - 3.11; post-panel view - 3.50;
OSCE view - 3.68).

Student comments indicated the panel in particular, empowered them to feel control over their
own goals, measures and outcomes, to share responsibility for their own results. This is captured
in the following extract:

\textbf{Student Quotation:}

“… I really liked the panel and the preparation for the panel it really allowed me
learn and pick up important concepts and then clarify them during the panel. I
could get involved in discussion…build on the knowledge… an effective way to
communicate with classmates and also to see their input.. a very creative and
original way to permit students to do their own learning and to participate…
panels are useful for building up knowledge … clarifications and questions on the
MCQ forum were a good way of thinking more critically about the information}
..quite helpful when we were able to find any discrepancies in the assessment, in preparing for tests, to see how my classmates were thinking, and to show me what I should be considering... the questions allowed evaluation of knowledge and immediate validation/rejection of ideas submitted by students, which made it easier later on to remember which points were valid…The forum adds to atmosphere of communication and idea sharing, provided many opportunities to clarify concepts and ask questions…”

6.4.4 Idea Improvement

Students should improve their learning as they progress, regardless of method. Nevertheless, there is a suggestion of added benefit from design feature implemented in this research.

The improvement in pre-to-post-panel student generated self-assessment exam questions indicated idea improvement. Additionally, students’ performance within this course context compared to previous years, or performance in other courses, was considered. Scores show students performed better than previous cohorts in this course. Students also performed better in the third year course with full designs than they did in the second year version with only the panel design. Records also show that while there was a trend for combined third year courses GPAs to decrease, presumably due to increased difficulty and heavier course loads in the third vs. the second year (a well-known phenomenon), this was avoided with the study course, while it is obviously not possible to isolate courses for observed improvements. Students felt more empowered and responsible for their own learning and that of their peers.

6.5 Summary

In summary, the case study elements provide 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. The progress that this example represents suggests implications and the possibility for transferability across other health care educational programs or university curricula with increased enrollments.
Chapter 7
Conclusions

7  Introduction

This final chapter provides summaries of the data analysis in terms of conclusions and implications from the research. Recommendations for future study endeavours and final comments are provided.

7.1  Research Questions and Answers

The research question examined outcomes related to the goals of epistemic agency and collective responsibility for knowledge advancement.

“What classroom interventions and technological or social supports are effective in terms of promoting Knowledge Building practices in an undergraduate Pharmacy course?”

Results suggest this research succeeded in all areas. 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.
7.2 Strengths of this Research

The research results that panels and student generated self-assessment exam questions were important methodological strategies as well as designs which advance Knowledge Building principles are significant strengths. They present insights that might be shared with other contexts involving large groups, empowerment of individuals and the need to create Knowledge Building communities, particularly in undergraduates.

In Chapter Six, implications about how and why epistemic agency and community responsibility matter to maintenance of competency in self-regulating professions were discussed. These results may be important to other health care contexts. In particular, the student-generated assessment design may impact training techniques for practitioners, in situations where self-sufficiency is most needed: Kruger and Dunning suggest that there is little relationship between performance and self-rated ability; the vast majority over-rate their performance; and the worst offenders are those in the lowest quartile, those most in need of remediation (Kruger and Dunning, 1999). As may be recalled, results reported for student generated self-assessment tests, using a method of pre and post individual and collective reflection, indicated that student items were of equal caliber to those of experienced teachers. This suggests the design may provide skill development techniques for self-evaluation for practitioners approaching entry to practice.

"…..forced to take the perspective of the other, we are wrenched out of our self."
Sweder, 1986

This research reported the emergence of epistemic agency and community responsibility in a single group of participants. As such, the case study approach was valuable in terms of deep understanding of how a combination of influences impacted a community: their perceptions, changes in attitudes, and willingness to assume control and collective responsibility. Students were given a voice in goals and outcomes, and the opportunity to relate how they felt about assuming control and responsibility. The large class size, despite contributing to the challenges,
provided a substantial sample size for surveys ratings and comments and made the emergence of a sense of collective responsibility noteworthy.

The research included interpretations by the instructor (researcher) from her perspective as teacher, researcher and practitioner. These provided insights about contrasts observed over iterations, shifts in behaviour towards control and responsibility, as well what is important within that context. Active engagement and support of the instructor (researcher) may have facilitated a Knowledge Building environment.

7.3 Limitations of this Research

The 182 participants, class of 0T7, were chosen as a typical cohort of undergraduate students. One might question if their perceptions and perspectives are common to other incoming groups, how similarly their constraints and affordances will affect future classes, and the transferability of these results. Thus, a limitation of this research may have been the case study design as opposed to an iterative design research approach. Conclusions regarding important concepts are drawn from data situated in a unique and limited period of time. Close scrutiny of the data presented should allay some concerns about these issues. Data was triangulated from many sources, in substantial volume and variety.

Since the researcher was also the instructor, the acknowledgement of potential for bias is made. While important in interpreting the contextual results, it nonetheless might have removed a degree of objectivity and detachment. To counter this, counterbalances were put in place. These were described in detail in the ethics section of Chapter Four, and therefore will not be outlined here again. They addressed limiting interpretive bias as much as possible through the use of traditional qualitative strategies for validating research with respect to this issue and were deemed sufficient and approved by the Ethics Review Committee at OISE/UT.
7.4 Recommendations for Further Research: Progressive Steps

These results and conclusions are drawn from the specific situation in this case study. Future research could establish the trustworthiness of interpretations and achieve generalizability, projections, insights and questions for future cohorts. Verification from a series of similar instances of the course would add more substance to the evidence which could be disseminated more broadly across health professional education. Acceptance and transferability of new methodologies needs to be based on sustainable objective data, and on enduring changes in attitudes.

Progressive refinement of the design features in future course iterations lends itself to study within the design research paradigm. In studies of educational interventions, ‘design experiments’ (Brown, 1992; Collins, 1992) also called ‘design research’ (Collins & Bielaczyc, 2004) arose from the recognition of the complexity of classroom designs and dissatisfaction with existing methodologies for exploring the outcomes from such interventions. It built understanding about the nature and conditions of learning, cognition, and development, through iterative cycles of refinements for implementation (Barab & Squire, 2004). Its fundamental assumption is that cognition is not located with the individual thinker but is a process distributed across and co-constituted by the knower, the environment in which knowing occurs, and the activity in which the learner participates, which cannot be treated as isolated entities.

Further design refinements were made by this instructor (researcher) who continued to teach the course. An indication of the sustainability of these results and potential for future developments is suggested by examination of a few instances of subsequent course iterations as described following.

Recognizing the importance of the students’ and pharmacist observers’ feedback, the next several semesters continue to incorporate student suggested features in order to enable epistemic agency and collective responsibility. With each year, reflective contemplation brought increased understanding and additional changes.
7.4.1 Hand-Held Audience Response Meters

In the year following (F2006), students wished to increase the engagement of the audience during panel discussions. Accordingly, hand-held audience response meters were introduced to give the entire classroom community an equal voice in deciding patient solutions. Meters were successful in including everyone in terms of preparation and participation, as evidenced by the fact that students requested they be incorporated into course assessments (designating a pass of 70% accuracy) as a requirement for the following year, to increase self assessment. This change was approved by a curriculum committee vote, and instituted the next semester (S2007, F2007) for both second and third year courses.

7.4.2 Student Generated Experiential Practice Laboratory

In the subsequent year (F2007), students identified the increasing need for more valid, authentic workplace experiential training during class time. Accordingly, they carried out the planning, and implementation of a student-generated practice lab. This enabled practice sessions for each student in the laboratory during the class demonstration time, working in sections. Student pairs volunteered to create fifteen patient problems and answer keys, printed for distribution. Half the class watched the classroom demonstration while the other half role-played the same cases in groups of eight in the lab. They alternated the next week. Each student played one patient and one pharmacist role. They returned to the classroom, where class discussion took place. Views were created in Knowledge Forum to subsequently post the case, content integration, and issues relating to patient interviewing dynamics.

Participant survey results and outcomes were collected and reviewed. Students performed significantly better in performance assessments (OSCE) than the previous cohort. Findings suggested participants perceived the transfer of responsibility for this course feature to students enhanced their motivation and effectively enabled emergence of communal accountability and development of epistemic agency (Sibbald, 2008).
7.4.3 Self-Directed Online Self-Care Course

The following year (F2008), an existing elective for fourth year students, in the self-care context, was realigned according to student input. This self-directed online course had been created to facilitate progress in three contributing areas: content, meta-cognitive discussion, and assessment. Students requested an additional course objective, enabled through redirection and or additional assignment requirements. The new objective was to assist graduating pharmacy students in meeting standards directed towards patient safety, professional development and contributing to communities of practice. Students in their final year completed this refined three-component online course, each participant focusing on one practice topic. Pre-existing dimensions included critical assessment of the literature; planning strategies for content goals, building meta-cognitive skills; and creating an interactive, case-based integrated online lesson. The lesson offered multiple-choice options and feedback regarding knowledge and assessment skills. The new component was to plan and implement strategies for addressing clinical competencies. Each lesson is offered as continuing online education for the health care practitioner.

An exit online survey was submitted at the commencement of experiential rotations. It evaluated Knowledge Building principles and perceptions regarding skills development and preparation for competency standards. Students reported acquisition of twelve Knowledge Building principles measured via Likert scales of 1-5 (mean = 4.5). Comments highlighted improvements in learning approaches, enhanced responsibility for individual and community learning, and increased skill and confidence. They felt elements of key competency standards were achieved. The implications were that student participants recognized assuming responsibility for learning goals and outcomes enhanced motivation and Knowledge Building; and enabled student agency and community knowledge, collective responsibility through peer teaching. The impact and value of the course design were judged important for addressing practice standards related to patient safety, self-regulation, maintenance of competency and inter-professional education (Sibbald, 2009).
These results suggest the research reports of epistemic agency and community knowledge, collective responsibility, can be confirmed and further validated through the evidence of future investigations.

### 7.5 Final Comments

"The Road goes ever on and on
Down from the door where it began
Now far ahead the Road has gone.
And I must follow if I can.
Pursuing it with weary feet,
Until it joins some larger way,
Where many paths and errands meet.
And whither then? I cannot say."

Tolkien, 1965

This unique case study has contributed to an understanding of the complexities of large size classrooms and how design interventions aimed at supporting principles of epistemic agency and collective responsibility might be transferable to enhance the development of community Knowledge Builders across broader contexts. In establishing the credibility and trustworthiness of assertions, and in selecting evidence, reporting observations and developing claims, the instructor (researcher) considered what constituted reasonable and useful warrants for advancing assertions; the boundaries of this naturalistic context and how the understandings of the immediate context inform broader practice.

It is hoped that this research will stimulate continued study of the design features and Knowledge Building principles explored. Many more questions arise as a consequence of this work, and the roles of students, researchers and social context are paramount in influencing educational practice, transforming future research and in interpreting the social, learning and technological impact of Knowledge Building supports on tangible adoptable programs. The concept of usefulness or consequentiality will entail influencing practice while advancing the pedagogy and technology of Knowledge Building theory.
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McCann, E.J. & Turner, J.E. (2004). Increasing student learning through volitional control Teachers College Record, 106 (9), 1695-1714.


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Appendices
Appendix 1: Third Year Student Consent Form For Data Inclusion

I am a senior tutor at the Faculty of Pharmacy and PhD student at OISE/UT in Curriculum, Teaching and Learning, interested in understanding more about the learning experiences of students. Such information is important in allowing the Faculty to refine structure of classroom or online supports for undergraduate study. At this time, it is important to continue to reflect and assess the impact and value of classroom format and conference system's technological and social affordances as supports for learning. As key participants who have experienced these elements in the course just completed, your perspective, perceptions and input are invaluable to the teaching/learning process and incoming students who will benefit from your insights. Thank you for taking the time to consider participating by allowing your course data to be examined.

The purpose of this data analysis is to examine the impact of using Knowledge Building panels and the Knowledge Building ™conference forum in the third year Faculty of Pharmacy 320F self-care course, fall 2005. No participant will be identified by name in any research, conference or publication in which these data are discussed. Sharing of these insights with other educators may occur in order to benefit learners or teachers in other programs.

Your participation in the course is a requirement for completion of PHM 320F and therefore not voluntary. All assignments are obligatory. As part of these course assignments for 320F, you must complete two comparative surveys which are not voluntary.

Nevertheless, you may decide whether or not to have your grades and survey responses included in the data that will be examined after you have completed the course and your grades have been assessed and submitted. This choice will be kept confidential from everyone who was associated with assessing your final grade for PHM 320F. If you prefer not to have your grades or survey responses included, I will remove your grades and survey responses without penalty or reprisal, and you will not be affected by your choice.

If you agree to have your grades and survey responses included in the data, this analysis will occur in the months after your 320F marks have been submitted to be calculated for your third year GPA. For the data analysis, your name will be removed from the marks so that it will not be possible to identify you from the data. The data will be examined in aggregate form to ensure anonymity. The data files will be encrypted using the password-protection facilities of Microsoft Word XP and Microsoft Excel. The data files will be stored on a secure server in my locked office for five years, after which they will be deleted.

If you have questions now or later, or wish to have information about the research results, you are free to inquire at any time. You may contact Debra Sibbald (978-0842): Debra.Sibbald@utoronto.ca

If you understand the information presented above and choose to have your marks, surveys, or interview anonymously examined, please sign the form below. Thank you.

________________________________________________________________________
I, _______________________________, have read and understand the information provided above and all my questions have been answered to my satisfaction. I understand I am under no obligation to have my marks, and/or surveys, included, nor I am under any obligation in the future, to be interviewed or have interview information included. Nonetheless, with my signature below, I give my consent to let my data be examined, with the understanding that I may withdraw this consent at any time without penalty.

Mark Inclusion    ___________________________________________       ________________________________

S i g n a t u r e       D a t e

2 Required           ___________________________________________       ________________________________

Course Surveys  Signature      Date
Appendix 2: Observe/Rater and Guest Lecturer Consent Form For Data Inclusion

I am a senior tutor at the Faculty of Pharmacy and PhD student at OISE/UT in Curriculum, Teaching and Learning, interested in understanding more about the learning experiences of students. Such information is important in allowing the Faculty to better structure classroom supports for undergraduate study.

As key participants who have taught or rated students in the course your perspective, perceptions and input are invaluable to the teaching/learning process and incoming students who will benefit from your insights. Thank you for taking the time to consider participating by allowing your feedback ratings to be examined.

The purpose of this data analysis is to examine the impact of using Knowledge Building panels in the third year Faculty of Pharmacy 320F self-care course, fall 2005. No participant will be identified by name in any research, conference or publication in which these data are discussed. Sharing of these insights with other educators may occur in order to benefit learners or teachers in other programs.

We are asking that at the completion of each panel observation, you complete an evaluation survey, which addresses your feelings about the demonstration of Knowledge Building principles from the third year students you observed. If you decide not to complete the evaluation form, this will have no impact on any future participation as a rater or guest lecturer.

If you choose to complete the evaluation survey, you will do so anonymously and your name will not be included in any way with the data when it is processed. The data files will be encrypted using the password-protection facilities of Microsoft Word XP and Microsoft Excel. The data files will be stored on a secure server in my locked office for five years, after which they will be deleted.

If you have questions now or later, or wish to have information about the research results, you are free to inquire at any time. You may contact Debra Sibbald (978-0842) : Debra.Sibbald@utoronto.ca

If you understand the information presented above and choose to have the evaluation survey, anonymously added to the study data pool, please sign the form below. Thank you.

I, _______________________________, have read and understand the information provided above and all my questions have been answered to my satisfaction. I understand I am under no obligation to have the evaluation survey included in the data analysis. Nonetheless, with my signature below, I give my consent to let my data become part of the data pool, with the understanding that I may withdraw this consent at any time during or after the analysis without penalty.

Evaluation Survey   __________________________     __________________________________
Signature      Date
Appendix 3: Survey for Panel Observers

Demonstration of Knowledge Building Principles 2005

Indicate the topic: ______________________________________

Indicate your perspective: ☐ observer/assessor ☐ guest facilitator ☐ course coordinator

In your view, indicate the degree to which the panel you observed demonstrated each of 12 Knowledge Building principles:

5 = strong and consistent  4 = relatively strong/consistent  3 = observed but inconsistent  2 = occasional  1 = not observed

<table>
<thead>
<tr>
<th>Knowledge Building Principles</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Ideas, Authentic Problems elaborated</td>
<td></td>
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<tr>
<td>Knowledge Building Discussion</td>
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<tr>
<td>Improvement of Ideas</td>
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<tr>
<td>Diversity of Ideas</td>
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<tr>
<td>Conceptual change: understanding that rises above previous ideas</td>
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<tr>
<td>Student agency in advancing understanding / ideas / concepts</td>
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<tr>
<td>Community knowledge as collective responsibility (class or panel)</td>
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<tr>
<td>Democratizing Knowledge (class or panel)</td>
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<tr>
<td>Symmetric Knowledge advancement (across panel or class)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pervasive Knowledge building (including audience engagement)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructive Use of Authoritative Sources</td>
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<tr>
<td>Assessment</td>
<td></td>
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</tr>
</tbody>
</table>

Comments: Use reverse page to provide any free-responses you wish -eg.
- Note any particular edifying examples of any of the principles
- Note any incidents (positive or negative) of note
Appendix 4: Sample Pre / Post Panel Multiple Choice Question/Answers

Name____________________________ Date/Time of e-mail_________________ Topic_____________________________

Create you case in the box below.  Do not share this information with anyone. Do not bullet your a,b,c,d,e options

Pre Panel MCQ

Patient Case and 5 Answer Options :

Answer with reason:

Post Panel MCQ

If the same with no changes, indicate reason:

If improved, provide edited version below:

Patient Case and 5 Answer Options:

Answer with reason:

Reason for editing:

Indicate all that apply to your panel experience:

- Authentic Problem(s) Elaborated
- Improvement of Understanding of Concept(s)
- Advancing Understanding/Ideas /Concepts
- Knowledge Discussion
- Idea Diversity
- Use of Authoritative Sources
- Understanding that rises above previous ideas
- Self Assessment which is transformative

Indicate all that you experienced or observed during your panel experience:

- Collective Responsibility for Knowledge
- Pervasive Knowledge building (including class participation)
- Democratizing Knowledge for All
- Advancing Knowledge Symmetrically (across panel/class)

Which applies to your panel experience?

- reinforced knowledge
- acquired new knowledge
- further investigation needed
Appendix 5: Student Evaluation Survey of Four Learning Activities

320F 2005-2006

As a third year student, you completed four PBL activities for a self-medication topic:

1. **C** = Knowledge Building Class Skills lab (Panel)
2. **P** = Peer Teaching Presentation [Key Points Summary/Case creation/Class PowerPoint Presentation]
3. **A** = Assessing Case [Creation and Marking Key/Training Students/Class Role-play assessment]
4. **V** = Interactive Online Case Completion (VITAL©)

Rate each of these four activities with respect to the fulfillment of content and process-related course objectives, on a scale of 1-5. Then compare and rank the four activities with respect to each objective to reflect which activity was relatively strongest, second strongest, third strongest or least strong:

<table>
<thead>
<tr>
<th>Enabling Knowledge Building</th>
<th>Class Panel</th>
<th>Peer Teaching Task</th>
<th>A = Role play Task</th>
<th>VITAL Online case</th>
</tr>
</thead>
<tbody>
<tr>
<td>This activity helped me acquire detailed knowledge relevant to one specific self-limiting condition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>This activity helped me to use problem-based techniques applied to case studies to determine important issues in the pharmaceutical care process</td>
<td></td>
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</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>This activity heightened my awareness of special techniques and appropriate communication skills for patients with special needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>This activity helped me to identify other important issues for establishing patient relationships.</td>
<td></td>
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</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
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<tr>
<td>This activity helped me to determine the pertinent issues in collecting, synthesizing and assessing patient history information.</td>
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</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
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</tr>
<tr>
<td>This activity helped me to identify, prevent and solve drug-related problems related to self-care and nonprescription drugs</td>
<td></td>
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</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
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<tr>
<td>This activity was useful in comprehending the pathophysiology, etiology, and differential diagnosis of a particular self-limiting or minor condition.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>This activity helped me to evaluate correct and incorrect assessment and treatment approaches</td>
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</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This activity was useful in assessing the comparative value of non-drug and drug therapy for a self-limiting or minor condition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>This activity was useful in determining the situations in which patients should seek advice of a physician or other health care professional, and when they can safely self-medicate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>This activity was useful in determining parameters for monitoring outcomes for a self-medicating patient with this condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>This activity made me aware of moral, ethical and legal responsibilities or social issues for this condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ONTARIO INSTITUTE FOR STUDIES IN EDUCATION OF THE UNIVERSITY OF TORONTO
<table>
<thead>
<tr>
<th>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This activity made me aware of self-medication hazards and/or consumer perceptions of advertising issues.</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity was useful as a stimulus for reviewing the published literature about this condition</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity was useful as a stimulus for reviewing other Internet sources about this condition</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity serves as a useful supplement to information provided in didactic lectures</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This is a useful problem-based learning activity requiring self-direction</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td><strong>Enabling Skills Building</strong></td>
</tr>
<tr>
<td>This activity encouraged students to take responsibility for their own learning</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity was helpful in building students' confidence in their ability to learn</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity helped develop the skills to manage large complex tasks</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity encouraged creativity</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity helped me to develop skills to teach my peers and pharmacists in practice settings</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity enabled acquisition of new skills useful in my profession</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity enabled development of skills important for patient education.</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>This activity was at a level of difficulty I could perform competently</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>Number of hours necessary to complete each activity</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
<tr>
<td>Which was most helpful in preparing for the skills lab?</td>
</tr>
<tr>
<td>Rank the 4 activities for this variable (1&gt;2&gt;3&gt;4)</td>
</tr>
</tbody>
</table>

**Student Free Response**

- How did the activity affect the way you learn in this course?
Appendix 6: Solo Taxonomy Data Analysis Instrument

Data Analysis Model

Case Creation with

1. Lack of understanding or cohesive thinking
2. Exploration of rudimentary ideas
3. Connections and analysis of multiple components (formulaic)
4. Synthesis and integration of situated relevant components
5. Demonstrates transfer: insights, extensions, perceptive evaluation, or critical judgements
Appendix 7: Survey of MCQ Submissions

Case Creation with Multiple Choice Question and Answers

In your view, indicate your estimate of the level of training of the author of the following case question and multiple choice answers:

4 = Faculty lecturer Post-graduate degree  
3 = Pharm D practitioner  
2 = BScPhm  
1 = Undergraduate student

<table>
<thead>
<tr>
<th>Level of Training</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Description...........</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Answer option</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Answer option</td>
<td></td>
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<tr>
<td>• Answer option</td>
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<tr>
<td>• Answer option</td>
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</tr>
<tr>
<td>• Answer option</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Case Description........... |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |

| Case Description........... |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |

| Case Description........... |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |
| • Answer option            |   |   |   |   |

Additional rows provided for sixteen sample questions

Comments: Use reverse page to provide any free-responses you wish
Appendix 8: Student Evaluation Comparative Survey of Five Design Features

320F 2005-2006

As a third year student, you completed 2 class panels, submitted MCQs and engaged in 4 KF forum views:

- \( C \) = Knowledge Building Class Skills lab (Panel)
- \( P \) = Pre-Panel KF Discussion View
- \( T \) = Post-Panel KF Discussion View
- \( M \) = Multiple Choice Questions KF Discussion View
- \( O \) = OSCE KF Discussion View

Rate these with respect to enhancement of 12 Knowledge Building principles, on a scale of 1-5, (disagree strongly, disagree, neutral, agree, agree strongly) Also compare which activity was relatively strongest, second strongest, third strongest or least strong with respect to each principle:

<table>
<thead>
<tr>
<th>Enabling Knowledge Building</th>
<th>Class Panel</th>
<th>MCQs KF</th>
<th>Pre-Panel KF</th>
<th>Post-Panel KF</th>
<th>OSCE KF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Ideas, Authentic Problems</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge Building Discussion</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement of Ideas</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diversity of Ideas</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual Change: Ideas that ‘Rise Above’ current understanding</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epistemic Agency in Advancing Ideas / Concepts / Understanding</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community Knowledge as Collective Responsibility</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Democratizing Knowledge</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symmetric Knowledge Advancement</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pervasive Knowledge Building</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructive Use of Authoritative Sources</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformative Self-Assessment</td>
<td>Rank the 5 features for this variable (1&gt;2&gt;3&gt;4&gt;5)</td>
<td></td>
<td></td>
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</tbody>
</table>

Student Free Response

How did the activity affect the way you learn in this course?
Appendix 9: Sample Knowledge Forum Discussion Views

- http://db.iki.it:8001 - View: PHM320F: Welcome - Microsoft Internet Explorer provided by Compaq

PHM320F: Welcome

- Pre-Panel Discussion
- Post-Panel Discussion
- Multiple Choice Questions
- OSCE Preparation

Welcome to the Knowledge Forum (K-F) by Manager M. [2005, June 21]
Example of the First Build on Note-It a Thread by Manager M. [2005, June 24]

View Information
Created: 2005, June 10
Modified: 2005, June 10
Revisions: 0

Author: Manager M.

External Link: View URL for external use (copy and paste a "copy button" function)

- http://db.iki.it:8001 - View: PHM320F: Multiple Choice Questions - Microsoft Internet Explorer provided by Compaq

PHM320F: Multiple Choice Questions

1. List edit by Manager M. [2005, June 24]
4. Percussion edit by Manager M. [2005, June 24]
5. For Infection edit by Manager M. [2005, June 24]
8. Vomiting edit by Manager M. [2005, June 24]
15. Constipation edit by Manager M. [2005, June 24]
17. Pre-Panel Discussion edit by Manager M. [2005, June 24]
18. Post-Panel Discussion edit by Manager M. [2005, June 24]

View Information
Created: 2005, June 24
Modified: 2005, June 24
Revisions: 2

Author: Manager M., Manager M.

External Link: View URL for external use (copy and paste a "copy button" function)
Appendix 10: Survey One Comments - Epistemic Agency

Quotations from Online Survey Access Database recorded January 22, 2006:

“…by having the opportunity to do these things, I felt like we, the students, controlled what we learned, so it pushed me to be more responsible with what we learn in class and to learn; …made me more active in my learning. I found I wasn't just reviewing the information as in previous years, but trying to come up with other potential situations and applying the information to them….”

“…the new class panel enabled me to be an active participant in my learning and taught me how to be an independent learner… by struggling to learn the material and solve the cases on my own, I gained and retained so much information….”

“…The panel was the most useful activity as it helped me to focus on the most pertinent points and it streamlined the way I completed my readings….It forces the student to learn about each topic as they go along and made me study in advance and prepare for the class panel. It encouraged self learning and was helpful because it makes me research more and apply my knowledge….”

“the panel requires good time management and self-directed learning. They motivated me to do more independent learning…helping students gain important skills needed to practice pharmacy and help patients. The panels make you "think on your feet…"

“…allowed me to learn the material thoroughly at my own pace….put more pressure on me to try and know the topic really well, so that I don't make a fool of myself in front of the class. They definitely helped me learn the material in such a way that I could pick out the information relevant to pharmacists and patient care. …”
“…a useful way to learn the information for each topic. It also ensured that the student stayed on top of the material….increased the amount of knowledge and skills that I gained. They also encouraged me to seek information from various sources independently….I enjoy self-directed learning - this panel format made me responsible for the information in a new way…”

“…helped me learn how to use different resources to gather information and build knowledge….allowed us to research, learn topics, then apply the skills and knowledge we gained on our own as well as add new ones…My learning became more structured due to the panels. I learned to pick out the most relevant and important information. It's the panels and need for preparation for each topic that made the most difference for my learning. ..Panels encouraged me to look outside of the text and recommended readings for more insight into treatment options and specifics, especially for special populations and helped me take responsibility for my own learning….”

“…Preparing for each class individually was quite useful in that in that it forced students to learn and be truly accountable to their own education. I learn well in self-study so this class was designed well for my learning style. Panels promoted self-directed learning which I enjoyed. It is best for students to gather information on their own rather than being spoon-fed all the time….”

“…The class panel is a great way for self learning. It makes the student responsible for his/her learning, and ensures that the student completes the readings, and understands the material before the class. The panel experiences reflect what's really important in practice (which sometimes is different from what the books and readings suggest). Also, because we don’t know when we'll be on the next panel, this forces us to prepare in advance and read up on topics beforehand. It motivated me to learn on my own….”
“…Preparing for panel allowed me to learn all of the material and to think about how the information applies to different populations. This method ensured I read and considered all relevant information in different lights….it is very self directed. The responsibility for us as students to learn each topic on our own first helped me understand each topic in depth and I think I found it a much more valuable experience then normal didactic lectures…”

“…The panels forced me to learn new material on an ongoing basis which is in contrast to my typical routine of learning when a test approaches. Since this material requires life-long retention, continuous learning and review of material is essential. It ensures that this important course does not get pushed aside when our schedule is particularly heavy. Panels affected learning in that it encouraged independent work and in this way helped solidify information related to specific medical conditions…”

“…The panel portion of the class really forced me to use self-directed learning, and I found that doing this made test preparation much easier. I enjoyed the panel set-up the most, because it forces students to learn topics well during the semester instead of just for an exam, and builds students confidence when they are able to competently participate in panel discussion. Having to prepare for panels forced me to study the material every week ahead of time. It is a good method of forcing the students to keep up with the material covered in class…”

“..Panel design was very helpful with learning because it forced me to assess the disease states and therapies for myself before seeing them in class. I think the new class format is great. It keeps you from procrastinating and trying to learn everything last minute for an exam. I find that the way this class is set up is great and it really improved the way I learn and remember…”

“…Panels helped for me to be more proactive in learning the course materials. The student panel was incentive to keep up to date with the
reading materials. I feel that they were the most useful activity. The skills panels forced me to prepare for class every single week, and in doing so, forced me to stay on top of the material throughout the entire semester. I often have difficulty staying up to date with assigned readings so the learning format was very useful for me. Also, I was scared of making a fool out of myself on the panel. This was additional motivation to prepare for class…”

“…It helped me acquire knowledge about self-limited conditions at my own initiative, with further reinforcement or clarity provided during class panels/discussions. It is more helpful in this respect than simple didactic lectures. Panel forced me to familiarize myself with the material prior to the panel…. panels helped me to learn independently and assess my level of familiarity of disease conditions and their treatment approaches in a "safe" environment…”

“…The class panel preparations were easier to prepare for and easier to learn the information, as one can work independently on the task, whereas, the other formats were not as easy to learn. Since this course is more self-taught than any of the other courses that we have, it required me to spend more time researching and reading pharmacy related material prior to the classes, as opposed to after the classes. It really required self-directed learning which is quite different from didactic lectures…”

“…The class panels allowed a method of learning which requires preparation. This forces one to study in advance for each topic. I enjoy self-directed learning - this made me responsible for the information in a new way and careful preparation before class…very helpful…”

“…Panels encouraged and motivated students to self-learn which is an important skill in the workplace. It gives students the incentive to research the topic on their own. By doing all this, the student will have a better grasp of the topic. I think that the most important aspect was taking the responsibility for acquiring the knowledge and then achieving a level
of understanding such that a complex case could be developed with others…”

“…Panels really helped me to not just memorize information like I usually do but to actually learn it and understand the concepts. I found that I was remembering things that I had learned in class even before I had studied for the exam. I came to class having some knowledge behind me so that I could follow what was being discussed on the panel and answer things in my head. It required a lot of my time to prepare for classes each week so I had to budget my time well….,”
Appendix 11: Survey One Comments - Community Knowledge, Collective Responsibility

Quotations from Online Survey Database recorded January 22, 2006:

“…enabled to do my own studying and research first, preparing in advance, then collaborate with peers and classmates to discuss issues and develop ideas and solutions further;… deepened understanding of each topic;… opportunity to clarify confusing concepts and simultaneously evaluate our understanding;… retaining the information better;… through studying more carefully and paying more attention to detail, with the motivation that we would be sharing information with others.…”

“…provided me with multiple perspectives on a topic because each panel member usually had something insightful to impart to the rest of the class… It provided an active learning experience. Instead of trying to memorize the information, it needed to be understood to explain the information to others…”

“…the panels were motivating students to work individually and as a group as well. It also allows for creativity and critical thinking… together we work to solve in class…”

“…panels enhanced my self-directed learning and problem based learning skills. They also helped me work with the panelists to share our different views and work through questions and concerns for each topic together…”

“…self directed learning was effective in teaching me how to draw upon the resources of my class members as this is how I perceive practice to be like in the real world. It provides a chance to discuss and realize the reasoning behind the suggestions that we made instead of simply memorizing therapies… It helped me to select and apply the information that I read and learned in a patient case…”

“…panel discussion helped me retain things better. When you are directly presented with a problem, whether you know the answer or not, once you
discuss the answer with others, it's something that you remember not just for the short term. The panel enables students to be able to answer questions on the spot as you will have to do in the workplace on the spot. In addition, panels help to focus, assess, and prioritize information…”

“..Discussing the problems with others in class enhanced my problem solving skills which are important in doing well in practice. The panels positively affected the way I learn in that they are a great way for self directed learning. It forced me to analyze data and upon getting new information from the panel discussion to re-evaluate the information learned initially…”

“…Panel enabled me to apply the knowledge that I got from the background readings. It reinforced the information I already had and contributed new information. The interactive nature allowed for better flow of information between class and students. I would do similar prep work before every panel. This would include writing up notes from the text, PSC and other sources (old write up tables etc). My note reviewing tactics changed. In the beginning, I would concentrate on memorizing facts. I had to adapt and now anticipate discussing and sharing information with others…."

“…The panels encouraged me to learn proactively with other students to enhance learning - it was more interactive, so it forces you do your readings. Panel discussions made me more aware of the amount of material that we have to learn and the importance of learning it well, as the cases do not come with "tidy" answers. Class panels make you prepare for each topic in depth and also work with others to complete the task…”
### Appendix 12: Survey One Comments - Students’ Perceptions of the Panel Design

- Class panels are useful for building up knowledge
- Learned a lot from the class panels
- The class panels helped to encourage self-directed learning
- Class panels promoted self-study and independent initiative
- The class panel format is very helpful because by learning using this problem-based approach, we actively remember the material because we take initiative for our learning.
- Class panel: helped build on the knowledge I acquired from the readings
- The class panel enabled me to apply knowledge that I had studied.
- Class panels motivate me to study and prepare for the topics well before each class.
- The class panel was great as it allowed us to prepare for a topic beforehand, enhancing the overall knowledge experience
- Panel providing me the core knowledge
- The panels in class were really good to build knowledge and to reinforce the information you have learned.
- Class panels gives me a real life perspective on what situations we can encounter
- The preparation for class panel made me actually learn things better than simply trying to memorize didactic lectures.
- Students feel that preparing and participating in the panel actually makes them learn differently (not memory) and they feel that this improves learning - they learn better
- The class panel was very helpful in clarifying issues presented in the tertiary references we were presented with
- Panels really helped me learn the material.
- Class panel was very informative and helpful in clarifying new or confusing concepts.
- Class panel helped me apply the knowledge learned from the readings to a particular case.
- Panels allowed students to address concerns and questions
- Class panel preparation forces me to apply knowledge into real situations.
- The panel is a great idea. It made sure that I always prepared for class and I found that in the end I didn’t have to suffer before the final because all I had to do was review the topics instead of actually trying to cram everything at the last minute. I found that the class panel made sure that I did not fall behind in the course; and made studying for the OSCE exam “less” difficult.
- Panel - the most informative way to learn the information by participating in discussion with the instructor and other students.
- The class panel forced us to be prepared for class which allows us to learn at a deeper level.
- The class panel was the most useful learning tool. It reinforced what I had read in preparation, clarified misunderstandings and gave me an opportunity to apply my knowledge.
- Class panel forces you to do the required reading,
- Class panel questions were a good way of thinking more critically about the information.
- The panel really helped with clarifying my readings.
- The panel was where my learning was solidified for the most part.
- lot of knowledge at once to synthesize in your head before speaking. More systematic organization of thoughts.
- Panels were extremely beneficial,
- Panel were great in helping to synthesize in your head before speaking. More systematic organization of thoughts.
- Class panels were very helpful because of the interaction
- The class panels were helpful in applying our knowledge to a case and making it more ‘three-dimensional’.
- Panel questions were a good way of thinking more critically about the information.
- The panel really helped with clarifying my readings.
- The class panel was where my learning was solidified for the most part.
- lot of knowledge at once to synthesize in your head before speaking. More systematic organization of thoughts.
- Panels were extremely beneficial.
- Panel were great in helping to synthesize in your head before speaking. More systematic organization of thoughts.
- Class panels were very helpful because of the interaction.
### Appendix 13: Survey One Comments – Students’ Perceptions of Areas for Improvement

<table>
<thead>
<tr>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>It'd be nice if the panel were easier to hear. Sometimes it's difficult to hear what's being said.</td>
</tr>
<tr>
<td>Perhaps you can open up some panel questions to the entire class so we have students from different areas of the room answering.</td>
</tr>
<tr>
<td>I often found it difficult to hear the panelists at the front</td>
</tr>
<tr>
<td>To add more of such an activity</td>
</tr>
<tr>
<td>Time was a barrier when considering other course work that we had.</td>
</tr>
<tr>
<td>Other classes put constraints on the time I devoted to each activity.</td>
</tr>
<tr>
<td>Great learning experience in the end since it forces you to prepare each time regardless of other time constraints.</td>
</tr>
<tr>
<td>I spent 6-8 hours a week for preparations and work</td>
</tr>
<tr>
<td>Course website needs to be more organized and easier to navigate to find information.</td>
</tr>
</tbody>
</table>
Appendix 14: Survey Two Comments - Epistemic Agency

Quotations from Online Survey Access Database recorded March 3, 2006:

“…students were held accountable for their own learning goals and there were multiple venues for students to explore their own styles of learning…panels were particularly a very creative and original way to permit and encourage students to do their own self-directed learning, self-study and to participate …by learning using this problem-based approach, we actively remember the material because we take initiative for our learning…class panels motivates me to study and prepare for the topics well before each class…”

“…These activities facilitated a more self-directed learning method, and allowed us to more effectively prepare for pharmacy practice (real problems help prepare for practice more effectively).. cannot believe everything that was written in the textbook and that I have to use my own professional/critical judgment when it come to making decisions regarding patient care…”

“…It's more self-directed learning, more active role in my learning, coming prepared for discussion, and keeping up with course materials. The panel is a great idea. It made sure that I always prepared for class and I found that in the end I didn't have to suffer before the final because all I had to do was review the topics instead of actually trying to cram everything at the last minute. I had to be constantly be on top of the information and the material in the course….”

“…The class panels helped to encourage self-directed learning which I found was very effective.. enabled me to be more of an active learner and
take responsibility for my own knowledge building, coming prepared for
discussion, and keeping up with course materials…”

“… It helped me to direct my own learning in areas that I felt that I was
weaker in, helped me recognize my strengths and areas for
improvement…at the same time, really seems to help you identify what is
important (key) for patient education and assisting them with their health
concerns…”

“…This course is completely self-directed - panels were a very creative
and original way to permit students to do their own learning and to
participate…all the course activities facilitated a more self-controlled
learning method, and allowed us to more effectively prepare for pharmacy
practice once we graduate…”

“… The class panels helped to encourage student-controlled learning
which I found was very effective…but these course activities were all self-
directed, thus they had to make me learn the pertinent information in such
a way so that it could be applied to any patient case; it's not just knowing
the material that is important but the ability to apply it to various patients,
in order to grasp a more thorough understanding…”

“…the course features encouraged self directed learning along with
collaboration among classmates for an overall strong outcome…”
Appendix 15: Survey Two Comments - Community Knowledge, Collective Responsibility

Quotations from Online Survey Access Database recorded March 3, 2006:

“… The online components in knowledge forum were an effective way to communicate with classmates and also to see their input…allowed us to share thoughts and ideas effectively.”

“…Classmates were very helpful in expanding on their knowledge and this was particularly useful. Post-panel forum was very helpful in widening my ideas from reading other people's tangents on a topic… I liked being able to bring any issues or confusing points to the table and discuss them with others… helped clarify any questions that were unclear and made me more aware of the different angles that one can take and further enhance my comprehension of the topics in this course….“

“…clarifications and questions on the MCQ forum quite helpful when preparing for tests, to see how my classmates were thinking, and to show me what I should be considering the question…most knowledge was gained from class panel discussions. Learning from the panel proved to be most important tool for building knowledge…”

“…post-panel forum helped clarify ideas shared in class and was the most useful tool in clarifying misconceptions in terms of learning from others questions and answers, clarifying ideas that were not clear or elaborated upon during panel... knowledge forum kept me up to date with what the rest of the class was thinking, and got me to look more into some sections than I had.. was helpful in that it organized the information to ensure that any new material that was mentioned and not caught during the panels (esp since not all students are clear when they make statements) …”

“…the panel is the most important part. This is where we find out what we cannot get from a textbook…contributing and listening during the panels to be the most effective in helping me learn because the pre-
readings provided a lot of general knowledge while the panels reinforced the important points, excellent to develop information being learned. It allowed evaluation of knowledge and immediate validation/rejection of ideas submitted by students, which made it easier later on to remember which points were valid. More systematic organization of thoughts allowed these questions to be addressed openly and by all class members.......

“...The class panel enabled me to prepare for a topic beforehand, enhancing the overall knowledge experience and then to apply knowledge that I had studied. Most importantly, it provided me with the opportunity to think about the topic from a different perspective than presented in the textbook/readings and allowed me to benefit from the insights of others, helped clarify some concepts that I didn't understand from the readings...

“...These features allowed me to learn in different ways, with the panel providing me the core knowledge and the post panel, MCQ questions and OSCE preparation allowing me to apply the knowledge and gain more knowledge in different ways. Provided me with many insights from my classmates... They facilitated interaction with classmates and allowed particular concepts to be brought up that were not previously considered. Instead of didactically, I learned from other students' responses as well. I really liked the fact that students were able to help one another learn... encouraged self directed learning along with collaboration among classmates ...

“...The forum is helpful for getting answers to questions that you may be unsure of or concepts they did help clarify things that may have been confusing if i had tried to learn without them. allowed these questions to be addressed openly and by all class members. I mainly learned the important points from class during panel discussions... understanding the material becomes much more important...”
“… The forum adds to atmosphere of communication and idea sharing, provided many opportunities to clarify concepts and ask questions, I really liked the panel and the preparation for the panel it really allowed me learn and pick up important concepts and then clarify them during the panel. I could get involved in discussion…build on the knowledge… an effective way to communicate with classmates and also to see their input.. a very creative and original way to permit students to do their own learning and to participate… panels are useful for building up knowledge …”

“…The knowledge forum allowed us to share thoughts and ideas effectively. post panel forum was also very useful for clarifying ideas that were not clear or elaborated upon during panel… Each activity in its own way provided me with a better understanding...Pre and post discussion forums were very useful for me because many of us shared the same questions regarding case topics and the forum allowed these questions to be addressed openly and by all class members… learning from other people's discourse is changing the way the student learns…”

“…These activities improved the way I learned the material in this course because I was able to gain the knowledge/insight that other students had to offer .The class panel format is very helpful because by learning using this problem-based approach, we actively remember the material because we take initiative for our learning… The forum adds to atmosphere of communication and idea sharing. I found that the class panel made sure that I did not fall behind in the course; and made studying for the OSCE exam "less" difficult. …”

“ They facilitated interaction with classmates. The preparation for class panel made me actually learn things better than simply trying to memorize didactic lectures… students feel that preparing and participating in the panel actually makes them learn differently (not memory) and they feel that this improves learning - they learn better…”
forced me to learn differently. Instead of didactically, I learned from other students' responses as well…”

“…. It was good having others respond to questions... the various forums was provided a double check station, when I came across questions that were not clearly answered in the textbook. Going through the decision making process on what is right and wrong with fellow students allowed one to have personal questions answered. I really liked the fact that students were able to help one another learn, it was helpful whenever questions arose, or to see what problems/concerns I had missed or didn't think of…”
Appendix 16: Survey Two Comments - Student-Generated Exam Questions

- The multiple choice forums were especially helpful in addressing & answering any concerns I may have had requiring any topic that were presented. MCQ questions were a good way of thinking more critically about the information.
- The multiple choice questions really helped me apply that knowledge that I learned to real life situations. In addition, it takes a lot of understanding in order to develop a “good” multiple choice question.
- The most beneficial tool (aside from panel) was the MCQ forum: in addition to helping me clear up concepts via my own questions, reading other's questions and comments brought to light new ideas and concepts.
- MCQ discussions are useful for reviewing sticky concepts.
- Multiple choice questions helped me learn how to think "outside the box"
- MCQ forum allows me further investigate the topic and enhance my problem solving skills
- Multiple choice questions: helped me apply the knowledge that I learned
- I used the MCQ submission format to guide my studying. Redoing the MCQ after panel helped to revise and refine knowledge.
- Knowledge Forum MCQs view was an interesting method of discussing test questions
- Redoing the MCQ after panel helped to revise and refine knowledge.
- The MCQ forum was very helpful in preparing for the exams
- access to questions and answers to help increase understanding of a topic. It was helpful when studying for exams.
- critical assessment of various topics and problem solving approaches.
- I believe that I best learned from the multiple choice, because I would have to go back to my text book to look something up
- MCQ activities helped me to allow me to know how much I really understand the topic, beyond the text book, and applying it to different types of patients.
- clarifications and questions on the MCQ forum quite helpful when preparing for tests, to see how my classmates were thinking, and to show me what I should be considering the question
- panel MC questions were a good way of thinking more critically about the information.
- the multiple choice questions were helpful because we were able to find any discrepancies in the assessment
- It allowed evaluation of knowledge and immediate validation/rejection of ideas submitted by students, which made it easier later on to remember which points were valid.
- multiple choice forum is useful for student feedback about confusing questions preparation motivates me towards self-directed learning in order to grasp a more thorough
- The mcq forum is helpful for getting answers to questions that you may be unsure of or concepts- helped me recognize my strengths and areas for improvement.
- really seems to help you identify what is important (key) for patient education and assisting them with their health concerns
  they did help clarify things that may have been confusing if I had tried to learn without them.
### Appendix 17: Survey Two Comments – Students’ Perceptions of Areas for Improvement

- I found the class panel to be the most useful, mostly due to time constraints.
- The pre- and post-panel questions and osce presentation did not contribute as significantly to my learning.
- The pre- and post-panel discussions were not very useful as answers were often left unanswered.
- The forum is a good asset to students communicating. But, it takes time to sift through all the threads and follow conversations. So, I think students don't use it as much as we could because our time is so limited.
- didn't use it often.
- I don't feel that the forum discussions aided in the learning process as much as the class panel.
- I never used any of the forums. We don't have any time to do anything other than the required readings.
- I found that I didn't use the forum for pre-panel because I honestly wasn't prepared in time.
- The forum had potential to be useful but was not used enough.
- knowledge forum was difficult to use, and therefore not frequently utilized.
- not used very much this year. This is partly because with our very heavy work load, there is very little time to constantly check the forum to see if anything was added, or to contribute
- I didn't find the pre & post panel discussions helpful but this may be because I didn't feel I had the time to use these resources.
- I think looking back it would be beneficial if more people used it
- The forum is a great idea in theory, however, time is a problem
- The forum was not very effective – time consuming
- The use of the forum was alright in terms of learning, although I did not use it very much