Self-assessment for knowledge building in health care

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Abstract

The 2002 Romanow Commission on the Future of Health Care recommended improvements in education and practice in end-of-life care for a growing and aging Canadian population. The aim of this study was to design, develop, and evaluate a continuing professional development program in end-of-life care for accreditation by the Ontario College of Family Physicians. The challenge was to provide a robust, interactive program easily accessible to busy family doctors distributed over a large geographic area. A comprehensive and collaborative knowledge building model, blending asynchronous Knowledge Forum® technology and synchronous interactive videoconferencing was created, to enable individual knowledge improvement and community advancement of ideas in clinical practice. The focus of this design research was a novel method of online, embedded and concurrent self-assessment. Results indicated gains in understanding and program satisfaction associated with knowledge building participation.

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Introduction

Purpose

The Romanow Commission on the Future of Health Care in Canada (2002) indicated the need for change in end-of-life (EOL) care to support a growing and aging population. Several studies examine the lack of comprehensive EOL care training in undergraduate and postgraduate medical education (Wear, 2002; Weissman & Bloke, 2002). The End-of-Life Care Distance Education Program (http://icarus.med.utoronto.ca/eolcare), a 22-week, continuing professional development course, was created and implemented to address this need (Figure 1). The knowledge building program and design research study was conducted from October 2004 to May 2005. The program is accredited by the Ontario College of Family Physicians, sponsored by the Ontario Ministry of Health and Long-Term Care, and the Temmy Latner Centre for Palliative Care, Mount Sinai Hospital, and offered through Continuing Education, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada.

This study involves the design, development, and evaluation of a comprehensive knowledge building (Scardamalia, 2002; Scardamalia & Bereiter, 2003; Scardamalia, 2003a) initiative in the context of a continuing professional development program for family physicians. The challenge was to provide a robust, interactive educational program easily accessible to busy family doctors distributed over a large geographic area (Simcoe, Toronto and York regions of Ontario, Canada). The purpose was to create a knowledge building community – one committed to collective knowledge advancement – and supported by an environment that encourages high level knowledge processes and embedded and transformative assessment.

Knowledge Building

The goal in the creation of a knowledge building community is to engage learners in a complex, interactive process that enables them to take charge of the educational process at the highest levels. As in the case of knowledge-creating organizations, participants see ideas as improvable,

Figure 1. The End-of-Life Care Distance Education Program of the Ontario Ministry of Health and Long-Term Care, a continuing professional development course for family physicians.

and their goal as improving them. Scardamalia and Bereiter (2005) argue that complexity theory or a systems approach to learning arises from the need to address two large problems – creativity and depth of understanding. Scardamalia further (2004) indicates that "a scientific basis for knowledge building must draw not only on the learning and cognitive sciences but on such diverse areas of inquiry as dialogue, self-organizing systems, emergence, and memetics." This study addresses a principle of knowledge building that is central to enabling learners to take charge of knowledge advancement at the highest levels – "embedded and transformative assessment" (see Scardamalia 2002 for an overview of the 12 knowledge building principles).

The importance of the principle of embedded and transformative assessment follows from the fact that learners cannot take charge of knowledge advancement at the highest levels if they remain dependent on outsiders to evaluate their progress. Despite the importance of this principle,

it is under-represented in efforts to elaborate knowledge building pedagogy. Reasons include: (a) a strong bias toward individual achievement rather than collective responsibility for knowledge growth; accordingly, the creation of a knowledge building community with learners helping each other seems antithetical to achieving the "top mark"; (b) media available to education have favored a one-to-many discourse in which one person – classically the teacher, is in charge of all "executive" processes; (c) the idea of embedded formative assessment (assessment that informs progress) runs counter to mandated evaluations that stress summative (after the course) analysis of learning gains for each individual.

Knowledge Forum®

A goal underlying the design of knowledge building environments (Scardamalia, 2003b) is to create communities for knowledge advancement, enabled by supports for high level processes and systems for embedded and transformative assessment. Knowledge Forum (Figure 2),

Figure 2. Access to EOL Care Knowledge Forum environment.

the founding knowledge building environment, was used in the present study (a) to provide a multimedia communal knowledge space for students to work collaboratively on solutions to complex problems; and (b) to enable embedded and transformative assessment. These points are elaborated below.

Multimedia Communal Knowledge Space

An asynchronous online knowledge building environment was integrated with synchronous interactive videoconferencing in this program. Seven modules were developed in total, of which two were interactive videoconferences and five were created specifically for collaborative knowledge building in Knowledge Forum (http://proxy.ikit.org/builder/19040) (Figure 3). The program opened with a videoconference called Introduction to Palliative Care. The next three modules

Figure 3. Seven modules were created in Knowledge Forum: five for online knowledge building and two related to videoconferences.
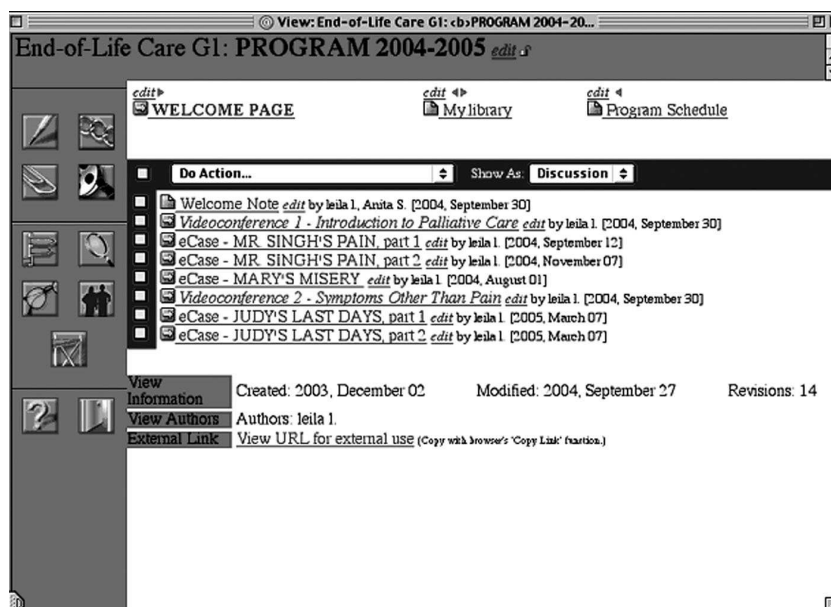
were knowledge building online cases. Mr. Singh's Pain, parts 1 & 2, focused on management of neuropathic pain, and the case entitled, Mary's Misery, dealt with complex pain and psychosocial issues. The fifth module was an interactive videoconference that explored palliative care symptoms other than pain, e.g. dyspnea. The sixth and seventh online modules, entitled Judy's Last Days, parts 1 & 2, dealt with patient and family issues around death and dying. The design of Knowledge Forum multimedia communal space was based on previous designs by Lax and colleagues (2003a; 2003b).

Each multimedia case scenario in Knowledge Forum begins with a text-based introduction, followed by a 3 to 5-minute clinical video vignette of the patient, followed by collaborative knowledge building issues for discussion (Figure 4). Video vignettes were provided in QuickTime and Windows Media formats optimized for high speed Internet. Text for

Figure 4. Multimedia case-based modules were designed using text and video vignettes of standardized patients and real doctors.

all videos was provided for those with low bandwidth Internet connections. The combination of text and video created an engaging multimedia knowledge space for collective cognitive work.

Individual and collective "Reflection-on-Practice" components were integrated within each scenario to draw out case relevance to real world practice for emergent discussion. Digital references were organized by case and clinical topic, in "My.library", to support evidence-based knowledge building. "Test Yourself" questions were embedded in the case for formative feedback. "Ideas as the Centre" (Scardamalia, 2003), related to the case objectives, were provided to guide the collective discourse. The case objectives were used to categorize subject matter knowledge on pre- and post-tests. Four sets of pre- and post-tests were given to participants for the purposes of self-assessment and to scaffold individual and collective knowledge building. Each online module was conducted over a one-month period of time to allow for sustained knowledge building and the development of deep relational understanding (Figure 5).

Figure 5. Collaborative knowledge building discourse.
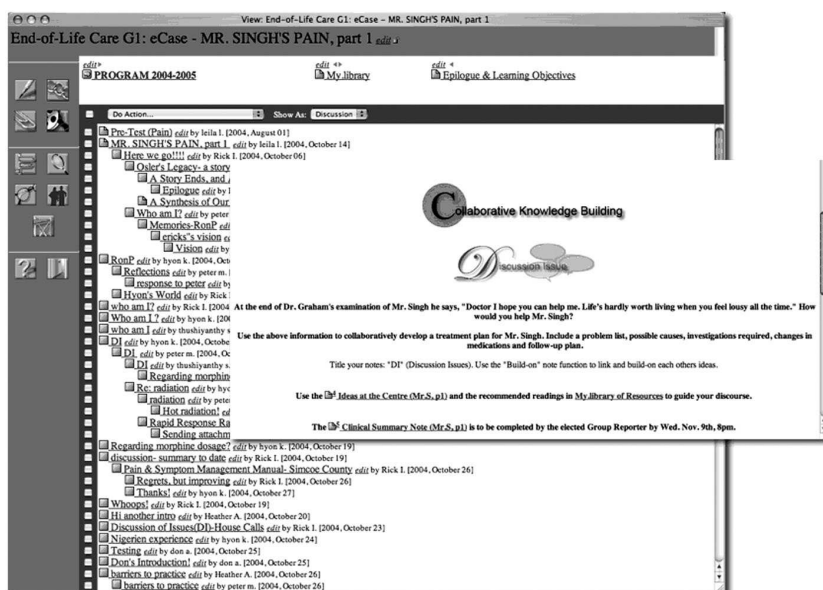
Two synchronous videoconferences were held using North Network technology connecting the Royal Victoria Hospital in Barrie, Ontario with the Sunnybrook and Women's Health Sciences Centre in Toronto, Ontario. Two eminent practitioners were chosen to conduct these two sessions. The videoconferences were interactive, participatory sessions, not didactic presentations, in keeping with a knowledge building approach.

At the conclusion of the 22-week program, an optional practice-based communication skills workshop was offered. This workshop provided participants an opportunity to practice skills face-to-face with standardized patients and receive feedback from colleagues, experts and the mock patients.

The asynchronous and synchronous aspects of this program were organized through Knowledge Forum. This environment was designed to provide a multimedia communal knowledge space for collaborative clinical problem solving and embedded and transformation assessment.

Embedded and Transformative Assessment

The knowledge building principle of embedded and transformative assessment was operationalized in the design of the EOL Care Knowledge Forum environment. Two complementary methods for addressing assessment are elaborated below.

Knowledge Forum Analytic Toolkit Measures

A powerful toolkit underlies Knowledge Forum and provides informative feedback in numeric or graphic form regarding contribution and participation patterns (contributing notes, building on, annotating, and referencing notes of others, etc.). A previous study by Lax and colleagues (2003b) demonstrated effectiveness in using the toolkit to provide embedded and transformative feedback, in a similar online program.

In this study the Analytic Toolkit measures were used for individual activity analysis to determine number and type of Mainpro continuing medical education credits awarded to participants for each module.

Pre- and Post-tests for Formative Feedback and Self-Assessment

Pre- and post-tests are commonly used to make claims and provide summative statements about change in knowledge and educational out-

comes. In this study they were used to provide formative feedback to support self-assessment, to identify knowledge 'lacks' (Scardamalia et al., 1989), and to promote individual and collective knowledge building, (Scardamalia & Bereiter, 2005; Bereiter, 2002a).

The difficulty of accurately assessing one's own strengths and weaknesses is acknowledged in the research literature (Eva & Regehr, 2005; Donovan et al., 1999; Regehr et al., 1996). To assist individuals in this regard, study participants completed four sets of online pre- and post-tests linked in Knowledge Forum notes in the EOL care program. The formative feedback knowledge tests were provided before and after the palliative care videoconference, the pain modules, the other symptoms videoconference, and the end-of-life care modules.

The tests engaged participants in complex problem solving around clinical patient assessment and management issues. The pain and other symptoms tests were composed of multiple choice, fill-in the blank, and short-answer questions; pre-test questions were exactly the same as post-test questions. The palliative care and end-of-life care test questions were case-based and required qualitative short answer responses; pre-test questions differed from post-test questions, but similar concepts and the same objectives were examined.

Participants were given a "Score Card" at the conclusion of each pre-test indicating their raw and percentile scores on items grouped by category according to learning objectives (Figure 6). The dynamic system allowed participants to check which questions they answered correctly or incorrectly. Correct answers were not provided on pre-test; instead, references corresponding to each question were recommended for further

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Figure 6. Pain pre-test sample titrating question and Score Card.
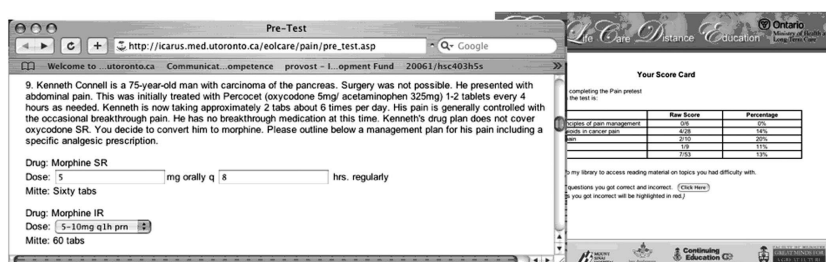
self-directed study. Participants were asked to review their individual Score Card and feedback, and address identified knowledge gaps by reviewing corresponding readings in My.library.

Upon completion of online collaborative knowledge building work, participants were provided with a post-test. The post-test Score Card provided pre-test scores for comparison to post-test scores, by objective category (Figure 7). In addition, individuals could access scoring of questions, answers, and detailed explanations of each question, including references to the literature, for continued self-directed knowledge building.

Unlike conventional pre-/post-test summative assessment formats where one test is given at the beginning of a course and one at the end of a course, the EOL Care Program uses pre-/post-test feedback continually throughout the program for embedded and transformative self-assessment purposes. A knowledge self-assessment system, such as this, is intended to enable individual conceptual change, as well as elevate the

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Figure 7. Post-test Score Card enabled pre- and post-test comparison by objective for self-assessment.
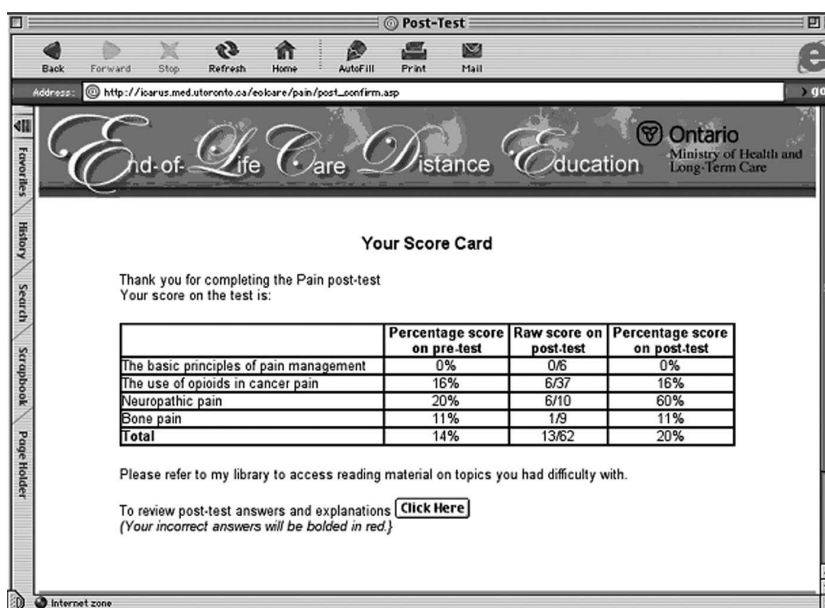
community knowledge building discourse; the ultimate goal is to evoke deep relational understanding, and to translate higher levels of knowledge into improved practice and patient care.

Methods

Research Design

The research protocol was reviewed and approved by the University of Toronto ethics board. This study was conducted from October 2004 to May 2005. Evaluation of the EOL Care Program was guided by a design research paradigm (Bereiter, 2002b). A mixed methods case study approach was used (Creswell, 2003) for summative evaluation and formative feedback for iterative improvement in program design.

Rather than making summative claims, as often follows from experimental designs with control groups, we focused on knowledge change by case objectives, using a relative scale (Regehr et al., 1996). Measures of change, in combination with contribution and interaction measures, and attitudes and opinion indicators, allow us to address important outcomes, in the absence of control-group contrasts.

Participants

Physicians practicing in three different regions of southern Ontario: Simcoe, Toronto and York, were invited to participant in the study and program. Eighteen family physicians and two facilitators initially participated in the course. Participants were divided into two groups (Group 1 n=8; Group 2 n=10) for online collaborative work in Knowledge Forum. The two groups were amalgamated after the third module to encourage higher levels of knowledge building activity. Minor attrition in group size was evident over the 8-months of the program. The original 18 participants dropped to 16 in the fourth module; 15 participated in the sixth module and 14 participated in the seventh module.

Materials and Procedures

Pain pre- and post-tests of knowledge, online activity and a self-reported attitudes and opinions survey were the three instruments used to collect data and inform iterative design.

Pain Knowledge Pre- & Post-tests

Pain pre- and post-tests were developed for online dynamic use. All tests were individually password protected. Learning objectives were categorized for the acute and complex pain modules, and guided pre-/post-test design, development and feedback. Twenty-eight multiple choice, fill-in-the-blank, and short answer/word recognition questions were constructed based on the following four learning objectives:

1. Understanding principles of pain management = 6 questions
2. Use of opioids in cancer pain = 7 questions
3. Understanding neuropathic pain = 5 questions
4. Understanding bone pain = 10 questions

Questions on the pain pre-/post-test were exactly the same. Tests were completed online and automatically dated and time stamped. Participants were given individual Score Cards upon completion of pre-test to aid self-assessment and identification of knowledge areas of strength and weakness.

Upon completion of the post-test participants were given a comparative pre-/post-test Score Card, the correct answers, in depth explanations for each answer, and references. Nine participants of 18 completed both the pre- and post-test for the pain subject modules (Mr. Singh, part 1; Mr. Singh, part 2; Mary's Misery). Participants' pre-and post-test data were matched and scored in Excel. Other participants completed only the pre-test; these unmatched data were scored but not used.

Online Activity: Analytic Toolkit Measures

Five, multimedia, case-based modules were created in Knowledge Forum for collaborative knowledge building around EOL care issues. Various Analytic Toolkit measures were analyzed, across all groups and online modules, at the conclusion of each case, including: number of notes created, percent of notes read, percent of notes linked, and number of themes.

Attitudes and Opinions Survey

An online Attitudes and Opinions Survey was constructed, using 5-point Likert scale and yes/no questions to examine participants' satisfaction with their continuing education experience, e-learning and collaborative knowledge building. The survey was linked in a Knowledge Forum

note, and data was collected online. Participants received an email invitation to complete it, at the conclusion of the course, and a reminder email two weeks later. Data was downloaded to Excel for descriptive analysis.

Results

Pain Knowledge Pre- and Post-test Results

Mean pre- and post-test scores were calculated for each of the four objectives, as well as the mean difference and standard deviation. A paired t-test was used to determine statistical change across objectives.

Objective 1, pain management, showed a high score on pre- and post-test. There was not much room for improvement, based on a high level of understanding from the beginning and/or easy questions in this section. For the post-test, all but one participant obtained a score of 100%.

Objective 2, the use of opioids, also failed to show increases in scores. However, the reason appears very different. For Objective 2, pre-test scores were below 50% and post-test scores were only moderately higher (57%). Lack of substantive change in Objective 2 supports the idea that problems were complex, and additional knowledge building in this area is required.

Objective 3, neuropathic pain, presented positive change; the mean score rose 14%, from 67% on the pre-test to 81% on the post-test.

Similarly, results from Objective 4, bone pain, demonstrated a positive increase of 22% in mean score, from 59% on the pre-test to 81% on the post-test.

Overall, the total mean score across all objectives (1 to 4), demonstrated positive improvement (paired t-test = 2.53, p<.05) of 15% from pre-test (65%) to post-test (80%) (Table 1).

Scores on individual questions indicated the need to provide support for deeper learning and understanding of opioid use in treating pain. A pharmacological conversion chart, additional references and focused fa-

Table 1. Total mean scores of pre- and post-tests across objectives

Pain Objectives	1	2	3	4	Total
mean pre (unmatched)	0.90	0.31	0.67	0.66	0.64
mean pre	0.91	0.46	0.67	0.59	0.65
mean post	0.98	0.57	0.81	0.81	0.80
mean difference	0.07	0.11	0.14	0.23	0.15
standard deviation	0.12	0.25	0.34	0.19	0.18
n	9	9	9	9	9
one tailed t-test	1.84	1.33	1.23	3.61	2.53
p	0.05	0.11	0.13	0.00	0.02

cilitator feedback in knowledge building discussions are planned iterative improvements for the course next year.

Online Activity: Analytic Toolkit Measures

Analytic Toolkit Overview (size of build-on trees=themes)
Group 1 (G1): Mr. Singh's Pain, parts 1 & 2 (8 students, 1 facilitator) n=9
Group 2 (G2): Mr. Singh's Pain, parts 1 & 2 (10 students, 1 facilitator) n=11
Amalgamated Group: Mary's Misery (16 students, 2 facilitators) n=18
Amalgamated Group: Judy's Last Days, part 1 (14 students, 2 facilitators) n=16
Amalgamated Group: Judy's Last Days, part 2 (13 students, 2 facilitators) n=15

Knowledge Forum Analytic Toolkit results suggest strong levels of online read/write activity (Table 2). Of particular significance is the percent of notes read (74% to 85%) by participants across all modules. Results point to the need for more attention to linking concepts and elaboration of concepts, and more support for participants in conducting these activities. It is recommended that the Analytic Toolkit data be used for concurrent, embedded feedback in the future. It was only used to determine individual continuing professional development credits and iterative program design in this study.

Table 2. Online activity measures by group

eCases	Number of Notes Created		% Notes Read		% Notes Linked		Number of Knowledge Building Themes	
	G1	G2	G1	G2	G1	G2	G1	G2
Mr. Singh's Pain, part 1	61	30	83	75	49	72	9	3
Mr. Singh's Pain, part 2	35	22	74	76	46	38	6	3
Mary's Misery	43		75		32		12	
Judy's Last Days, part 1	86		85		48		14	
Judy's Last Days, part 2	29		75		19		9	

Seventy-seven percent (10/13) of the participants responded to the Attitudes and Opinions Survey (Table 3). One hundred percent of respondents indicated that this continuing education experience was useful and that they acquired new knowledge. Eighty percent of respondents indicated that as a result of this course they would change their approach to palliative care.

Only one respondent had taken an E-Learning course previously. Most respondents (80%) indicated that the digital resources were easy to access in My.library. However, 40% indicated that ease of access did not prompt citation of evidence in online discourse.

Notable is the fact that pre-/post-test embedded feedback was considered helpful by 100% of respondents. In addition, 90% indicated that this type of embedded feedback helped them determine their individual learning needs. One hundred percent of respondents indicated collaborative knowledge building helped them self-assess their strengths, weaknesses and knowledge gaps, and reflect on different perspectives.

Eighty percent of respondents would like to see more continuing medical education courses online and 90% indicated they would recommend this particular course to a friend. Overall, 80% of respondents rat-

Attitudes and Opinions Survey Results

Table 3. Results of "Attitudes and Opinions" Survey. Respondents n=10/13 (77%)

DEMOGRAPHICS				
My practice is located in the region of:	Simcoe n = 3	Toronto n = 6	York n = 1	
I have been in practice:	0 - 5 yrs n = 3	6 - 10 yrs n = 2	16 – 20 yrs n = 1	over 20 yrs n = 4

CONTINUING PROFESSIONAL DEVELOPMENT FEEDBACK	YES % (x/10)	NO % (x/10)	
Did you find this continuing education experience useful?	100 (10/10)	0	
Did you acquire new knowledge?	100 (10/10)	0	
Do you think as a result of this course you will change your approach to palliative care?	80 (8/10)	20 (2/10)	

E-LEARNING	YES	NO	
I have taken a course using E-Learning (i.e. online collaborative learning) courseware before this one.	10 (1/10)	90 (9/10)	
Digital resources in My.library were easy to access.	80 (8/10)	20 (2/10)	
Access to digital references prompted use of evidence-based resources in online discussion.	60 (6/10)	40 (4/10)	
Pre- and post-test feedback was helpful.	100 (10/10)	0	
Pre- and post-test feedback helped me determine my learning needs.	90 (9/10)	10 (1/10)	

COLLABORATIVE KNOWLEDGE BUILDING OUTCOMES	YES	NO	
Collaborative knowledge building discourse in KF helped me reflect on different perspective presented.	100 (10/10)	0	
Awareness of my own knowledge, attitudes and opinions helped me to self-assess my strengths, weaknesses and/or knowledge gaps.	100 (10/10)	0	
Collaborative knowledge building helped me to identify changes I would like to make in my practice.	90 (9/10)	10 (1/10)	
Individual Reflection and collaborative Reflection-on-Practice sections were helpful.	100 (10/10)	0	

OVERALL EVALUATION % (x/10)	EQUIVOCAL	AGREE	STRONGLY AGREE
I would like to see more distance education programs for Continuing Medical Education made available.	20 (2/10)	20 (2/10)	60 (6/10)
Based on my experience of collaborative E-learning, I would recommend it to a colleague.	10 (1/10)	60 (6/10)	30 (3/10)

	AVERAGE	ABOVE AVERAGE	EXCELLENT
Overall I would rate the online collaborative knowledge building component of this program as:	20 (2/10)	60 (6/10)	20 (2/10)
Overall I would rate the videoconferencing component of this program as:	10 (1/10)	50 (5/10)	40 (4/10)

ADDITIONAL COMMENTS

"Thank you for holding this conference. i feel that it is a must for all health professionals"; "…reinforced skills around end of life issues"; "it has increased my comfort level tremendously"; "wider approach to palliative care patient and their family".

ed the knowledge building component of this program, on a 5-point Likert scale, as above average or excellent. Ninety percent rated the video-conferencing component as above average or excellent. Use of embedded pre-/post-tests as formative feedback was determined to be helpful to participants in identifying learning needs and knowledge gaps.

In summary, aggregate scores of pre-/post-tests demonstrated a 15% knowledge gain in pain understanding. These results were positively related to high levels participation and overall program satisfaction.

Discussion

The EOL Care Distance Education Program provides opportunities for family physicians to enhance their knowledge and compare their understanding of problems and solutions around clinical practice. Multidimensional evaluation of this initiative indicates overall strength of initial implementation and focal points for iterative design improvements. The EOL Care Program will run annually through the Office of Continuing Education, Faculty of Medicine, University of Toronto. This program has been recognized with the maximum number of Mainpro-C credits for a continuing professional development course by the College of Family Physicians of Ontario.

Many studies have concluded that it is difficult for individuals to accurately assess their strengths and weaknesses, or identify their own deficiencies (Eva & Regehr, 2005; Regehr et al., 1996). An important objective of this study was to address this issue through a novel means of feedback for self-assessment. Students were provided with pre-/post-test results, encouraged to read relevant resources, especially in areas where their scores were low, and engage in knowledge building discourse around these issues. Change scores suggest gains in understanding.

Overall, results from pre- and post-tests of pain knowledge, online participation and interaction measures, and satisfaction survey feedback indicate increases in understanding and satisfaction. Future research is required to determine the extent to which the high level of online reading activity actually contributed to gains. It is important to note that the percent of linked notes in Knowledge Forum is relatively low, suggesting that participants were not actively using the online medium to its full potential. Of course, many notes were conceptually related, although not

specifically linked. Lack of technical knowledge of Knowledge Forum, is presumed to be the cause of low use of explicit links. Positive satisfaction survey results indicate that all participants enjoyed the course and most think that they will change their present approach to palliative care as a result. Further research is required to track change in physician practices.

The ideal of "lifelong innovativeness" (Scardamalia & Bereiter, 2005) is rooted in the notion of continuous improvement. This study provides an encouraging model of concurrent self-assessment to scaffold this process. Additional research is required to explicitly examine the relationship between embedded and transformative assessment and collaborative knowledge building.

Acknowledgements

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