Assessing the Professional Growth of Post Secondary Students Studying the Education Applications of Emergent Technologies

Rick Mrazek, Doug Orr
University of Lethbridge
mrazek@uleth.ca, doug.orr@uleth.ca

Resumo: As avaliações "Level of Use of an Innovation" e o "Stages of Concern" são componentes chave do modelo CBAM (Concerns-Based Adoption Model). Estas ferramentas provêem uma clara articulação e caracterização do nível de adoção de tecnologia educacional na inovação organizacional. Uma adaptação do LoU foi empregada para avaliar mudanças no entendimento da competência com tecnologias educacionais pelos participantes de um curso de pós-graduação focado no uso das tecnologias emergentes para o desenvolvimento profissional. O instrumento reflete os critérios originais da ferramenta LoU, mas foi adaptado para utilizar uma escala estruturada de auto-resposta do índice 'nível de uso' para promover uma auto-reflexão colaborativa. Os resultados indicam o crescimento no conhecimento, e da confiança, com as tecnologias emergentes, dando suporte ao uso da reflexão colaborativa e da avaliação do processo de desenvolvimento profissional para incrementar o crescimento profissional.

Palavras-chave: desenvolvimento profissional, auto-reflexão colaborativa, tecnologias emergentes.

Abstract. The "Level of Use of an Innovation" (LoU) and "Stages of Concern" (SoC) assessments are key components of the Concerns-Based Adoption Model (CBAM). These tools can provide a clear articulation and characterization of the level of adoption of an organizational innovation in educational technology. An adaptation of the LoU was used to assess changes in understanding of and competence with educational technologies by participants in a graduate level course focused on the use of emergent technologies in professional development. The instrument reflected the criteria framework of the original LoU assessment tool, but was adapted to utilize a specifically structured self report scale of the "level of use" index to promote collaborative self-reflection. Growth in knowledge of, and confidence with, specific emergent technologies is clearly indicated by the results, thus supporting the use of collaborative reflection and assessment of the professional development process to foster professional growth.

Keywords: professional development, collaborative self-reflection, emergent technologies.

I BACKGROUND

The "Level of Use of an Innovation" (LoU) and "Stages of Concern" (SoC) assessments, identified by Hall, et al (1975), as key components of the Concerns-Based Adoption Model (CBAM) can provide an articulation and characterization of the stages of adoption of an organizational innovation. The LoU has been identified as "a valuable diagnostic tool for planning and facilitating the change process" (Hall & Hord, 1987). The LoU is intended to describe the actual behaviors of adopters rather than affective attributes (Hall, et al, 1975).

The thoughtful use of the LoU and SoC by a "professional learning community" (Dufour & Eaker, 1998) or a "community of professional practice" (Wenger, 1998) may allow members of such a community to self-assess their process and progress toward adoption of an innovation and to identify critical decision points throughout the process. An adaptation of the LoU was previously used by one of us working with

teachers in a school jurisdiction to allow members of that particular professional community of practice to self-assess personal and systemic professional growth during the course of the implementation of a staff development program. Components of the LoU and SoC indices have been adapted by various researchers to assess and facilitate personal, collective, and systemic professional growth during planned processes of implementation and adoption of educational technology innovations (BAILEY & PALSHA, 1992; GRISWOLD, 1993; ADEY, 1995; NEWHOUSE, 2001; GERSHNER, SNIDER & SHARLA, 2001.) We were interested in investigating the potential for using an adaptation of the level of use index as a tool to describe professional growth among professionals pursuing graduate course work in educational technology.

During "summer-session" (May-August) 2007 we taught a blended delivery graduate level education course at the University of Lethbridge (Alberta, Canada) titled "Using Emergent Technologies to Support School Improvement." During May and June students accessed readings, assignments, and instruction online via the university's learning management system (LMS). For two weeks in July the class convened in an intensive daily three-hour on-campus format. Following this, class activities concluded again online via the LMS. The students in this course were classroom teachers and school administrators who brought to the class a range of experience and expertise with educational technologies. The course instructors wished to ascertain (a) what levels of experience, expertise, and confidence with various technologies students were bringing to the class, and (b) if this experience, expertise, and confidence changed as a result of class participation. To that end, a LoU index questionnaire was adapted and administered to students in the class via the LMS survey function.

II DESIGN AND DATA COLLECTION

While a focused interview format is traditionally used to collect LoU data (HORD, et al, 1987; GERSHNER, SNIDER & SHARLA, 2001), the adaptation of the LoU used in this study utilized a specifically structured self-report scale of "level of use" to allow participants to self-reflect through the reporting process. The original "Level of Use" matrix (HALL, et al, 1975) identifies eight levels or stages of adoption of an innovation: "non-use", "orientation", "preparation", "mechanical use", "routine", "refinement", "integration", and "renewal".

Each of these levels of adoption is further defined in the terms of the attributes or actions of participants regarding "knowledge", "acquiring information', "sharing", "assessing", "planning", "status reporting", and "performing" as indicated by Figure 1. This complex of descriptors from the original CBAM/LoU (HALL, et al, 1975) was not used directly in our application as an assessment of level of adoption of educational technologies, but rather was utilized to frame precise stem structures and level descriptors related to the specific educational technologies of interest.

As the attribution of level of use in our application is self-reported, attention was paid to the design of the LoU for this purpose and in this format in order to be able to address issues of content validity (NEUMAN, 1997).

The validity of an instrument utilized in this fashion depends primarily on the researchers' skill in framing accurate and focused descriptors. In this instance, it was critical to ensure that the self-report scale devised was as specific as possible and accurately described the kinds of behaviors and changes in professional knowledge and praxis which we wished to assess. The response choices were worded identically for each stem related to each specific technology adoption being investigated.

Further, it was deemed important to use identical "radio buttons" or "check boxes" to identify individual choices rather than numbers (0, 1, 2, 3, etc.) on the respondents' forms used to assess their own level of adoption, so that no implied value was associated with a specific response. (See Figure 2.) The "levels" of the LoU in this application should not and do not imply a hierarchical progression, but rather a nominal description of the state of the community's adoption of an innovation.

	Categories						
Levels of Use	**Knowledge**	**Acquiring Information**	**Sharing**	**Assessing**	**Planning**	**Status Reporting**	**Performing**
Level 1 Non-Use	Cognitive knowledge related to the use of the innovation, the characteristics of the innovation, how it is used, and the consequences of its use.	Solicitation of information about the innovation in a variety of ways.	Discussion regarding the innovation with others to share plans, ideas, resources, outcomes, strategies and problems.	Examination of the potential for and/or actual use of the innovation.	Design of short and/or long range steps regarding the processes of implementation and adoption, including resources, schedules and activities.	Description of personal adoption status at present time regarding implementation of the innovation.	Degree to which the actions and activities entailed in operationalizing the innovation are carried out.
Level 2 Orientation							
Level 3 Preparation							
Level 4 Mechanical							
Level 5 Routine							
Level 6 Refinement							
Level 7 Integration							
Level 8 Renewal							

Figure 1: Level of Use Matrix (Hall, et al, 1975)

Θ	I really don't know anything about this technology, or I am not sure that it would be useful for my classes
	I have some information about this technology, and I am considering whether it might be useful for my classes
Θ	I now know enough about this technology that I am preparing to use it for my classes
Θ	I am using this technology now and I am primarily focused on learning the skills necessary to use it properly and effectively for my classes
Θ	I use this technology routinely without much conscious thought, and my use of this technology is fairly routine for my classes
Θ	I use this technology regularly, and I am implementing ways of varying its use to improve the outcomes derived for my classes
Θ	I am collaborating with colleagues to develop ways in which we can use this technology to better meet our common objectives for our classes
Θ	I still use this technology, but I am exploring other technologies to replace it that will better meet the objectives for my classes

Figure 2: Level of Use Descriptors adapted by Douglas Orr, from: Hord, et al (1987)

Results were considered (for purposes of analysis) in an ordinal fashion – indicating degree of adoption with respect to the "level of use." It is our contention that, as this use of the LoU index is intended to inform professional praxis and development, the instrument may be administered subsequently to the same participants in an identical form throughout the process of a professional development program (in this instance a graduate course in educational technology) to assess efficacy of the program and to provide a self-reflective "mirror" for participants in the professional development program.

The LoU, in this fashion, can be used to collect information over time, sampling a population at various points throughout the implementation of an innovation in practice – one

of the strengths of this type of tool. If the descriptor stems and responses are framed carefully and appropriately, the same survey can be repeated at various times during a project and the results can reasonably be expected to provide useful longitudinal data about change in professional understanding and practice.

In this particular application – where the intention is to facilitate collaborative decision making, professional growth, and personal reflection – the LoU survey asks participants to self-identify their own levels of adoption of various educational technologies. Respondents selected a "level of use" descriptive of their perceived level of knowledge, utilization, confidence, or competence; ranging from "non-use" through "orientation", "preparation", "mechanical use", "routine", "refinement", and "integration", to "renewal"; consistent with the eight levels of adoption of an innovation defined by the "Level of Use" index (HALL, et al, 1975; HALL & HORD, 1987; HORD, et al, 1987).

Respondents in this instance identified their level of use of twenty common educational/instructional technologies: web browsers, word processing software, spreadsheet software, mind mapping software, e-mail/web-mail, presentation software, video playback software, video production software, web site development software, image processing software, database software, videoconferencing, learning/content management systems, interactive whiteboards, interactive conferencing/bridging software, digital still cameras, digital video cameras, document scanners, scientific/graphing calculators, and laboratory probeware/interface systems.

III RESULTS

For this study, a class cohort of twenty-six graduate students was surveyed concerning their level of use of various educational technologies twice during this summer-session course and again four months after the conclusion of the course. Students responded to three identical, twenty-item, level of use surveys via the class online learning management system – the "pretest" survey posted in June prior to the students' arrival on campus, the "posttest" survey posted in August after the conclusion of the on-campus course component, and the "post-posttest" survey posted in December of the same year.

Twenty-five students (96%) responded to the "pretest" survey, twenty-two (84%) responded to the "posttest" level-of-use survey, and seventeen (65%) responded to the post-posttest survey. Twenty-one students (81%) responded to both the pretest and posttest surveys, while fifteen (58%) responded to all three (pre-, post-, and post-post-) surveys. Comparison of these three data sets reflects changes in self-reported knowledge and utilization of, and confidence and competence with, emergent educational technologies.

To reflect the possible potential for the use of this instrument as an indicator of change in praxis during and following a professional development program, we chose to restrict our analysis of results to the responses from the fifteen participants who completed all three administrations of the instrument. Due to the relatively small size of this data sample, we have avoided rigorous statistical investigation of the data and focused on inferences we believe can reasonably be drawn from the descriptive analyses, and in the context of professional development and change in professional praxis.

Results (Table 1) indicate self-reported increase of use for all twenty technology categories, and an increased "average level of use" (average of category means.)

Peripheral technologies, which were commonly used by students and instructors during the course but not directly addressed by the instructional activities (such as web browsers, word processing, spreadsheet applications, and e-mail) nevertheless revealed increased reported levels of use over the three administrations of the survey. The results for the use of "presentation software" (such as PowerPoint and Keynote) are worth noting. The use of this technology was not directly taught to students, but was consistently modeled by instructors throughout the on-campus course component.

Table 1: Mean, Median, and Standard Deviation by Category

	Pre-Test			Post-Test			Post-Post-Test		
Topic	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**
Web Browsers	4.53	5.00	1.407	5.80	6.00	0.561	5.80	6.00	0.775
Word Processing	5.67	5.00	1.000	6.07	6.00	0.258	6.47	6.00	0.834
Spreadsheet Applications	3.73	4.00	1.223	3.47	4.00	0.990	4.40	5.00	1.404
Mind-Mapping Software	2.60	2.00	2.131	3.40	3.00	2.165	3.14	3.00	1.956
E-Mail	5.47	5.00	0.640	6.33	6.00	1.113	6.07	6.00	1.163
Presentation Software	4.40	4.00	1.639	5.73	6.00	1.280	5.93	6.00	1.387
Video Playback	3.27	4.00	1.335	4.40	4.00	1.682	4.80	5.00	1.656
Video Production	1.67	1.00	0.976	2.87	3.00	1.356	2.73	2.00	1.580
Website Development	1.47	1.00	0.640	2.33	2.00	1.113	2.20	2.00	1.207
Image Processing Software	2.40	2.00	1.056	2.87	3.00	1.302	2.53	2.00	1.060
Database Programs	1.53	1.00	1.060	2.13	2.00	0.990	2.27	2.00	1.792
Videoconferencing	2.00	2.00	0.756	3.00	3.00	1.363	4.53	5.00	1.727
Learning Management Systems	2.80	3.00	1.146	3.93	4.00	1.033	4.93	5.00	1.624
Interactive Whiteboards	2.87	3.00	1.727	3.60	3.00	1.352	3.80	3.00	1.971
Bridging/Conferencing Software	1.00	1.00	0.000	2.27	2.00	0.704	2.60	2.00	1.121
Digital Still Cameras	4.13	4.00	1.407	4.93	5.00	0.961	4.93	5.00	1.438
Digital Video Cameras	4.13	4.00	1.407	3.60	4.00	1.502	3.67	3.00	1.877
Document Scanners	3.80	4.00	1.424	4.13	4.00	1.407	4.93	5.00	1.685
Scientific Calculators	1.67	1.00	1.113	2.33	2.00	1.447	2.08	1.00	1.553
Laboratory Probeware	1.13	1.00	0.516	1.33	1.00	0.816	1.27	1.00	0.594
Average Level of Use Index	3.01	2.95	0.428	3.73	3.70	0.570	3.97	3.75	0.753

Results (Figure 3) indicate a noticeable change from self-reported relatively low levels of use to considerably higher levels of use. The mean and median values increased from 4.40 to 5.93 and 4.00 to 6.00 respectively between the pretest and post-posttest administrations. And, interestingly, a number of students selected this technology as a topic or medium for their class projects.

Of greatest interest to us were the results for videoconferencing, learning management system, interactive whiteboard, and conferencing/bridging technologies; as these topics were the foci of specific teaching-learning activities in the on-campus course component.

The pretest results regarding, for example, videoconferencing (Figure 4) indicated that thirteen of fifteen respondents either had little

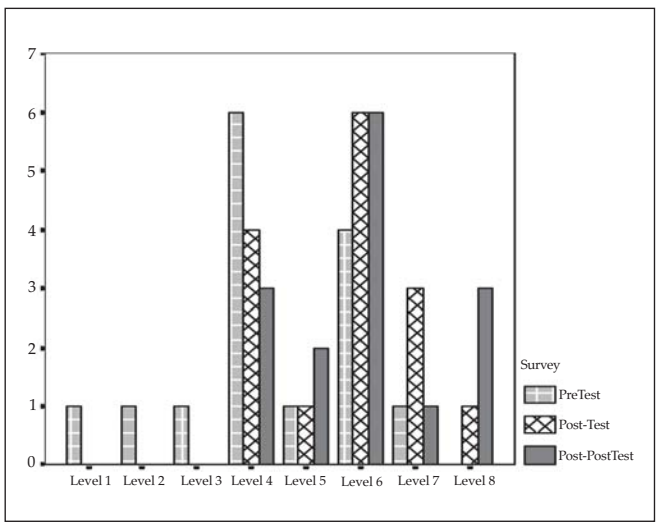

Figure 3: Reported Levels of Use of Presentation Software

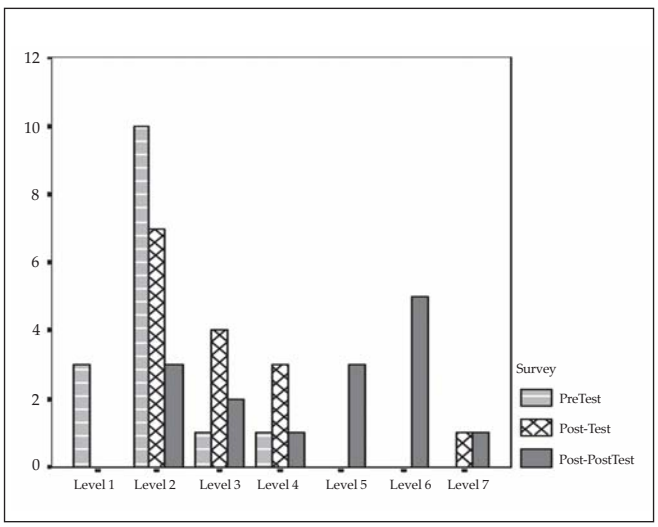

Figure 4: Reported Levels of Use of Videoconferencing

or no knowledge regarding or were merely "considering" the usefulness of educational videoconferencing; while the other two respondents reported themselves to be "preparing" and "focusing on learning skills necessary" to use videoconferencing technologies respectively (mean=2.00, median=2.00).

By the conclusion of the course in August there was an obvious, and not unexpected, increase in reported level of use (mean=3.00, median=3.00). It is most important to note the significant ($p<0.005$) increase in reported level of use as these students (practicing educational professionals) returned to the workplace and had the opportunity to access and apply these technologies within their schools (mean =4.53, median=5.00). Nine respondents reported their level of use as "routine" or higher.

Similar findings regarding reported continuing professional growth and positive change in praxis were reported for learning management system, interactive whiteboard, and bridging/conferencing technologies. A comprehensive learning management system (LMS) was used to deliver, complement, and supplement instruction for these graduate students throughout both the off-campus and on-campus components of the course.

These students (all practicing educational professionals) were expected to use this LMS to engage in collaborative discussions, to access assignments and readings, and to post written assignments. One topic specifically covered during the on-campus course component was the application of learning management systems in K-12 classrooms. As with videoconferencing, results indicated a noteworthy change in reported use of this technology over the course of this study (Figure 5).

Initially thirteen of fifteen respondents reported themselves to be at level one ("non-use") or two ("orientation"), with the highest level of use (one respondent) reported merely as "mechanical use" (mean=2.80, median= 3.00). By December (following the conclusion of the course and return to the workplace) eight respondents indicated LMS levels ranging from "routine," to "refinement," to "integration" (mean= 4.93, median=5.00).

The changes in level of use reported for interactive whiteboard technologies (Figure 6) were relevant to the context of this course, as this technology is being introduced into many schools. During the on-campus class we specifically instructed students about the classroom use of this technology and demonstrated its application supporting instruction delivered via videoconference.

It is worth noting reported levels of use regarding "orientation" and "preparation" between the August survey (administered at the

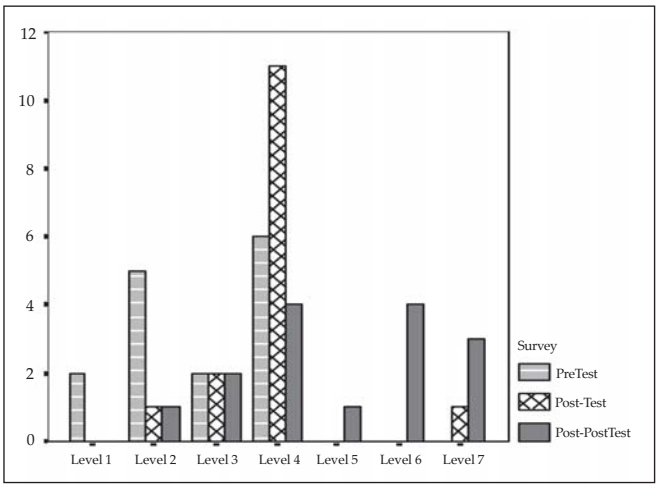

Figure 5: Reported Levels of Use of Learning Management Systems

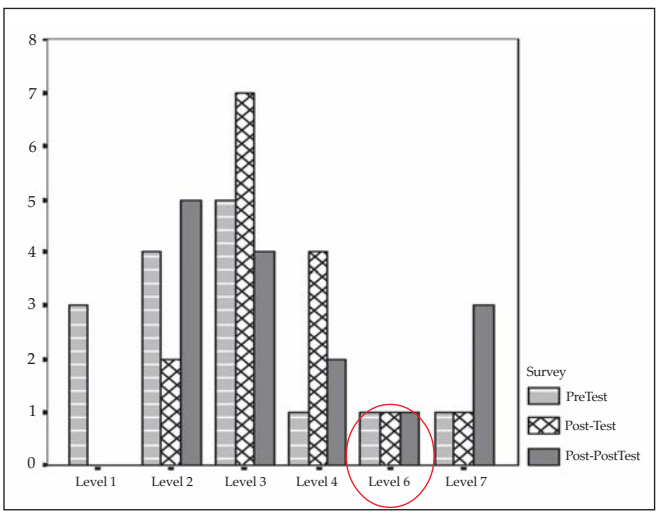

Figure 6: Reported Levels of Use of Interactive Whiteboard Technologies

end of the class) and the December survey (administered after these practitioners had returned to their school districts).

This result may provoke further questions concerning participants' perceptions of the "potential" use of a technology (perhaps surfaced during the class?) and their "actual" use of the technology once back in the schools. Of note, nevertheless, is the increase in the number of respondents reporting themselves as engaging in collaborative use of these technologies at the "integration" level for both interactive whiteboard and LMS technologies.

The significant ($p<0.001$) results for the reported use of bridging/conferencing software (Figure 7), perhaps reflect the introduction of a technology with which these professional educators had little or no previous experience. Of note was the number of respondents (four) reporting "preparation" for use, and the three respondents reporting either "mechanical" or "routine" use of this technology on the December post-posttest survey, and the concomitant increase in the mean reported level of use from 1.00 to 2.60.

The National Staff Development Council (2003) identifies collaborative practice within learning communities as a vital component of authentic and efficacious professional growth and change.

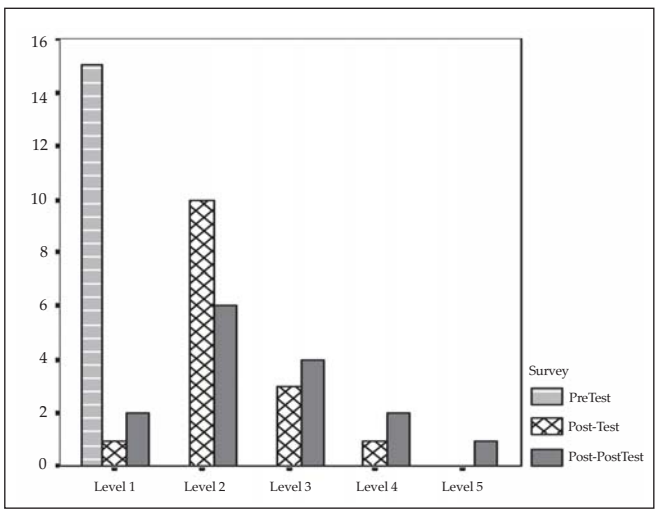

Figure 7: Reported Levels of Use of Bridging/Conferencing Software

Of particular interest, in terms of the development of communities of professional practice is the move from "skill development" and "mechanical" levels of use to "refinement" and "collaborative integration" which is reflected in these results.

IV DISCUSSION AND CONCLUSION

Questions concerning the accuracy of data are always of concern. Clearly the number of participants involved in this administration of the self-reported level of use index survey limits the ability to establish effect-size changes, or to explore questions of reliability. Nevertheless, it is worth considering within the context of a community of professional practice, strategies for promoting the validity and reliability of responses in order to corroborate the potential of this type of information-gathering to support collaborative professional development initiatives.

We posit that it is critical to create a supportive, collaborative, and intellectually and emotionally secure professional community of learners before asking participants to use a self-reporting, self reflective tool such as this adaptation of the LoU index to inform progress of and decisions about their professional growth and development. It is crucial that respondents know (a) that responses are anonymous (online survey tools facilitate this, but other "blind" techniques work as well), and (b) that it is "OK" to be at whatever level one is at.

It is crucial to stress with respondents that this tool is used to inform programs and processes, not to evaluate people. Thus, non-users of particular technologies should be empowered to voice disinterest in, or lack of knowledge about a program by indicating a low level of use. Similarly, there should be no perceived "status" attached to users who report themselves to be at refinement, integration or renewal levels of use. This reinforces the importance of writing clear, articulated, appropriate, non-judgmental, and non-evaluative stems and responses. No less importantly, one could and should collect related "innovation configu-

rations" (HALL & HORD, 1987; NEWHOUSE, 2001) such as teacher artifacts, login summaries, participation counts, attitude surveys, participant surveys, and classroom observations with which to corroborate and elucidate the LoU results.

It is critical throughout the process to maintain complete transparency in the collection and dissemination of results. In the ideal case, where a professional development program or innovation adoption is cooperatively and collaboratively initiated, planned, and implemented, the participants should want to respond as honestly as possible in order to accurately assess the program or innovation adoption over which they have ownership as members of a community of professional practice with a shared vision of professional growth and change (DUFOUR & EAKER, 1998).

It is gratifying to note results from the study indicate positive professional growth in respondents' knowledge and utilization of, as well as confidence and competence with, emergent educational technologies. Where addressed by the course content, growth in knowledge of and confidence with emergent technologies, as defined by the criteria, is clearly indicated by the results of this level of use survey.

We are primarily interested in the process of the development of this adaptation of the "Level of Use of an Innovation" as a self-reporting, self-reflective professional tool; and how the information derived from the results can be used to facilitate planning for and implementation of innovative changes within a professional community of learners. We are currently investigating possible applications of similar adaptations of the LoU index survey within other communities of professional practice, and ways in which adaptations for specific purposes can be derived from the original work of Hall, et al (1975) and Hord, et al (1987) and generalized to various communities of professional practice.

The specific adaptation of the "Level of Use of an Innovation" survey used in this study, including the focus on adoption of emergent educational technologies, is intended to be further adapted and applied to inform a collaborative professional development program for university faculty members, with a revised catalogue of technological innovations appropriate to the emergent technologies relevant to post-secondary instruction. An updated catalogue of technologies could include social networking, simulations and video gaming, video streaming, podcasting and vodcasting, and assistive technologies.

Additionally, we are investigating the design of a considerably more generic version of the level of use index survey to address questions regarding the current efficacy and potential new directions for professional development programs involving conservation and environmental educators across Canada. Guskey (2005) identifies the importance of providing data to "improve the quality of professional learning programs and activities," and "tracking the…effectiveness" of professional development programs. A critical challenge as we approach these tasks will be articulating concise descriptive statements reflecting the matrix of adoption of innovation (HALL, et al, 1975), while addressing the unique requirements of each specific professional development initiative.

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