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Issues in the adoption of broadband-enabled learning

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Abstract

This paper presents one case of broadband-enabled learning (BEL) involving geo-culturally and organisationally diverse collaboration using music as the vehicle. Findings from five evaluations over a 15-month period were considered in relation to issues of relative advantage, compatibility, complexity, trialability, and observability. Advantages included access to mentors, peers, and experts; support for cross-cultural and linguistic collaboration, interaction, and exchanges; promotion of a more open classroom; and exposure to alternative and new experiences. Compatibility with existing practices was evident, however, cross-cultural interaction presented difficulties as did synchronous communication across time zones and between institutions. BEL technologies are complex, however, users can develop a capacity to use the tools if provided with adequate support. Trialability is dependent on access to a high-speed connection and equipment, multiple partners, development of technical expertise, and support. Use of videoconferencing and choice of subject area can enhance observability.

Introduction

Broadband can be defined as online access using a digital subscriber line, cable modem, wireless, or satellite connection with a minimum 256 kbps transfer speed [International Telecommunication Union (ITU), 2003. In 2003, the ITU identified approximately 63 million broadband subscribers representing 10% of Internet users worldwide. The highest penetration rates were in South Korea, Hong Kong, and Canada, respectively. The rise in penetration rates has been paralleled by an increased interest in and demand for broadband-enabled and supported services. A telephone survey of 600 U.S. households to determine the appeal of Internet-delivered services identified entertainment as the most in-demand service followed by communications

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and education (Sage, 2002). The survey's report identified continuing education as "the service with the highest revenue potential" and requiring (along with movies) the most bandwidth for a quality experience (p. 6).

Canada has invested significantly in promoting use of broadband in education services through CANARIE Inc. a not-for-profit corporation supported by partners and the Canadian government to accelerate Canada's Internet development (CANARIE, 2002). From 2001 to 2004, CANARIE funded close to thirty projects involving broadband and learning. These projects rely on broadband to create networks of linked and interoperable learning object repositories (eduSourceCanada, 2004), provide K-12 teacher professional development (LearnCanada, 2002), develop interactive collaborative learning models for teacher development (Advanced Broadband-Enabled Learning Project, 2004), or establish broadband music education communities (MusicGrid, 2002; 2003).

Projects such as those supported by CANARIE promote inquiry into the role and value of broadband and what it might enable teachers and learners to accomplish in a context of broadband-enabled learning (BEL). However, to date, there have been few documented accounts or little evidence disseminated regarding adoption of broadband in teaching and learning beyond web site project descriptions, press releases, and evaluation reports. The latter frequently remain unavailable outside of the funding agencies or project participants. For this reason, we do not yet have evidence or understanding of how broadband contributes to learning or how it can be successfully integrated with existing practices and curricula. Because BEL assumes reliance on tools such as those supporting videoconferencing, it is important to know how easily teachers and students can use these tools and how much and what types of support might be required.

The purpose of this paper is to consider one case of BEL in order to better understand its role and value and to appreciate what it might enable in the context of teaching and learning. Using a framework articulated by Rogers (1995), findings are analysed from five evaluations of a BEL project called MusicGrid. The framework consists of five issues as follows: relative advantage, compatibility, complexity, trialability and observability. The paper begins with an overview of MusicGrid followed by a description of the framework. The findings are subsequently presented and discussed according to each of the five issues.

MusicGrid: an overview

MusicGrid aimed to pioneer large-scale broadband e-learning by connecting groups and individuals, for collaborative work around rich media content. Participants included elementary, secondary, university and conservatory students, professional music teachers, musicians, and technical and pedagogical researchers. Specifically, six music teachers and their students from schools in Quebec, Newfoundland, Ontario, Nunavut, and Iqualuit, Canada were involved. The project was designed to provide an opportunity to share knowledge, best practice, culture, and passion for music using broadband visual communication tools. Activities involved instruction, mentoring,

peer coaching, collaborative projects, performance, and auditions, carried out by individuals and ensembles playing, singing, composing, conducting, and listening with broadband-enabled activities integrated into ongoing music programs (MusicGrid, 2002; 2003).

Participating schools were equipped with or relied on existing connections which ranged from 400 kbps to 100 Mbps using fibre optic, cable, or satellite access over the private network CA*net 4. A teacher was provided with half-time release in order to serve as the pedagogical lead for the project. The project began in January 2003 and ended in March 2004. Tools used included videoconferencing software Isabel and H.323 for point-to-point and multipoint interaction and communication. In addition, a private video server allowed participants to view and add video segments of events and activities (MusicGrid, 2002; 2003). Technical support was available to all sites through personnel dedicated to the project and through existing technical support individuals associated with each school.

Conceptual framework

Rogers' (1995) framework for the adoption and diffusion of technological innovations highlights five issues that can guide inquiry into use of BEL: relative advantage, compatibility, complexity, trialability, and observability. Greater relative advantage, compatibility, trialability, and observability, combined with less complexity will more likely promote the rapid adoption of an innovation. Relative advantage refers to the ratio of benefits to the cost of the innovation, its profitability and the perception that it is "better than the idea it supersedes" (p. 229) or, at the social level, that it is status-conferring. It includes "economic profitability, low initial cost, a decrease in discomfort, social prestige, a saving of time and effort and immediacy of reward" (p. 233). Compatibility refers to consistency with "existing values, past experiences and needs of potential users" (p. 240). Socio-cultural values and beliefs incompatible with the innovation can block its adoption. Complexity refers to perceptions of how difficult an innovation is to understand and use and can exert a negative force on the rate of adoption. Trialability refers to the degree to which an innovation can be tried out or experimented with on a limited basis before commitment is required, in order to determine how well it works under specific conditions. The more easily the innovation can be tried, the more easily it will be adopted. Observability refers to how visible an innovation may be to others in a social system so that they may consider adopting it.

Methodology

The findings presented in this paper are the result of data collected in the context of evaluation of the MusicGrid project. Data were collected every three months or every quarter over a 15-month period. Techniques included individual and group interviews, questionnaires, observations, and document analysis. Interviews were semi-structured whereas observations were unstructured. Questionnaires were presented online in the MusicGrid site. Observations of some events and final interviews relied on use of videoconferencing.

Participants were primarily the six teachers involved in the project. However, interviews were also conducted with all technical support personnel directly involved with the project and the project administrators. For the final evaluation, individuals indirectly involved in the project were also interviewed. These individuals included school principals, observers such as Faculty of Music personnel and school board officials. Reports completed at the end of each quarter for each site were included as part of the data. Content posted to the MusicGrid site such as documents and a small number of discussion postings were also included.

Interviews and questionnaires aimed to assess project-related goals, challenges, experiences, and intentions of individuals and groups (eg, technicians and teachers). Interviews also provided opportunities to ask for clarification or further explanation regarding the data collected during observations or noted in the analyses of documents such as the quarterly reports. Likewise, the observations and document analyses provided an opportunity to detect any discrepancies between a participant's comments in an interview on one hand and the investigator's observation on the other. The observations were also relevant in terms of highlighting information or perspectives that the interviewee might fail to account for or notice.

Table 1 presents a summary of the data collected over the 15-month period.

Table 1: Summary of data collection for all five quarters

Report	*Period covered*	*Approaches to data collection*
1	January 01–March 31, 2003	Online questionnaires for all participants; In-person interviews with teachers, technicians, and administrators.
2	April 1–June 30, 2003	Telephone interviews with teachers; Observations of activities and events using Isabel and H.323 and onsite.
3	July 1–September 30, 2003	Analysis of issues raised in September pedagogical meeting in relation to the findings presented in reports 1 and 2
4	October 1–December 31, 2003	Telephone interviews with teachers; observations of activities and events using Isabel and H.323 and onsite.
5	January 01, 2004–March 31, 2004	Group interviews using Isabel with teachers; Observations of activities and events using Isabel and H.323 and onsite; Online questionnaires for teachers; Telephone interviews with technicians; In-person or telephone interviews with external observers; Quarterly reports from sites; Content posted to MusicGrid site by participants.

All interviews were recorded and subsequently transcribed. Observations were recorded in field notes. In addition, use of analytic memos facilitated the recording of emerging ideas and helped cluster data (Hammersley & Atkinson, 1983). Field notes and memos were subjected to a process of sharpening, focusing, discarding, organising, and reducing to avoid diffuseness and overload with the large amounts of data. Data were analysed to note changes and evolution over time to determine, for example, which issues remained consistent throughout the project and which ones were associated only with the initial implementation. Data were analysed to assess degrees of congruency of the goals, challenges, experiences, and intentions between individuals and between groups of individuals (eg, technicians versus teachers).

Analysis of data from one quarter subsequently influenced data collection in the next quarter. Data were aggregated, then were reduced, analysed, and grouped using propositions or statements as the unit of analysis. Pattern coding (Miles & Huberman, 1994) allowed for grouping of these statements into categories related to the framework. Findings were emailed to participants for reaction and reflection as a means to enhance the "confirmability" and "trustworthiness" of the findings (Guba, 1981) and assure the quality and validity of conclusions (Miles & Huberman, 1994).

Findings

Relative advantage

The advantages of BEL can be appreciated in particular through consideration of one school participating in the project. The school with 250 students is located in a remote, northern Canadian community of 750 primarily Inuit people where there are no public libraries, museums, or music teachers. As part of their school's participation in MusicGrid, a group of nine students with average age of 10 years received weekly virtual violin instruction using point-to-point, synchronous videoconferencing with a teacher 1000 km away. This teacher was the lead for an existing, experimental violin project in her own school with francophone, elementary students aged approximately 5–11 years. Instructional sessions lasted 15 minutes and frequently included the two groups—one colocated and the other remote—being taught simultaneously by the one teacher. This teacher served as the musical expert. Onsite in the Inuit school was another teacher who had no prior musical training but who learned violin along with the students. In between lessons with the expert teacher, the onsite teacher retaught/reinforced the material with the participating Inuit students.

During the 2003–2004 school year, violin instruction continued one afternoon per week through collaboration with another MusicGrid-participating school in a large Canadian urban centre. The difference in the instruction in this case was that it was delivered by high school violin students under the guidance of their music teacher. The urban students and their teacher worked with the Inuit children to show them techniques of holding, fingering, tuning, bowing, and caring for the violin. Students learned how to play simple tunes which were sometimes performed simultaneously and collaboratively by the two groups.

Throughout the year, students performed in virtual concerts along with students from other participating schools and in front of audiences connected virtually. One of these audiences consisted of the music director of Canada's National Arts Centre (NAC) Orchestra along with Canada's national librarian. Another music program that was enabled by the broadband connection involved traditional Inuit drum dancing and throat singing. Although the community is Inuit, it lacks experienced drummers and singers. However, videoconferencing via satellite once per week meant that a teacher in another community could pass on these skills to members of her culture. Students as young as Grade 2 participated and were able to practice in between sessions with a teacher onsite who learned along with them.

The participation of this school provided an opportunity to appreciate the advantages of BEL for remote and rural schools. However, MusicGrid also included participation of schools in large and small urban centres. Their participation in the project provided an opportunity to appreciate how BEL can present advantages for learning beyond those that might be experienced in remote and rural areas. In this instance, broadband access provided support for a cultural exchange via music between students from a school in Geneva, Switzerland and students from Newfoundland, Canada. Students shared musical compositions and performances as well as ideas and knowledge in real-time without the hindrance of distance. The speed of the connection and quality of the technology ensured that delay was minimal so that students could perform simultaneously. The session's activities included introductions, discussions about virtual music production, demonstrations of how music is created in the software, and presentations of drum and bass patterns. Another session featured student musicians from Geneva performing and demonstrating along with student musicians from three geographic and linguistic areas of Canada. For example, Inuit students from Iqaluit performed and demonstrated throat singing and drum dancing. Another group of students presented a cultural heritage demonstration of music, art, dance, and literature indigenous to Newfoundland, Canada that included folk song, tale, dance, and fiddling. The demonstrations were followed by a period for questions and discussions between sites.

For students in these urban centres, broadband access allowed them to benefit from experiences that would otherwise not have been available to them. One participant described how the access provided an opportunity to break down "barriers" to leave the "confines of this classroom" and "meet other students in other schools" and to overcome a form of isolation that might be common even in urban classrooms. The teacher indicated that these opportunities helped students "learn more" and to "learn from a wide variety of different sources."

Learning from a wide variety of sources included exposure to greater cultural diversity than what might be achieved without the technology. The elimination of the barriers that normally prevent interaction and collaboration between classrooms in different schools and geographic areas also provided points of comparison for students and their teachers as one individual explained, "You can compare yourself. You can see where you are in regard to the relationship of your own musical performance." The interaction

with peers also presented other advantages as one observer noted, "Peer-to-peer performance sessions offered important exposure to different musical genres and cultural practices."

Access to expert mentors was also identified by participants as a significant advantage of using the broadband technologies. Part of the project involved a partnership with Canada's NAC Orchestra which provided for some master classes with the orchestra's conductor as well as weekly mentoring sessions with an NAC trumpet player. One teacher described this access as "an incredible resource for students" and commented that "…to have somebody who is knowledgeable in so many areas brings the kids that much more to a higher level." Another teacher described the advantage of working with NAC musicians as follows, "They're getting a session with a professional who can coach them in a way that might not necessarily otherwise be available as readily. It's instant feedback." The advantages for learning were described explicitly in terms of students having an expert model with whom they might compare themselves and from whom they could gain expert skills and knowledge. The access to mentors and experts also supported teachers' learning providing them with an opportunity to be exposed to a "wide variety of instruments and techniques."

Compatibility

The issue of compatibility relates to how well or easily BEL can be integrated into a context of existing practices, beliefs, experiences, and values related to teaching and learning. Participants engaged in videoconferencing to communicate and collaborate with students, teachers, mentors, and experts from other schools or from organisations such as the NAC Orchestra, in other geographic areas geographically in different time zones and with different languages and cultures.

The issue of compatibility was most evident in relation to the Inuit school's participation. The onsite teacher was English-speaking. His students were primarily Inuit whose first language was Inuktitut. The violin instructor with whom they connected virtually was a francophone. The students at her site who were simultaneously learning violin were also francophone. The language adopted for instruction was English. Some of the francophone students could communicate partially in English and some of the Inuit children could communicate in French which supported some direct communication between the children. From a linguistic perspective, there was compatibility between students of different languages. In particular, over time, the communication improved as the violin teacher observed, "[T]he language barrier is not as large a problem this year as it was last year. It's not that the kids are better in English. It's that they are communicating better with the music."

From a cultural perspective, however, compatibility was less easily achieved. The violin teacher's music repertoire for this age group consisted largely of songs that would normally be familiar to children from a francophone culture. Her pedagogy relied on students' prior familiarity with this type of music in general and with the songs in particular. Whereas her own colocated francophone students were able to benefit from

this familiarity, such was not the case for the Inuit students. Not only were the songs unfamiliar to them but, so too was the type of music somewhat foreign in terms of their own Inuit musical tradition. Cultural differences also became evident in the approach to teaching music. The francophone violin teacher relied on the Solfege method using the syllables of *do*, *re*, *mi*, *fa*, *so*, *la*, *ti* to name the pitch in a scale of notes as this is the method common to her own culture. However, the English-speaking teacher who assisted with the violin program onsite was accustomed to the method of assigning notes using the first seven letters of the alphabet.

Another way that the issue of compatibility manifested itself in the context of the project was in relation to synchronous communication and collaboration across time zones and between different schools with different schedules. What might represent a convenient time for one group of students in one school might be a lunch hour or inconvenient time for the collaborating group in a different time zone as one teacher explained, "The problem is the time, and so when we try to get together, not all teachers have the same schedule… We had it on the lunch break, but then students didn't have enough time to eat."

Complexity

The issue of complexity relates to difficulties of engagement in BEL. The more difficult the tools are to use, the less likely they will be adopted by other users. In the case of MusicGrid, difficulties occurred in relation to the use of tools and in coordinating collaboration between groups of individuals. The project's videoconferencing software and equipment were chosen, not in an effort to reduce complexity, but to test the limits of the technology as part of the project (ie, how many users can simultaneously collaborate around music, with what bandwidths, etc). H.323 was not difficult or complex for participants to use. However, Isabel requires technical support or implementation time for teachers and students to learn to use it. As a technical support person indicated, "Isabel is not that simple… it is a burdening product, a kind of a science project on wheels. More windows open up than you can shake a stick at to make it go." Yet, there are technologies available that support multipoint videoconferencing that have very low levels of complexity and that could support BEL (eg, CU-SeeMe, Microsoft NetMeeting, etc).

However, even when highly complex tools such as Isabel are used, with sufficient support, teachers and students can engage in BEL. In spite of the newness of the tools and the fact that some teachers were inexperienced technology users, as the following technical support person observed, they gradually built capacity to use the tools, "The teachers really have moved along with the technology. At first, they were pretty shaky, but now it seems like they can handle pretty much anything." At the end of the project, one teacher described how she had become accustomed to use Isabel, "I would recommend Isabel as the tool to use the most because this is the one I've become most comfortable with and the one I have the most access to… . We use it everyday now. I've found it to be very easy to use."

Complexity may also arise in a context of BEL because of the types of interactions that the technology supports such as synchronous videoconferencing between two or more sites. For example, the use of broadband for videoconferencing in the context of MusicGrid required coordinating interaction and activities in a minimum of two different sites. Complexity became apparent in terms of being able to match schedules, goals, and intentions between sites. Without the support of an individual assigned half-time to this coordinating role, the complexity may have rendered synchronous communication unworkable particularly in cases where more than two sites were involved.

Trialability

Trialability refers to the ability of a different group of users in another context and in different conditions to be easily able to experiment with this technology. The focus of MusicGrid was primarily on the use of the technology in the area of music. However, project participants also took advantage of their broadband connection to test its use with other subject areas and with other teachers in the school. The broadband connection was used to support activities in the area of language arts whereby students and teachers collaborated, interacted, and communicated around literature to complete a novel study of the book *Hanna's Suitcase*. In another instance, students and teachers took advantage of Canada's National Library's virtual book club, in which classes from across the country participated in a book-reading session that included a special guest talking about the book.

Results of this experimentation were positive and, as one individual commented, "[O]f course the technology can be used for other areas. I think we've more than proven that it can pretty much be used with any subject." Another individual observed, "I can see this type of project being relevant for almost anything we might try." The relevance of use of a variety of subject areas besides that of music suggests that BEL is not only relevant in this context but it could also be easily used and tried in other areas.

However, its use in other subject areas depends on a high-speed connection as well as access to related equipment, software, and technical support. In addition, it requires some release time for teachers as well as mastery of what one individual described as a "fairly long and experimental learning curve." The costs of the project itself was in excess of one million dollars, some of which included in-kind contributions and much of which represented the high connectivity costs for broadband access. Broadband-enabled learning also implies that there will be a minimum of two partners that are not colocated and that rely on videoconferencing for communication and collaboration. Trialability therefore is dependent on at least two groups being able to experiment with the technology.

Observability

The issue of observability relates to the visibility of this innovation to others within a similar context so that they may consider adopting it. The BEL activities were visible within the local schools and communities because of formal efforts to make others aware and to publicise use of the technology. Media, special guests, teachers, students,

and school administrators were invited to witness the technology in use and to observe sessions. An additional factor that promoted visibility was the choice of subject area. The project's focus on music meant that much of the use of broadband would be for performance activities with audiences. In one case, the audience consisted of 600 individuals who had come to see a concert that included virtual performers using broadband technologies as well as performers onsite.

Discussion

The case of MusicGrid provides an opportunity to consider the advantages that broadband can bring to a context of learning. Rogers considers relative advantage in terms of criteria such as economic profitability, decrease in discomfort, social prestige, savings in time and effort, and immediacy of the reward. The advantages associated with BEL in the context of MusicGrid did not reflect these criteria. Instead, they reflected criteria more closely related to what might represent an advantage from the perspective of teaching and learning. The use of broadband enabled access to mentors, peers, and experts; access to learning and cultural opportunities; support for peer-to-peer interaction and communication; elimination of distance as a barrier to communication and interaction; support for cross-cultural and linguistic interaction, collaboration, and exchanges; promotion of a more open classroom; and exposure to alternative and new experiences. Each of these criteria also present advantages in and of themselves and are related to each other. For example, access to peers, mentors, and experts allowed for greater diversity of experience and access to knowledge or resources that learners might otherwise not have. In the case of MusicGrid, learners in both rural and urban areas benefited by being able to access expertise and knowledge that would not be available to them without the technology.

Although it is important that BEL offer advantages, it is also important that it be compatible with existing practices or with existing values, beliefs, and experiences. Typically, schools are not associated with easy or frequent adoption of innovation. Instead, as Papert (1993) argues, "the education establishment... remains largely committed to the educational philosophy of the late nineteenth and early twentieth centuries" (p. 3). Bringing about changes or introducing new practices and ways of behaving can therefore easily result in incompatibility. Incompatibility, however, did not manifest itself in this way in the case of MusicGrid. Adoption of new practices such as reliance on experts and peers for learning instead of relying on the teacher was welcomed. In the case of MusicGrid, the incompatibility arose because of use of BEL for cross-cultural exchange, interaction, communication, and learning. Linguistic differences did not result in incompatibilities, however, cultural differences in some cases hindered or made more difficult the achievement of communication, interaction, and learning. This incompatibility resulted more from the context of use than it did from the technology. For example, if the vehicle of instruction had been something other than music, cultural differences might not have occurred. Also, if interaction had been solely between students of similar cultural backgrounds, such differences might have been less apparent.

Subsequent investigations of BEL could focus specifically on issues related to cross-cultural interaction and communication to better understand what barriers learners do encounter and how they do or do not manage related incompatibilities. Other contexts of the use of BEL such as with a different subject area might also investigate how users experience and manage compatibility in contexts of synchronous communication across time zones and between institutions, organisations, and groups of individuals. Broadband eliminates spatial barriers thus making technically possible real-time communication and interaction between geographically dispersed individuals and groups. However, as the case of MusicGrid illustrates, temporal barriers may hinder interaction and communication across time zones and are not eliminated as easily as are spatial barriers.

In relation to complexity, Rogers argues that the easier an innovation can be used, the more likely it will be adopted. The experiences of the MusicGrid participants did not support that claim. BEL and the tools and technologies associated with broadband are very complex. For example, as one of the technical support participants commented, Isabel is a highly complex tool. Yet, in spite of this complexity, participants relied extensively on this tool in this context of BEL. Support played an essential role in managing the complexity of the technology. In addition, the support was delivered in a way that fostered capacity-building in participants so that they were able to eventually manage the use of the technology independently. Complexity was also evident with regard to the types of interactions that had to be organised and managed in this context of BEL. At times, as many as five or six different sites with different organisations in different countries and time zones came together simultaneously to collaborate, engage in similar activities, and share knowledge, skills and experiences. This type of communication and interaction is complex to manage. However, the project provided for a lead individual who was dedicated halftime to coordinating these sorts of interactions and thus, the complexity was managed. The case of MusicGrid suggests that with sufficient and appropriate support, high levels of complexity will not pose a threat to adoption of BEL.

Trialability is an attribute that relates to other users being able to experiment easily with the innovation. Although the project relied on music as a vehicle, there was sufficient evidence to suggest that BEL could be easily tried with other subject areas besides music. Trialability of BEL will depend also on access to a minimum of resources including a high-speed connection, videoconferencing equipment and software, and technical and lead/administrative support. Trialability will also require a minimum of two individuals or groups who are not colocated. As high-speed Internet access becomes more prevalent, BEL may be more easily tried by users. Improvements in software and in compression formulas may also continue to make videoconferencing a more ubiquitous and easily trialable activity. The observability of BEL in this case was enhanced by the reliance on videoconferencing which is technology easily viewable by large audiences. Although the choice of subject area and inclusion of performances enhanced the overall observability of BEL, videoconferencing is a highly visible and observable technology. Compared to other uses of technology, even use of audio, video-

conferencing can be easily witnessed and observed by other individuals not directly involved in use of the technology.

Conclusion

As broadband becomes more ubiquitous, we can expect to witness more contexts of use of BEL. The increased use will present an opportunity to appreciate the role of new and emerging technologies in contexts of teaching and learning and to investigate a number of questions related to BEL. What can or will teachers and learners do when provided with broadband tools? Will the use of these tools alter their behaviours and patterns of interaction and approaches to teaching and leaning? What will happen when learners are not confined or restricted to interaction within their own classroom, school or even community? What challenges will they encounter in learning outside of the confines of their community? How will learners benefit from interaction with their peers and from experts and mentors? Can BEL present opportunities for pedagogical as well as technical innovation?

Other contexts of use of BEL will also provide an opportunity to consider issues besides those considered in this paper. Issues of affordability and accessibility of BEL may need to be considered particularly in cases of use in public educational institutions in remote and rural communities where the broadband infrastructures are not yet in place. Additionally, the issue of support might constitute a focal point for future inquiries into BEL as support plays an important role in relation to complexity of BEL. These and other issues and questions represent pertinent foci for inquiry to ensure that BEL can migrate and evolve from the laboratory project setting and be adopted in more contexts of teaching and learning.

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