Barriers to Successful Implementation of Technology Integration in Educational Settings

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Abstract

This paper presents barriers as conditions that do *not* support integration of technologyy within a sound educational eco-systemic framework. The departure point is ISTE's (2009) fourteen essential conditions. They were clustered in a way as to respect their initial order, and research literature, especially the findings of the International Handbook of Information Technology in Primary and Secondary Education (Voogt & Knezek, 2008). In section one, each cluster is used in backdrop to the identification of four barriers that present key challenges to educational agents working to integrate technology into specific communities (schools and classrooms). The second section presents the results of Thematic Working Group 7's context-based discussions of essential conditions at EDUSummIT 2011. The interdependence of educational agents who want change to happen is stressed, and a fifteenth conditions is put forward, 'information ecology', for guiding educational agents toward sucessful implementation of technology integration.

Introduction

When addressing the topic of barriers that confront the integration of ICT into educational settings, two issues arise. First, can "barriers" be better understood against the backdrop of essential conditions? If so, is there a universal set of essential conditions across international and regional settings? Second, some are uncomfortable using the term "barriers" and would prefer alternates such as "opportunities" or "challenges." Participants in the 2011 EDUSummIT addressed these issues, and others, as they relate to the role that barriers and essential conditions play in the successful implementation of ICT in educational settings. While identification of "essential conditions" can be somewhat contextualized, varying from region to region and country to country, some more encompassing conditions have emerged.

'Under which conditions does ICT have a positive effect on teaching and learning?' was the leading question of the International EDUsummIT 2009 Call to Action in The Hague, the Netherlands. In 2011 in Paris, this question was the focus for Thematic Working Group 7 (TWG 7): To develop and disseminate a list of essential conditions that need to be in place to ensure benefit from technology investments. TWG 7's discussions priorized the fourteen essential conditions identified by the International Society for Technology in Education (ISTE, 2009) to serve as standards to varying degrees depending for local, national, and regional contexts.

This paper builds on the above contributions in its analysis of barriers that need to be removed to maximize benefit from technology investments. To this end, we adopted an eco-systemic perspective, one much grounded in Senge (1990a) and Engeström's activity theory framework (1987, 2008).

Research on Agents, Tools, and Communities

Activity theory's primary assumption is the social nature of individual actions. Educational agents do not act alone, however creative or resourceful they may be. They are part of a community (e.g., a classroom, a school, a school district or a statewide education system). When introducing new technology or new goals in a community, ICT early adopters (Rogers, 2003) challenge the course of its normal activity. Opportunities and tensions arise. The latter must be faced. Otherwise, they erect barriers. Activity theory (Engeström, 1987) teaches us that tensions seed~~s~~ transformation. A community manifests agency by addressing tensions that arise. Agency is intentional transformative action based in an interpretation of the situation (Engeström, 2008). He argues that such interpretation is the result of an expansive learning cycle during which participants seek resolutions of contradictory goals, tools, roles, norms and rules. In this section, we present ISTE's (2009) essential conditions can be as "experienced" resolutions of such tensions by agents who broke down barriers as they made progress toward successful implementation of technology integration in educational settings.

Barrier 1: Tradition and educational agents' difficulty to agree on their community's future activity

Tradition runs deep in formal education systems. There are artefacts, roles, policies, rules and routines. Agents' technology integration efforts meet dynamic homeostasis, this tendency of a system to maintain internal stability through its growth. Activity transformation requires some sort of agreement within an educational community.

A Shared Vision. ISTE's (2009) first essential condition for successful implementation of technology integration is defined as follows: Proactive leadership in developing a shared vision for educational technology among all education stakeholders including teachers and support staff, school and district administrators, teacher educators, students, parents, and the community. In a learning organization a shared vision is a work in progress. Senge (1990: 9) provided a major impulse when he wrote: ''It's the capacity to hold a shared picture of the future we seek to create''.

Across the world, agents multiply efforts to bring computers, peripherals, and Internet connectivity to schools. Financial resources are added and/or reallocated. In the United States, the ratio of students to instructional computers with Internet access was at 3.1 to 1 in 2008. According

to Statistics Canada, Yukon is the most connected educational jurisdiction in Canada with a student/computer ratio of 2.9:1. One-to-one computing is now a reality in a number of classrooms. Internet has become a valuable technology for school communities and statewide education systems. A shared vision emerges from experience (Fullan, 2001). Of course, student access to the Internet varies widely from country to country and from region to region.

The building of a shared vision hints at how and to which extent computers, including mobiles, will be used in the classroom. Different options co-exist, and the digital divide challenge (Resta & Laferrière, 2008 ; Warschauer, 2010) takes new meanings as tutorials do not have the positive impact of rich and creative uses of technology (Balanskat, 2006; Cox, 2008; Higgins, 2010; IES, 2010; Means, 2009; Voogt et al, in press; Wenglinsky). More tensions grow among educational agents when leaders put the emphasis on second-order change[1].

Empowered Leaders. ISTE's (2009) second essential condition is defined as stakeholders' empowerment, at every level, to be leaders in effecting change. Educational agents, including students, teachers, school administrators, parents, researchers, social leaders and public servants, are all stakeholders in a given community. Moreover, external partners may be involved. Those favourable to tradition and those pushing for innovation are in tension, and educational leaders' challenge is to leverage the creative tension between both positions (Kuhn, 1977; Senge, 1990b). In a learning organization, change is enacted through the principle of creative tension, one arising out of an emerging vision of the future and a pragmatic picture of how things are at the present. For instance, in a school an accurate picture of the current activity is as important as a compelling picture of a desired future (Haddad & Draxler, 2002). Senge suggests that leaders are more effective as change agents when they entertain such a creative tension. Educational agents are encouraged, therefore, to adopt a participative approach, building a vision of where they would like their classroom, school, school district or statewide educational system to be as they integrate new technology (ISTE's first condition). They are also encouraged to be reflective about the roles, norms and routines that shape their current daily activity (ISTE's second condition).

Classroom activity does not change easily (Cuban, 2001; Zhao & Frank, 2003). Content, process, and assessment are usually well-aligned. Student voice rarely affects the course of classroom activity. However, learners should be the change agents (Fielding, 2007; Rudduck & McIntyre, 2007). The shaping of one's future activity as a student, teacher, ICT coordinator, or administrator of a school,

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[1] According to The National Academy for Academic Change, first-order change is doing more – or less – of something we are already doing whereas second-order change is deciding – or being forced – to do something significantly or fundamentally different from what we have done before (http://www.thenationalacademy.org/ready/change.html).

school district or statewide educational system is a participative effort, one that calls for successive iterations. As steps are being taken for digital learning resources and tools to pervade the classroom, new affordances arise. There could be dissonance when digital resources and tools do not represent the same educational value to all stakeholders, especially when some have different roles bound by specific policies and rules within an educational setting.

Implementation Planning. ISTE's (2009) third essential condition reads as follows: "a systemic plan aligned with a shared vision for school effectiveness and student learning through the infusion of information and communication technologies (ICT) and digital learning resources". Law et al. (2000) identified three different models of ICT implementation: 1) the technological adoption model applies a managerial perspective, stressing the infrastructure establishment and development of teachers' ICT competence; 2) the catalytic integration model points to visionary leadership, clear curriculum goals and supports for teacher professional development; and 3) the cultural integration model emphasizes a clearly discernable vision of education, a strong sense of mission, and ICT integration without too much pressure on school leadership and teachers. Technology leadership is exercised top-down or bottom-up (Anderson & Dexter, 2000; Davies, 2010; Dede, 1993; Schiller, 2002). For Dexter (2008) the three dimensions of IT leadership are to set directions, to develop people, and to make the organization work.

A multitude of ecological factors are at play in ICT implementation (Li, 2010). Activity theory reminds us that human activity is complex, mediated by other people, tools or instruments, and artefacts. The object of the activity being learner driven, personal and collective productivity is at stake.

Robertson *et al.* (2006) concluded their study on conversations toward effective implementation of ICTs in Australian schools saying that ''there is likely to be considerable agreement about the content of such conversations in schools and that they are likely to be concerned with people and processes rather than with ICT technology/software/hardware and the like per se''. However, when funding is lacking, the nature of the conversation is likely to shift back on technology.

Barrier 2: Competing educational needs and lack or withdrawal of funding

Schools have plural needs to meet. Moreover, technology access is a moving target. From Internet connectivity into school to one-to-one technology in the classroom the demand is growing, and budgets are limited.

Consistent and Adequate Funding. ISTE's (2009) fourth essential condition for successful implementation of technology Integration is ongoing funding to support technology infrastructure,

personnel, digital resources, and staff development. This conditions remains at issue even in affluent areas as demand for bandwidth increases with mobiles (ipods, tablets, laptops) being increasingly used in schools. For instance, the NYC public school system allowed iPads into classrooms but later announced that its wireless network was « approaching its resource limits » (Kambouras, 2011). From a qualitative and quantitative study based on eleven case studies and conducted five years after the data collection in SITES-M2 (1999-2002), Schulz-Zander and Birgit Eickelmann (2009) pointed to the hindering effect of the withdrawal of resources caused by the lack of sponsoring and the withdrawal of public-private-partnerships.

IP traffic is going up, resources are in decline, and schools, yet, school districts and statewide educational systems tend to invest more of their regular budget into digital tools and resources rather than connectivity. Although access to Internet-based tools is increasing almost anywhere in the world, Akpabie (2008) observed, while presenting a UNESCO proposal, that ''ICTs in education is still not that widespread and ICT policies for education are still at an experimental stage in a majority of countries''.

Equitable access. With its fifth essential condition, ISTE's (2009) insists on equitable access, that is "robust and reliable access to current and emerging technologies and digital resources, with connectivity for all students, teachers, staff, and school leaders". Obviously, professional educators are in the process of retooling their profession, and equitable access to digital tools and resources is meeting challenges more daunting than with previous technology. Funding is an issue, and the choices are numerous.

Skilled Personnel. ISTE's sixth essential condition calls for **"**educators, support staff, and other leaders skilled in the selection and effective use of appropriate ICT resources". Nardi and O'Day (1999: 49) suggest the term "Information ecology" for referring to "a system of people, practices, values, and technologies in a particular local environment. In information ecologies, the spotlight is not on technology but on human activities that are served by technology." Means et al (1993) presented a classification of digital resources on the basis of how they are used by students instead of their base technology: tutorial, exploratory, tool, and communications uses of technology. Classroom authentic tasks are not the province of technology experts. A technology plan is meant to lead to some consensus between those working inside and outside the classroom. Recognizing the relative advantage of some technologies over others is critical for innovation (Rogers, 2003). Roblyer (2005) points to four areas of relative advantage: prevention of inert knowledge (Brown, Collins, & Duguid, 1989) with visual technologies like simulations and video-based scenarios; increasing cultural awareness and acceptance (e.g., with distance collaboration projects); increased reading

comprehension with interactive technologies (e.g., interactive/electronic storybooks) and increased comprehension of abstract concepts (e.g., with spreadsheets, geometry software) to clarify concepts that students traditionally find complex and difficult to understand.

In spite of the fact that the value added of technology in schools is increasingly recognized, the percentage of students actually using the Internet in the classroom at some level of engagement remains low.

Ongoing Professional Learning. ISTE's (2009) seventh essential condition is "technology-related professional learning plans and opportunities with dedicated time to practice and share ideas". Law, Pelgrum & Plomp (2008: 252) found that lifelong-learning orientation in ICT-using teacher practices ''significantly correlated with the means of the school factors analyzed, namely principal's vision for ICT-use to support lifelong learning, technical support for ICT-use and the principal's priority for leadership development". When these conditions are high in schools ICT-using pedagogical orientations are also high. However, as pointed out by Law, ''these correlations are not about whether a teacher's practice relates to the school conditions under which he or she teaches'' (p. 252). Epistemological, pedagogical, and organizational factors may compete in teachers' perceptions of students' needs (Venezky, 2004). Law (2008: 431) stresses: ''teacher professional development for pedagogical innovation must address the issues of educational values and epistemological beliefs, which can only be cultivated through the social, institutional, and professional milieu within which the teacher lives and works". She pointed to the importance of sharing experiences in a professional network of innovators.

School-based professional learning communities (Dufour, 2004) are seen as critical for building consensus regarding professional values and norms. They are also found to be effective as they lead to changes in teaching practice and improve student learning (Vescio, Ross, & Adams, 2008). The role of technology to support learning communities and communities of practice has been stressed (Hartnell-Young, 2006; Law, 2008; Riel & Becker, 2008; Riel & Fulton, 2001). However, the role of professional learning communities to support technology infusion is less documented. As pointed out by Lawless & Pellegrino (2007: 604) ''there are a host of approaches to professional development. Each approach has its own strengths and weaknesses''. There are adjunct issues, with consensual pedagogical effort is at one end of the continuum and technical support at the other end.

Technical Support. ISTE's (2009) eighth essential condition, which refers to "consistent and reliable assistance for maintaining, renewing, and using ICT and digital learning resources". Along with time and professional development technical support remain the most mentioned conditions for innovation with ICTs. In the early stages of ICT integration, they may be there, and their

discontinuation continues to be perceived as an hindering factor (Schulz-Zander and Birgit Eickelmann, 2009).

Barrier 3: Paper format tools' convenience for structure, equality and fairness in the classroom community

Common curricula may be changing but a teacher has the responsibility to structure, one way or another, classroom activity and provide an egalitarian and non-threatening learning environment to students. Paper-based resources are means to these ends whereas digital tools bring more flexibility. Conventional classroom organization and management, which relies on clear expectations and fairness, is somewhat challenged but still persists. Daily classes looking the same for all students have been criticized from a number of perspectives (e.g., Cooper, 2010; Hallinan, 1988), including the learning sciences (Bransford, Brown, & Cocking, 1999). The tension between sameness and difference in the classroom is exacerbated as digital tools are introduced in the classroom community, with some communities having a distinct advantage over others.

Curriculum Framework. ISTE (2009) defines the ninth essential condition for successful implementation of technology integration as follows: "Content standards and related digital curriculum resources that are aligned with [state or other official curricula, and especially those supporting] digital-age learning and work". Voogt (2008: 117) points to the distinction between the intended, the implemented and the attained curriculum: the rationale and goals for learning as the intended curriculum, the way they are understood (implemented curriculum), and the attained curriculum being student outcomes. Voogt notes (2008: 129): ''The integration of the full potential of IT in the curriculum will often imply that curriculum content and goals need to be reviewed and examination programs revised.''

UNESCO's (2011) recognizes the critical importance of the curriculum as part of its ICT competency framework for teachers. The three competencies UNESCO stresses are technology literacy, knowledge deepening, and knowledge creation. They represent a huge leap forward with regard to what is expected of teachers and students in elementary and secondary classrooms.

Li (2010: 293) suggest that ''the impetus for technology implementation may come not only from a drastic revamp of curriculum or teaching methodology but also from the informal social forces and the empowerment of teachers and students in the process."

Student□Centered Learning. ISTE's (2009) tenth essential condition is defined as "planning, teaching, and assessment center around the needs and abilities of students". McCombs and Vakili (2005) present a framework for elearning building on APA's (1997) learner-centered principles that

summed up century-long research in educational psychology. Anderson (2008) identifies current knowledge-based models linking educational needs with ICT and knowledge concepts. With its focus on knowledge deepening and knowledge creation, UNESCO's (2011) framework pushes beyond student-centered learning emphasizing classrooms as knowledge building communities (Scardamalia and Bereiter, 2006, 2010).

Ertmer (2005) argued that teachers' beliefs was the final frontier in the quest for technology integration. Wong and Li (2011) found evidence of the critical role of pedagogical intervention in bringing about changes in learning as well as the critical role of transformational leadership in shaping school climate. A powerful lever could be new assessment tools (Erstad, 2008).

Assessment and Evaluation. For ISTE (2009), the eleventh essential conditions reads as "continuous assessment, both of learning and for learning, and evaluation of the use of ICT and digital resources". Anderson (2008: 11-12) presents a Student Knowledge Framework "to explicate how societal knowledge demands suggest that learning activities and assessment strategies be structured''. Binkley et al drafted a white paper for the Assessment and Teaching of 21st Century Skills (ATC21S) that collides and expands on what has been written on competencies or skills for digital-age learning and work. Digital tools for the assessment of learning that the project is designing are meant to be aligned with those skills.

Assessment for learning means using data to inform leadership, including teacher leadership, and management strategies. Moyle (2008) distinguishes between tangible and intangible assets. The former refers to what has been traditionnally measured; in most organizations, it can be seen and touched. Whereas intangible assets refer to human, information and organizational capital. For instance, teachers' competencies, collective memory including data bases, and a school culture can be considered as intangible assets but, as pointed by Moyle (2008), no models yet exist for measuring intangible assets in schools.

Barrier 4: Communities' memory shortage when it comes to maintaining conditions for innovation

Conditions for innovation may be hard to gather initially but their maintenance is even harder. Tubin (2009: 404) stresses that "most schools experience an 'attrition of change' and start to regress toward the mean and shift back to conventional directions''. He points to three ways for avoiding such a process of regression toward the mean: setting an exception; reallocation of resources; and adoption of alternative standards. We suggest adding a fourth—shared decision-making. In her study of decision-making by key stakeholders in the context of a lasting innovation, the Remote Networked School (RNS, 2002-2012) that involves 23 school districts and over 100 small-size schools, Hamel (2010) emphasizes the role of RNS steering committees, implemented from the start, that were the

'unique' locus of shared decision-making. They not only protected the innovation over the years but assure its sustainability and scalability.

Engaged Communities. ISTE's (2009) twelth essential condition is defined as "partnerships and collaboration within communities to support and fund the use of ICT and digital learning resources". Reporting on a case study Li (2010:284) observes that "the impetus for change comes from the social capital and informal social forces in the school", and she points to the importance of parental support. The impetus may also be coming from an outside partner but the ownership of all stakeholders in the educational community is critical. In any case, at the onset of innovation, partnerships and collaboration is the condition that "breaks up the status quo" – a must according to Kotter (1996) and Ely (1999).

Support Policies. ISTE's (2009) thirtheen essential condition is the following: "Policies, financial plans, accountability measures, and incentive structures to support the use of ICT and other digital resources for learning and in district school operations". Yet, as observed by Turcotte and Hamel (2008), there is a tendency to process ICT implementation as 'another project' in the entire set of school/school district activities. Integration into daily practice, that is, 'Realizing the Potential of IT in the Curriculum' (Voogt, 2008: 122), requires support within and outside the school (Owston, 2006).

Supportive External Context. ISTE's (2009) last essential condition reads as follows: "Policies and initiatives at the national, regional, and local levels to support schools and teacher preparation programs in the effective implementation of technology for achieving curriculum and learning technology (ICT) standards". Looi, So, Toh and Chen (2011) document the Singapore experience, emphasizing the synergy of national policy, classroom practice and design research (Collins, Joseph & Bielaczyc, 2004). Turcotte, Laferrière, Hamel & Breuleux (2010) provide another example of such synergy in Quebec, Canada. As pointed by Voogt, Knezek, Cox and Knezek (in press) this research approach is ''grounded on collaboration between researchers and practitioners, and practitioner-driven research agendas are assumed''.

In this section, we have attempted to make the case that educational agents alone, be they located at the micro, meso or macro level, cannot successfully implement technology in education, while taking on the entire educational community of stakeholders. As ISTE points out, a shared vision must inform all related activities. Ideally, such activity is located within a community that works out, from an "activity theory" perspective, the tensions that technology implementation create. Support for such a position comes from Divaharan & Cher Ping's case study (2010), which presents a case

study of three schools engaged in such activity ~~systems.~~ They point to the relevance of confronting tensions/contradictions that new technology brings within and across communities' activity systems.

TWG 7's activity outcome at the EDUsummIT 2011

TWG 7 found much value in the "essential conditions" established by ISTE (2009), building on some of them in two distinct groups that came together to find a common voice towards the summit's end.

EDUSummIT TWG 7's expression of agency for removing barriers to successful implementation of technology integration

Participants reached consensus on a *shared vision,* being a key factor. They concluded that

> In order to achieve sustainable successful outcomes, a shared vision has to be a belief that technology is beneficial, as defined by different communities of users or practice and educational models, and to be embraced with an open mind by all involved. (Searson, Laferriere, & Nikolow, 2011)

Another area of focus for the EDUSummIT TWG 7 was student technology experiences, where it is recommended that a shared vision would "recognize the importance of informal learning through ICT in the 21st Century."

As difficult as it may be to reach a consensus on a global shared vision, TGW 7 recognized that it is a necessary step in any context. For instance, the Global eSchools and Communities Initiative (Hooker and Wachira, 2009), drawn from the ISTE model, and addressing the question, "What are the essential conditions that must be in place to begin moving forward?" From the original set of ISTE essential conditions, it focused on six, as prioritized by roundtable participants, with the first three—a shared vision, empowered leaders and implementation planning. For a shared vision, it identified three "challenges": A lack of understanding of the benefits of ICT as a concept in Education, lack of a policy framework, and resistance to change.

TGW 7 noted that others had distilled the ISTE set of essential conditions even further. For example, in a study of Malaysian Smart Schools, Ali, Not, and Alwi (2009) made a distinction among "emerging," "essential," and "supporting" conditions. They concluded that essential conditions can be reduced to "availability of ICT resources" and "acquisition of ICT knowledge." TGW 7 got a sense of a focused shared vision guiding Malaysian leaders in implementation planning.

The critical role of empowered leaders was also emphasized, building on Eickelmann's (2011) observation that empowered leaders *"take* account supportive factors of sustainable ICT implementation to respond to the rapid development of ICT and education." TWG 7 insisted that all stakeholders—in addition to empowered leaders—must be involved. Participants argued that a shared vision should be at the center of any stakeholder's ICT integration strategy, from teachers to

teacher educators to teacher candidates, across universities, policy makers, parents, parents, communities, municipalities, NGOs or SMEs (open-source software, venture capitalists) or other industry leaders in this area. And, in all cases, learners should always be central to such work.

TGW 7 noted that curriculum framework, student-centered learning and assessment and evaluation are the three other conditions shared jointly by ISTE and, for instance, the Global eSchools and Communities Initiative. Preferably, they would be aligned with a shared vision focused on 21st skills (see EDUsummIT 2011 TWG 6). Through their practices, educational policymakers, teacher educators, teachers and candidate teachers are in best position to provide such alignment. However, TGW 7 was aware that barriers that could thwart such efforts include: 1) disagreement in values, theoretical models, practices; 2) teachers fear that they will loose control over the learning process; and 3) authoritarian and dogmatic approaches to knowledge transfer.

TWG 7 focused on two additional ISTE essential conditions—"skilled personnel" and "ongoing professional learning"—to help teachers' understanding and develop their capability to engage actively and collaboratively with learners, ensuring that the learning process would continually enhance shared curriculum goals. This could be accomplished by focusing teacher education and professional development on learning outcomes, when using ICT, so that teachers gain confidence in a "communities of practice" approach to technology integration. The deployment of technology to support onsite/online programs for teachers and students would incorporate processes such as coaching, modeling, and the building of online professional learning communities (teacher educators, in-service and pre-service teachers). Two caveats were formulated : 1) the use of technology in the curriculum must prevent overstimulation and understimulation of the learner, which could otherwise serve as barriers to effective learning, and 2) a clear alignment between resources allocated to technology integration and a demonstration of effective integration that positively impacts learning. Other essential conditions should be galvanized to support these objectives to ensure that effective technology integration is fully realized.

Finally, EDUsummIT 2011 TWG 7 participants took the position that the status of educators who successfully integrate technology—especially toward developing 21st century, global citizens—should be elevated. The present lack of teacher status in this area was identified, along with other critical barriers, such as the lack of infrastructure support. Collectively, these barriers undermine the development of a 21st century workforce. Here again, the importance of regional perspectives on "barriers" and "essential conditions" was reaffirmed. While barriers to successful implementation of ICT in schools is an issue for all communities, it is more critical in developing countries where access to emergent technologies and the Internet may be severely limited in the home and local

communities, posing a greater challenges to educators attempting to meaningfully integrate technology as a tool for learning.

EDUSummIT TWG 7's recommended actions

Essential conditions could be complemented with an additional and more focused agenda. No factor can be considered a barrier in and of itself. EDUsummIT 2011 TWG 7 participants pointed to the following specific actions for helping policy makers and experts at different levels understand the benefits of technology in learning, and the importance of involving key stakeholders, including learners, in policy, strategy and implementation:

> 1) the conduct of top-level conferences and opportunities for informing decision makers by key stakeholders, particularly learners;
> 2) the creation of communities of practice focusing on particular issues to bring together decision makers and stakeholders;
> 3) the involvement of powerful international backers and agencies (e.g., UNESCO) to support global shared activity;
> 4) the proactive engagement of users of learning technologies with producers of learning materials and software content to have the needs of learners and teachers met as well as developers' aspirations; and
> 5) the gathering of a range of funders and educational technology stakeholders so they could better understand their varying perspectives, and move toward the development of user-led materials.

Discussion

For successful implementation of technology integration the interdependence of educational agents is emphasized both in the research literature and in TGW 7's discourse, be they students, teachers, school principals, parents, school district superintendents or ministry officials. A shared vision is a premium condition, one likely to evolve over time as empowered leaders progress through the implementation process. Yee (1998) suggested that deeper understanding of what computers can do and how they can be applied to improving student learning empowers administrators to invest in technology implementation. Rather, administrators and policy makers are eager for research results showing technology impact. Such results are context-bound.

We suggest that ISTE could add a fifteen condition to its list, that of an "information ecology" to counter the challenge of "silo" action. It is through co-evolution of people, practices, values and technologies in a given educational setting that best progress regarding successful implementation of technology integration could be made. An eco-systemic perspective is the basic on which we also suggest research gaps to be addressed:

- The role of technology to support learning communities is stressed (Riel & Fulton, 2001;

Tan, Seah, Yeo, and Hung (2008) but the role of the classroom-based learning community as an empowered leader is yet to be articulated. Forkosh-Baruch (2005) et al alluded to that when identifying the 'island of innovation' pattern but more research is needed.

- Roblyer (2005), who identified four research lines to move educational technology research forward, builds on Roger's study of innovation (2003) to stress 'Research to establish relative advantage condition'.

- The complexity and dynamic nature of research into the uptake, use and impact of IT in education is stressed by Cox (2008) as different factors need measuring in addition to attainment and learning gains. Li (2010) suggests more in-depth studies on understanding the interplay of a wide range of psychological, social and organizational factors that govern the dynamics of change implementation in schools.

The four "barriers" identified in this paper were formulated out of an eco-systemic perspective. We provided a conceptualization of ISTE's essential conditions in backdrop in an attempt to offer a fresh but realistic perspective for successful implementation of technology integration into schools and classrooms. To the question, 'Is there a universal set of essential conditions across international and regional settings?' we are inclined to say 'yes' althought the ways to word them may differ.

Conclusion

Literature supports the notion of some type of continuum of barriers and essential conditions. Conditions that do *not* support integration of technology could be considered *barriers* to optimal learning conditions. This paper built on that as we researched the literature and understood barriers in relation to four subsets of ISTE's conditions, ones reflective of an eco-systemic perspective.

Experience, expertise and knowledge of Summit participants could be leveraged by administering a survey, informed by research, to identify barriers to successful technology integration, with an eye toward providing solutions and finally realize the goal of robust technology integration for all learners across the globe.

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