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Technology's Achilles Heel: Achieving High-Quality Implementation

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Abstract

An inherent characteristic of technology education is the continual development of new technologies and creating innovative applications of already existing technologies. As exciting as these innovations can be, technology educators and school staffs are frequently challenged to accomplish high levels of implementation. The metaphor of the Implementation Bridge and four research-based constructs of the Concerns Based Adoption Model are introduced in this article. Each can be used to evaluate the extent of implementation and as diagnostic tools for facilitating implementation. Each also can be applied in studies of relationships between extent of implementation and student outcomes. (Keywords: change, implementation, evaluation, leaders, Concerns-Based Adoption Model, CBAM)

The hardest thing about technology is not selling them on it.
It is getting them to use it!

— Phil H., district tech coordinator (reflecting on the importance of understanding that change is a process)

This quote summarizes much that is currently understood about the significance of technology as an innovation and the challenges entailed in the widespread presence of new forms and integrated uses of technology in today's schools and classrooms. Cuban's (1986) thoughtful review of the history of the introduction of various technology innovations in education is an important reminder that developing a new form or process does not guarantee that it will be widely used. The continuing challenge with technology innovations is to move beyond their early adoption by technology enthusiasts and scale up to widespread use.

An exciting array of technology resources is available to today's teachers and classrooms. Most classrooms have access to laptops for students and teachers, document projectors, digital photos and video, interactive whiteboards, sound systems, and the Web. However, how each is used and the extent of use by teachers and students varies dramatically. For example, in many classrooms, use of the interactive whiteboard is limited to projection of teacher-generated information, and PCs are used only for remediation or free time. In other classrooms, there is true integration of the available technologies and extended applications. The whiteboard is regularly connected to the Web. Students create their own video productions and develop digital portfolios.

There is also a gap between students' use of technology outside the classroom (e.g., texting, MP3 players, and social networking) and what they do in the classroom (e.g., printing documents). Many promising technologies are widely available, but the Achilles heel is a lack of understanding about what is involved in helping teachers to fully implement and integrate their uses.

This challenge takes place at the nexus of technology innovation development and the dynamics of personal and organizational change. Development of a promising technology does not guarantee that it will achieve widespread use. Teachers will vary in their interest in adopting a new approach and in their competence to use it. This is where constructs and tools from change process research can be instructive. The extent and quality of use of new approaches can be greatly enhanced when there is understanding of how people change. Regardless of the potential power of a technology, until it is used and used well, the promised outcomes will not be attained.

This paper begins with the assumption that various technology innovations have been developed and that there is interest in achieving widespread and appropriate use. The constructs introduced herein also can be used to evaluate impact and determine the necessary actions for going to scale. The article will also introduce research-verified constructs and measures, along with related findings, to illustrate how the dual challenges of evaluating an innovation's impact on outcomes and achieving its widespread use. The concluding discussion draws implications for research, evaluation, and facilitation of implementation.

Four Simple Questions

Regardless of the potential promise of any technology innovation, specialized effort is needed to assure widespread and effective use. An important beginning point is accepting as fact that different implementers are not likely to use the technology exactly as the developer envisioned. Exact replication from classroom to classroom is highly unlikely. Therefore, as an innovation is disseminated, each prospective user should ask four simple questions:

1. Is it being used?
2. How well is it being used?
3. What factors are affecting its use/nonuse?
4. What are the outcomes?

As obvious as each of these questions may seem, they really are too simplistic. For example, one of the well-established perspectives for understanding change is Diffusion of Innovation Model (Rogers, 2003). In this perspective everyone does not "adopt" the innovation at the same time. Some are quick to try the new way, whereas others deliberate and delay. In one set of classic diffusion studies, researchers examined characteristics of farmers and their decision to purchase hybrid corn seed instead of planting seed they had stored from last year's crop (Ryan & Gross, 1943). Some were quick to try the new way, but others waited to see how the new way worked out. The researchers identified a set of characteristics that distinguished those who were first to adopt a new approach from those who took longer. Five adopter categories were identified ranging from Innovators, to Early Adopters, to Laggards. To have all adopter categories in this study make the change—in other words, to achieve widespread use of hybrid corn seed—took years.

The decision to use a particular technology innovation in schools is more complicated. First of all, the decision to adopt most technology innovations is made by administrators, not teachers. Second, becoming skilled in using a new form of technology takes time. In addition, whereas planting hybrid corn seed requires no new machinery or procedures, most new applications of technology are more complex and may require new infrastructure, such as greater memory or bandwidth. Also, most of the time teachers will benefit from training in how to use the new technology.

Another important difference between agricultural settings and schools has to do with what it means to be a user. In agriculture, where the Diffusion of Innovation Model bloomed, farmers either "adopted" hybrid corn seed or planted the seed they saved from last year. Determining who was using the innovation was straightforward. Adoption of the innovation was dichotomous; it was used or it was not used. In contrast, teachers and schools becoming high-quality users of technology innovations is a process, not an event. In other words, teachers and schools are not non-users of a particular technology one day and expert users the next day. There is a gradual process of trial and error as each implementer learns how to use the new tool, process, or function.

Unfortunately, too many research and evaluation efforts implicitly assume the agricultural type of dichotomy of use/non-use. For example, the Gold Standard research design requires random assignment of subjects to treatment and control groups. Most program evaluation studies assign teachers or schools to program and comparison groups. The assumption in the assignments is that one group uses the innovation and the other does not. This is a misleading view of how change works on the ground. It is much more complicated for teachers and schools to accomplish high levels of implementation, and rarely are the comparison/control groups pure. An implication of this phenomenon is that conclusions about the effects of the innovation are suspect when researchers/evaluators haven't defined and verified that implementation occurred in the experimental group and is not present in the control group.

Another of the change perspectives, the Concerns Based Adoption Model (CBAM) (Hall & Hord, 2011), addresses the messiness of real-world

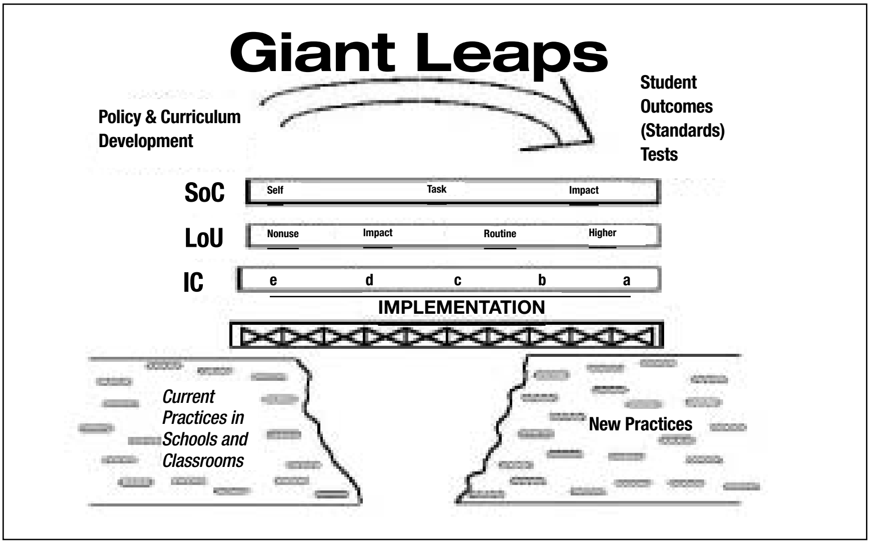

Figure 1. The Implementation Bridge.

implementation. The CBAM offers several research-based constructs and tools that can be used to understand, facilitate, and evaluate the more complex efforts entailed with introducing technology innovations in classrooms and schools. An important beginning point with the CBAM perspective is the assumption that change is a process, not an event (Hall, Wallace & Dossett, 1973; Hall & Hord, in press). Rather than assuming use is dichotomous (use/nonuse), in this perspective becoming a competent and confident innovation user is a developmental phenomenon that takes time. Four of the CBAM constructs that address this complexity will be introduced below, but first a metaphor.

The Implementation Bridge

As emphasized above, an important consideration about changes in education is appreciating the complexity, sophistication, and subtlety of most of today's innovations. For most innovations, change should not be considered in terms of adoptions. Instead change needs to be thought about as a process of implementation. For example, technology experts may easily pick up and use a new device or application, but for the typical teacher or school, implementing the new way may not be easy. Integrating the uses of several technologies and applications in the milieu of the classroom is even more complicated and challenging.

There is often insufficient appreciation of how complex the implementation processes can be. This is the metaphorical equivalent of asking implementers to back up, take a running start, and attempt to leap across the chasm from past practice to full use of a new way. That chasm can be deep, and the distance from one side to the other can be very long. To help illustrate these realities of a change process, in 1999 the author introduced the metaphor of an "implementation bridge" (see Figure 1). The challenge of accomplishing sustained and widespread integrated uses of technology is the metaphorical equivalent of providing a bridge to facilitate teachers and schools progressing across a bridge. Instead of expecting teachers and schools to make giant leaps across the chasm, providing an implementation bridge will result in more frequent and higher-quality use.

The implementation bridge metaphor addresses another important component: outcomes. The explicit assumption with most innovations is that if they are used properly, there will be higher outcomes (i.e.., increases in student learning). When the perspective of an implementation bridge is employed, outcomes can be expected to vary with how far across the bridge each implementer has progressed. In theory, those that are farther across the bridge should have higher outcomes. This hypothesis has been found to be true in some studies (see, for example, George, Hall, & Uchiyama, 2000).

Four Refined Questions

When change is accepted as a process requiring the equivalent of an implementation bridge, and technology innovations are considered complex, the four simple questions introduced above can be refined and made more nuanced:

1. How can the change process be facilitated to achieve high levels of implementation in classrooms and across a school?
2. What factors and approaches can be applied for achieving widespread use?
3. What is the extent of implementation with each individual and school?
4. How do outcomes vary with extent of implementation?

The remainder of this paper will introduce constructs, measures, and research findings from studies of implementation and use them to describe and illustrate ways to address each of these questions.

Three Diagnostic Dimensions for Assessing and Facilitating Implementation

The three rows on top of the implementation bridge in Figure 1 represent the three Diagnostic Dimensions of the Concerns Based Adoption Model (Hall & Hord, 2011). Each has an extensive history of research and evaluation applications. Each construct can also be used by researchers, evaluators, leaders, and implementers. This means that the same construct and its data can do double duty: It can be used to document the current extent of implementation and as diagnostic information for planning interventions to further facilitate implementation. In other words, the researcher/evaluator can use information from each dimension to measure how far across the bridge each implementer has progressed. Change facilitators can also use the same constructs and information for planning and making interventions to help implementers move further across the bridge.

Table 1. Levels of Use (LoU) of the Innovation: Indicators

	Use
VI Renewal	The user is seeking more effective alternatives to the established use of the innovation.
V Integration	The user is making deliberate efforts to coordinate with others in using the innovation.
IVB Refinement	The user is making changes to increase outcomes.
IVA Routine	The user is making few or no changes and has an established pattern of use.
III Mechanical Use	The user is using the innovation in a poorly coordinated manner and is making user-oriented changes.
	Nonuse
II Preparation	The person is preparing to use the innovation for the first time.
I Orientation	The person is seeking out information about the innovation.
0 Nonuse	No action is being taken with respect to the innovation.

Hall & Hord (2011)

Use and Nonuse: Using an Innovation is not Dichotomous

Levels of Use

As noted above, learning to use technology innovations, as well as most other education and business innovations, is not as simple as is assumed in the various "yes/no" change-is-an-event perspectives. Rather than being dichotomous (use or nonuse), change process researchers have established that there are different Levels of Use (see Table 1). Levels of Use (LoU) describe eight operationally defined behavioral profiles. There are three ways of being a nonuser of an innovation and five behavioral profiles of users. The established method for measuring Levels of Use is a focused interview protocol that has been research verified and applied in many studies (Hall & Loucks, 1977; Hall, Dirksen, & George, 2006).

The Levels of Use can be used to describe the current state of each implementer. The LoU assessment information can be used diagnostically in making interventions that help the teacher(s) move to a more advanced level of use. For example, the person at Nonuse (LoU 0) is not doing anything in relation to the innovation. Even if they are expected to be using it, they are taking no innovation-related actions. Interventions aimed at this LoU would be intended to move them toward engagement with learning about use (LoU I: Orientation), whereas persons at Orientation (LoU I) are looking for information about the innovation. They have not decided to use it, which would place them at Preparation (LoU II). They may be talking with others or searching for information online, but they still are nonusers. This is a time to provide descriptive information about the innovation and encouragement to consider its use.

Most first-time users of an innovation will be at Mechanical Use (LoU III). Their behaviors are related to organizing/scheduling and attempting to make everything work smoothly. The primary focus is on just making it work. Teachers at Mechanical Use with implementing technology are struggling with management acts such as distributing devices, continually referring to the user manuals to see which icon on the toolbar will do what they want to do, and grouping students to maximize efficiencies. Even tech experts can return to mechanical use when the new technology/application is less familiar or poorly documented. Although it might be expected that in the second year of use most would move beyond Mechanical Use, this is not what longitudinal studies have found. Many teachers in the second and even third year of implementation will still be at Mechanical Use.

To achieve continued use of an innovation, it is best for teachers to move beyond Mechanical Use. The Routine Use (LoU IVA) level users have repeatable procedures in place and can predict where they will be next week and beyond. Some will move to one of the higher Levels of Use by making adaptations in their use with the intention of increasing outcomes. The typical time period for teachers in a school to move from Nonuse to Routine Use and higher is three to five years, if not longer (see for examples: Hall & Loucks, 1977; Hall & Hord, 2011; Thornton, E., & West, 1999). Of course, the amount of time it takes dependa on a number of factors, such as the size of the innovation, the amount of implementation support, and what other changes are being implemented at the same time.

Levels of Use is one way to describe and measure the extent to which each implementer has moved across the implementation bridge. With technology innovations, each of these levels is easily imagined. For example, some teachers do not look at what is new or could be done differently (LoU 0: Nonuse). Other teachers explore what a new application could do, but they do not decide to use it at this time (LoU I: Orientation). LoU III Mechanical users consume a great deal of tech support attention and time. These are the implementers who call the technology coordinator daily seeking help with finding certain subroutines because they can't find the right icon or forget that you need to right click for certain functions (LoU III: Mechanical Use). Of course, the ideal users are the two teachers at LoU V: Integration. They are the ones who have been using interactive whiteboards individually and now decide to work together to integrate their use and combine their students to achieve higher student outcomes (LoU V: Integration).

Assessing Extent of Implementation with LoU

Another application of Levels of Use is in evaluation and research studies. Levels of Use can be used to document how far across the bridge each implementer has progressed. This information about extent of implementation can be related to student outcomes and other factors such as the change leadership style of the principal.

An important methodological implication of LoU has to do with the assignment of teachers/schools to so-named treatment and control groups.

The long-established practice of random assignments does not make the two groups pure. The researcher/evaluator needs to carefully check at the individual level in both groups to be certain that there are no nonusers in the treatment group and no users in the control group. Otherwise, it is very likely that both groups will in fact be composed of a mix of users and nonusers. Without documentation of the purity of each study group, doubts should be raised about conclusions that may be drawn about the effects of the innovation. For example, in one school district program evaluation with 11 project schools and 11 comparison schools, the evaluators concluded that there were no significant differences in student test scores. When LoU was measured, it turned out that both groups were made up of users and nonusers. Only 80% of the teachers in the project schools were using the innovation, whereas 49% of the teachers in the comparison schools were users (Hall & Loucks, 1977). No wonder the school district evaluators concluded that there were no significant differences between the two schools.

Levels of Use and Student Outcomes

Addressing the fourth refined question, examining relationships between extent of implementation and student learning, is more work. The Level of Use of each implementer has to be measured and then related to one or more measures of student outcomes. To have representation of most levels usually requires longitudinal study designs and several years of effort. An informative example of this type of a study is one that examined constructivist teaching of mathematics. This innovation represented a paradigm change from teacher-led instruction to teacher-as-facilitator of student construction of understanding. For example, instead of accepting a single teacher-taught way of calculating, teachers were to encourage students to use different approaches. In one school district, LoU was assessed each of the first two years of implementation. This particular district-wide implementation project had strong leadership from the superintendent and three master teachers assigned to facilitate implementation (Johnson, 2000). Level of Use of over 100 teachers was measured each year.

In this study, the relationships between student outcomes and how far across the bridge teachers had progressed was nearly linear. The highest outcomes were found with two teachers at LoU V Integration. This LoU is where two or more implementers are working together to make changes in their efforts to increase student outcomes. The lowest level of student outcomes was associated with teachers at Mechanical Use (LoU III). Teachers at Routine Use (LoU IVA) had slightly higher outcomes than the teachers at Refinement (LoU IVB) (George, Hall, & Uchiyama, 2000).

A Further Implication of LoU for Facilitating Implementation

The first of the four refined questions in this paper asks what can be done to facilitate further implementation. Leaders of change efforts can use Levels of Use as a diagnostic tool. The same information that is collected to address research/evaluation questions can inform change facilitation. For example, in the above-referenced mathematics study, 20+% of the teachers remained at Mechanical Use (LoU III) at the end of two years. This information as a diagnostic would suggest that these teachers need individually targeted, purposeful interventions to move them to higher Levels of Use.

Levels of Use are easy to envision with technology innovations. For example, Mechanical Use is all too frequently observed and talked about. This Level of Use can be observed, and experienced, with relatively simple technology changes, such as upgrades in e-mail as well as when complex system changes are introduced, as with an all new data management system. Depending on the complexity of the change and the amount of implementation facilitation support, the time period for Mechanical Use (the length of the implementation bridge) will be shorter or longer.

Fidelity of Implementation: More Important than Ever

Innovation Configurations

Another critical implementation question to address is how close the practices of each implementer match with the vision of the innovation's architect. A colleague, Ed Caffarella, tells the story of what happened on his campus when the school was first introducing PCs. The campus provost distributed PCs to 10 faculty members and encouraged them to explore ways to use them. Most did the expected things, such as word processing and computations. However, a faculty member in the art department took his PC apart and made a mobile! All 10 PCs were being used, but there was tremendous variation in how closely each application fit with what the manufacturer had envisioned.

In change process research, the construct that is used to address these variations in how an innovation is made operational is called Innovation Configurations (IC). Different configurations of an innovation can exist in different classrooms within a school and most certainly from school to school. When asked, each implementer is likely to say, "Oh yes, I am using XYZ technology." But what they are doing and which components of the innovation are being used can range from exact replications of what the developer had in mind to a practice that is unimaginable to the developer. This means that in practice there will likely be a very wide range of configurations under the umbrella of the innovation's name.

For example, in the K–12 environment, Donovan (2007) found that within one middle school in which a 1:1 laptop program was being implemented, there were three different implementation "models" or configurations. Interestingly, some teachers represented more than one model, highlighting the phenomenon that implementation of technology in schools may not only involve more than one configuration, but some implementers may use different configurations with different students.

Innovation Configuration Map for the Mathematics Program

3) Teacher Poses Mathematical Tasks/Investigations {poses, frequency, open0ended questions, language}

a	b	c	d	e
Teacher poses open-ended problem, highlights mathematical aspects and asks students to determine how to figure them out. Open-ended questions are used to pose problems, not only at the beginning but also throughout the lesson. Teacher uses mathematical language to present tasks/investigations.	Teacher identifies mathematical aspects of tasks/investigations and explains how to figure them out. Teacher directions are clear. Some mathematical language is used. Some open-ended questions are asked.	The teacher presents the activity with little or no explanation. Teacher uses little or no mathematical language. Some teacher directions are clear. Nearly all questions require one-word answers.	Teacher structures activity and directs students/activity. Questions requiring one-word answers are used to check for student understanding. Isolated use of math vocabulary.	Teacher presents/explains isolated concept or procedure and assigns individual student work. Questions requiring one-word answers are used to check for student understanding. Isolated use of math vocabulary.

Figure 2. Example Innovation Configuration Map Components. Component from IC map for Teaching and Learning Mathematics (Alquist & Hendrickson, 1999, p. 22).

In this time of high emphasis on use of "evidence-based" practices, fidelity considerations are more important than ever. If a technology has been verified to produce certain outcomes, then future implementers are going to expect to obtain the same outcomes. This requires two sets of information:

1. The developers must identify and provide information about what a high-fidelity implementation configuration of their innovation looks like.
2. Implementers must strive to put in place the high-fidelity configuration(s).

Innovation Configuration Mapping

The construct of IC is easy to imagine. Answering both questions requires a methodology for measuring fidelity of implementation. A generic method for assessing configurations has been developed. The approach uses the metaphor of a map. A map provides the information for getting from point A to point B. One may take an interstate highway, state highways, back roads, or maybe a train or a walking trail. An Innovation Configuration map is designed to describe the different ways that the various components of an innovation could be implemented (Hord, Stiegelbauer, Hall, & George, 2006).

Developing an IC map requires intensive study of all of the materials and resources associated with the innovation, interviewing the developer, and observing a range of sites. The field work needs to cover the range from ideal implementations to efforts that the developer judges to not be representative of the innovation.

All of the information is first used to identify key components of the innovation. To provide a simple example, consider student grouping to be a component. The next step is to identify different possible variations of

Student control of laptops during learning experiences (control, position, decision making)			
a	**b**	**c**	**e**
Laptops are centrally positioned and students share control in relatively equal proportions during learning experience. It is difficult to determine whose laptop it is. Students consult with each other on navigation and aesthetics of content.	Laptops are centrally positioned, yet it is apparent that one student is sharing with the others. Control of laptop is generally by one person, but consultation on navigation and aesthetics of content is evident.	Laptops are positioned in front of one individual but turned for others to see. Control is by one person, and others are observers.	No sharing of laptops. Students who do not have laptops use alternative learning tools.

Figure 3. IC map Component for One-to-One Laptop Program in the Middle School (Donovan & Green, 2009, n.p.).

the component. For example, students could work independently, in pairs, in small groups, or as a whole class. On an IC map, each variation is to be a "word picture" description of one way that component could be implemented.

The variations of a component are displayed as in a rubric, but with several important differences. Unlike in most rubrics, the ideal variation is labeled "a" and placed to the left-hand side. The remaining variations are laid out from left to right to reflect decreasing fidelity of that component and labeled accordingly: "b," "c," "d," etc. Another key difference from traditional rubrics is that the variations to the right-hand side don't just describe less of "a." These variations describe what has been implemented instead of what is described in the "a" variation. Figure 2 is an example component from the earlier referenced mathematics study. Figure 3 is a sample component from Donovan's IC Map of Student Uses of Laptops.

Innovation Configuration Findings

Once fully developed, an IC map can be used as a tool for assessing degree of implementation and as a diagnostic for planning further implementation of supporting interventions. In the typical study, collecting the data to complete an IC map requires a combination of classroom observations and teacher interviews. The IC map becomes the summary document for what has been observed and heard about regarding how the innovation is implemented. The circled variations for each component on an IC map will represent that teacher's configuration. The IC map information also can be summarized for all teachers by component to provide an overall picture of how far across the bridge implementation has progressed. For example, six teachers were using the "a" variation of Component 6, five were using the "c" variation, and two were using the "f" variation. Also, cluster analysis techniques can be applied for identifying which combination of components and variations are most typically implemented (Hord, Stiegelbauer, Hall, & George, 2006).

Donovan (2007) found multiple and vastly different configurations of laptop program implementation in one middle school. In one configuration, students were using laptops for authentic project-based learning, whereas in another, students were using the laptops for more limited purposes—word processing and as a calculator. This second configuration could lead people to believe the laptops were not a valuable investment. They certainly would appear to contribute to different student outcomes. It would be unfair to draw summative conclusions about student use of laptops without documenting the configurations implemented in each classroom.

Exploring relationships between Innovation Configurations and student outcomes can be done. Planning for this analysis is one of the structural reasons for having the ideal variation named "a." The number of variations may be different for different components, but if "a" always represents the ideal, then data analyses are easy to follow. With cluster analyses, it is possible to distribute the configurations from high to low fidelity. Those classrooms with more "a" variations represent higher fidelity, whereas those with more "e" and "f" variations represent low fidelity.

Keeping with the mathematics study example, it was found that those classrooms with higher-fidelity configurations were associated with higher student outcomes. This will not always be the case, but in this study there were significant advantages in terms of student outcomes when the innovation was used with fidelity (George, Hall, & Uchiyama, 2000).

In the case of the laptop program at the middle school, exploring relationships with outcomes was not an integral part of the study design, but during IC map development it became evident that a component of the IC map was student off-task behavior during technology-based lessons. When the relationship between student off-task behavior and individual configurations was explored more closely, Donovan (2007) was able to determine that increased access did not necessarily equate to increased technology-based off-task behavior. Of the three configurations, the "b" configuration, in which the students used the laptops relatively consistently, but not always for authentic learning tasks, had more frequency of student off-task behavior and a greater variety of off-task behaviors (e.g., Web surfing, e-mail, games) than the "c" configuration, in which students sporadically used the laptops, and the "a" configuration, in which students used the laptops for the majority of their class time. Oddly enough, this highlights the relationship between fidelity of technology implementation and desired outcomes, but only when we look at all three configurations.

Implications of IC for Facilitating Implementation

One of the important uses of IC maps is to make them available to the implementers. All too often, teachers are provided with abstract descriptions of what the innovation should look like when it is used with fidelity. Developers are much more effective at describing the innovation's philosophy, outcomes, and implementation requirements than what it looks like on the ground. An IC map presents clear descriptions, component by component, of what use of the innovation can look like. An IC map also is useful to the change facilitators, coaches, and principals, who are supposed to know what to look for when they are observing the innovation in use.

Table 2. Stages of Concern (SoC) about the Innovation (George, Hall, & Stiegelbauer, 2006; Hall & Hord, 2011).

6 Refocusing	The focus is on the exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.
5 Collaboration	The focus is on coordination and cooperation with others regarding use of the innovation.
4 Consequence	Attention focuses on impact of the innovation on students in his/her immediate sphere of influence.
3 Management	Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
2 Personal	Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
1 Informational	A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. She/he is interested in substantive aspects of the innovation, such as general characteristics, effects, and requirements for use, in a selfless manner.
0 Unconcerned	Little concern about or involvement with the innovation is indicated.

The Personal Side of Change: Feelings and Perceptions Count

The third diagnostic dimension for understanding implementation addresses the affective part. The people who are engaged with getting across the implementation bridge experience feelings, perceptions, frustrations, and moments of joy. The emotional part of change often is neglected, with resulting arousal of unnecessary resistance to the innovation.

Stages of Concern

The construct for describing the affective part of change is called Stages of Concern about the Innovation. There is a long history of research and application of this construct and its measures. Many of the studies have been done with technology innovations. Four basic areas of concern have been identified:

1. *Impact.* The focus is on how the innovation is affecting students and what can be done to increase outcomes.
2. *Task*. Time, logistics, schedules, and fitting everything in that must be done are of concern.
3. *Self*. Personal feelings of uncertainty, whether one can succeed with this innovation, and whether the supervisor will support the efforts are central in thought.
4. *Unconcerned*. Other things are of more concern at this time than the innovation.

These four areas of concern have been further divided, as summarized in Table 2 (p. 243). There are two parts to Self concerns, Stage 1: Informational and Stage 2: Personal. Three distinct parts to Impact concerns have been identified, Stage 4: Consequence, Stage 5: Collaboration, and Stage 6: Refocusing. At any time, each implementer will have some combination of these concerns, with some being more intense and others not being intense at all.

Stages of Concern Findings

There is a long history of study around Stages of Concern (SoC) beginning with the pioneering studies of teacher education students by Frances Fuller (1969). One theme across the studies is that, if there is appropriate change support and time (three to five years), there will be progression across the different SoC. In other words, as implementers move across the implementation bridge, their concerns will progress from Unconcerned, to Self, to Task, and ultimately to Impact. However, there is no guarantee that this will happen (Hall & Hord, in press).

For example, Donovan and Green (2009) found that even with offers for support, some of the teacher educators involved as faculty in a 1:1 laptop teacher certification program did not shift in their concerns at all, whereas others' concerns shifted from Self to Impact.

There are three ways to assess concerns. Change facilitators in the field can use an informal conversation called a One-Legged Interview. It doesn't take much time and is not threatening. A second way is the Open-Ended Concerns Statement (Newlove & Hall, 1976), which asks respondents in their own words to write their concerns. For research and evaluation purposes, the 35-item Stages of Concern Questionnaire (SoCQ) is available. A new form of the SoCQ (Form 075) has recently been established that has demonstrated reliability and validity. The scoring of the SoCQ provides a concerns profile that indicates the relative intensity of concern for each stage (George, Hall, & Stiegelbauer, 2006).

Implications of SoC for Facilitating Implementation

SoC is particularly relevant to the first of the four refined questions listed above. Interventions that facilitate implementation need to be concerns based. For example, responding to the old refrain of "computer fear" begins with understanding that Self concerns are high. Responses need to be more supportive of the person (Stage 2: Personal) and provide answers (Stage 1: Informational) to reduce the uncertainty. The time to offer how-to-do-it tips is when implementers are out on the bridge and Task concerns are high. This is not the time for a lecture on the philosophy of why the new way is better. A related intervention study by Dobbs (2004) using SoC documented the importance of training approaches for implementing distance education.

Table 3. Change Facilitator Styles (Hall & Hord, in press).

Initiators have clear, decisive, long-range policies and goals that transcend but include implementation of the current innovation. They tend to have very strong beliefs about what good schools and teaching should be like and work intensely to attain this vision. Decisions are made in relation to their goals for the school and in terms of what they believe to be best for students, which is based on current knowledge of classroom practice. Initiators have strong expectations for students, teachers, and themselves. They convey and monitor these expectations through frequent contacts with teachers and setting clear expectations of how the school is to operate and how teachers are to teach. When they feel it is in the best interest of their school, particularly the students, Initiators will seek changes in district programs or policies, or they will reinterpret them to suit the needs of the school. Initiators will be adamant but not unkind. They solicit input from staff and then make decisions in terms of the goals of the school, even if some are ruffled by their directness and high expectations.

Managers place heavy emphasis on organization and control of budgets, resources, and the correct applications of rules, procedures, and policies. They demonstrate responsive behaviors in addressing situations or people, and they initiate actions in support of change efforts. The variations in their behavior are based in the use of resources and procedures to control people and change processes. Initially new implementation efforts may be delayed if they see that their staff are already busy and that the innovation will require more funds, time, and/or new resources. Once implementation begins, Managers work without fanfare to provide basic support to facilitate teachersí use of the innovation. They keep teachers informed about decisions and are sensitive to excessive demands. When they learn that the central office wants something to happen in their school, they become very involved with their teachers in making it happen. Yet they do not typically initiate attempts to move beyond the basics of what is required.

Responders place heavy emphasis on perception checking and listening to people's concerns. They allow teachers and others the opportunity to take the lead with change efforts. They believe their primary role is to maintain a smoothly running school by being friendly and personal. They want their staff to be happy, get along with each other, and treat students well. They tend to see their school as already doing everything that is expected and not needing major changes. They view their teachers as strong professionals who are able to carry out their instructional role with little guidance. Responders emphasize the personal side of their relationships with teachers and others. They make decisions one at a time and based on input from their various discussions with individuals. Most are seen as friendly and always having time to talk.

Another Key Factor: Leadership Makes a Difference

The above descriptions have introduced briefly three research-based constructs and tools for measuring how far across the implementation bridge each implementer and/or group of implementers has progressed. The bridge metaphor and the three diagnostic dimensions offer ways to think about, study, and facilitate change processes. An important reminder is that, in evaluation and research studies, Levels of Use, Innovation Configurations, and Stages of Concern information needs to be determined for each implementer. Each individual in any comparison or control group also should be assessed. The individual assessments can be aggregated to view how groups are doing.

As important as each of the dimensions is individually and in combination, there is another factor that drives change success. The importance of attending to the fact that individual implementers are part of an organization and that there are organization factors that affect the rate, as well as whether or not implementers make it across the bridge, are too often neglected. Teachers are part of a school. Factors within the school can significantly affect implementation success.

Perhaps the most significant school-level factor affecting teacher implementation success is the leadership role the principal plays. Some principals provide strong leadership and support for teachers as they engage with implementation. Some principals closely attend to providing materials and other resources. Some cheerlead and leave the details to their teachers. Each approach represents a different style of leadership, and that style is highly correlated with teacher implementation success.

Three Change Facilitator Styles

Researchers have identified three different approaches to change leadership that principals may exhibit. These do not represent every possible style, but three that have been found frequently and studied in depth. The three Change Facilitator Styles (CFS) are called Initiators, Managers, and Responders (see Table 3, p. 245)). Principals of each style have been studied in several countries, including Australia (Schiller, 1991), Belgium (Vandenberge, 1988), the United States (Hall, Rutherford, Hord, & Hulling, 1984), and Taiwan (Shieh, 1996). Although only the Schiller study was done with technology, the same basic descriptions and approaches have been found to fit with many education innovations and settings. The consistent finding is that principal leadership is a critical factor related to implementation success.

Initiators have a strong set of ideas about what their school should be like and what it should become. They have a passion for the school, and they will push their teachers to do all that is needed. Managers focus on following the rules and controlling resources. They are skilled at working within the organization, getting the most out of budgets, and keeping everything well organized. Responders focus on listening to the concerns of their staff. They do not feel that they have to do everything themselves. They want everyone to be happy and to get along (Hall & Hord, in press).

Findings from Research

The reason for introducing Change Facilitator Styles (CFS) in this discussion is the consistent findings about the relationships between CFS and teacher implementation success. The findings are strong and consistent across innovations that depending on the CFS of the principal, teachers will have different degrees of success in implementing new programs. The U.S. studies have focused on curriculum innovations, the Australian study examined implementation of technology, the Belgian study was of restructuring primary schools, and the Taiwan study examined principals' interpretations and uses of external pressures and implementation of cooperative grouping.

The general pattern to the findings is that teachers in schools led by Initiators and Managers have the most implementation success. Teachers in Responder CFS schools have much less implementation success. The findings also trend toward the most implementation success in schools with Initiator CFS principals.

Implications of CFS for Facilitating Implementation

The first implication from the work with CFS is that, just as with students and teachers, there are individual differences in principal leadership. All principals do not facilitate implementation in the same way. If the findings from the CFS by teacher implementation success studies are accepted, then there are major implications for the provision of implementation support. Depending on the CFS of the principal, different types and intensities of facilitation will be needed.

An additional implication may be that careful consideration should be given to the selection of schools for alpha and beta field tests of new technologies and applications. Responder CFS leaders will welcome the effort but provide little direct support for implementation. Manager CFS leaders will organize the resources and schedules to support implementation, assuming they have enough lead time. If Initiator CFS leaders like what the innovation purports to achieve, they will strongly support its implementation. However, if they do not agree with the promise of the innovation, then they will make sure it is not implemented in their school.

Discussion, Implications and Recommendations for Education Technology Change

The guest editor for this issue of JRTE, Neal Strudler, suggested that in this paper I "piece together best work and current overview of [my] research on change and highlight some key points and implications for effective integration of technology. In other words, what educational technology advocates and researchers should know about their prospects for successful change" (Neal Strudler, e-mail communication, July, 2009). This is no easy task, especially when considering that full books are written about the constructs and studies highlighted herein.

As we know well, achieving change success is always a challenge, and even more so with technology. As Straub (2009) observed in a review of three adoption theories (Diffusion, Concerns-Based, and Technology Acceptance), adoption of technology is "complex, inherently social, [and] developmental" (p. 625). The research-based constructs introduced above represent key approaches to understanding the complexity, addressing the human aspect, and documenting the developmental nature of change processes.

Technology innovations add an additional complexity. Along with the usual issues and dynamics of change processes, technology innovations themselves keep evolving. Once developed and field tested, most innovations remain stable in terms of their ideal configuration. However, most technology innovations continue to evolve—in large and small ways. Sometimes it is a new device (e.g., a handheld or netbook), and other times it is an upgrade of a computer's operating system or new software version. Each time, the delicate balance of the classroom lesson plan can be upset as a teacher tries to anticipate how to teach a math lesson on the new version of Excel, or instruct students on saving to a network server rather than a disc. Over time they add creative adaptations and make refinements, and the time between changes becomes shorter and shorter. A consequence for researchers can be that the critical components of the alpha test configuration have been combined and supplemented in ways that emphasize different component by the time the epsilon version is ready for field testing.

This paper has introduced one metaphor (the implementation bridge) and four research-based constructs that address elements of change. Each of these provides conceptual and empirical foundations for drawing implications and recommendations to consider in achieving future successes with technology changes. Each also can contribute to explaining the limited extent of use and going-to-scale of past efforts.

The Implementation Bridge

The first assumption in our research has continued to be that change is a process, not an event. Many developers become such true believers of their innovation and the difference it can make that they start assuming that others will believe the same. The expectation is that everyone will automatically see the benefits and adopt the new way, thereby making change an event. An informative example of the consequences of maintaining this view was seen in the 1960s and 1970s with the national curriculum development projects. One of the stated themes was that each curriculum would be so up to date, so well evaluated, and so well packaged that it would be "teacher proof." The expectation was that teachers would not make adaptations to these well-developed programs. Unfortunately, teacher proof had a different meaning in practice; most teachers didn't use the new programs.

Although the implementation bridge is a reminder that change is a process, it also provides an image of implementers needing to progress across the bridge. Three constructs and related measures have been introduced here that can be used to assess how far across the bridge each implementer has progressed. The same information can be used as diagnostics to determine what interventions will assist each implementer making further progress.

An additional use of the metaphor is in thinking about implementation bridges having different lengths. Some implementation efforts are short, whereas others take years. Planning for change success should be different depending on the normative length of time required to achieve implementation success. Updating a familiar piece of software should be quick, whereas learning to use a new operating system will take more time. Using one browser may be very much like another, but using a course management system or science simulation may prove more difficult. The ultimate goal of having integrated uses of technology by teachers and their students requires a longer bridge.

Levels of Use

Use of an innovation is not a dichotomous, yes/no phenomenon. The long-used, tried-and-true two-group research design does not make sense with human-use practices and innovations. The Levels of Use construct provides operational definitions of three distinguishable ways that an individual or group can be a nonuser and five ways an individual or group can be users. The traditional research design does not differentiate these different levels and simply views treatment (LoU 0, I, and II) and comparison groups (LoU III–VI) as pure—a fatal flaw.

For example, one unacknowledged danger of the two-group study design is the possibility that many/most/all of the members of the treatment group will be first-time implementers. Change process studies consistently document that most first-time users of an innovation will be at LoU III: Mechanical Use. By definition, there is a disjointedness to their use, short-term thinking, and inefficiencies. There should be no surprise to finding no significant differences between groups when treatment/control studies are conducted with first-time implementers. Early implementers are engaged in trying to learn how to use the innovation. More surprising is that, in many of these studies, the comparison group doesn't achieve more than the new way. Summative evaluations and treatment studies should be done with implementers that are beyond LoU III.

There also are implications of LoU for facilitating change. For example, if a technology change has a number of parts, many routines, and complicated steps to its use, then it is easy to predict that implementers will spend more time at LoU III: Mechanical Use. The timeline for facilitating implementation should anticipate this, and the plan should include resources, such as technology specialists assigned for support, to address and resolve the various mechanical-use problems that are likely to occur. The implementation game plan should also be in place for sufficient time so that most implementers can attain at least LoU IVA: Routine Use. Otherwise, sustainability is not likely to be achieved.

Innovation Configurations

It is likely that a range of configurations will be found in practice with most technology changes. In many instances, adaptation and innovative uses are encouraged. However, having more variation in configurations becomes a problem when there is a need to document results. Unless a particular configuration(s) associated with higher outcomes can be described, future implementers will not know which components and practices really are most critical to success. And innovations will receive credit for successes and failures that may not be deserved. For these reasons, developers should describe their ideal configurations clearly and in operational terms. Otherwise, it may have the same name and pieces, but the configurations that are implemented in different settings can range from high fidelity to drastic mutations of what the developer envisioned.

This is particularly important as more schools and colleges of education invest in more technology (i.e., interactive whiteboards, handheld devices, laptop computers) that could be costly investments without clear understanding of all implementation configurations. For example, in Donovan's IC map of the laptop program, if you focused only on the "c" configuration, you would not want to expand the program. However, focusing on "a" and "b" configurations presents a more optimistic picture of how laptops can be used in the classroom.

Stages of Concern

Failing to appreciate the importance of the personal side of change is problematic. Many of the most promising innovations have been lost or have taken a very long time to go to scale because leaders have failed to attend to the feelings and perceptions of the implementers. Simply saying, "You should use this because it is good for students," will not win over those teachers with Self or Task concerns. Stages of Concern provide a construct and measures for understanding the personal side of change from beginning to end of a change process.

The dynamics of concerns are especially useful for those with responsibility to facilitate implementation. For example, quite often what is seen as resistance to change is related to having intense Stage 2: Personal concerns. Reduction of high personal concerns requires being empathetic and providing information. However, a change process will go much more easily if personal concerns do not get high in the first place. This means anticipating the potential for the arousal of personal concerns and, early on in the change process, providing relevant information that addresses Stage 1: Informational concerns.

Change Facilitator Style

The fourth research-based construct introduced in this article, Change Facilitator Style, addresses the importance of administrator leadership. All too often, innovation advocates think only about the front-line implementers, teachers in classrooms. Administrators are addressed to obtain the adoption decision, then nearly all attention is devoted to installation, training, and support for the implementers. An important reality is that teachers are members of organizations, and leadership is a significant factor in their having change success. The research on principal CFS offers a framework for distinguishing different approaches to change leadership. The different CFS are significantly correlated with teacher implementation success (0.76 in the original study). Implementers with Responder CFS leaders have less change success. In most studies, implementers in schools led by Initiators have the most success.

Keep in mind that three CF Styles have other implications. For example, Responder leaders are most willing for new efforts to be introduced in their schools. They say, "Go ahead. We like trying new ideas in this school." However, their follow-through and support will be limited. Managers will ensure that there are sufficient resources and all rules and procedures are followed. They say, "My teachers are very busy. If you give me a grant or another position, then we can do it." Be sure to have clear budget proposals and detailed timelines. Initiators will check to see how well the proposed innovation aligns with his/her vision and directions for the school. They ask, "How will this fit with our priorities to increase students' higher-order learning?" Information about outcomes will be important with Initiators. With each style of principal, gaining entry requires addressing different questions, and achieving implementation success requires thinking beyond initial ease of access and providing different levels and types of implementation facilitation.

Consideration of the Ultimate Question: Increasing Outcomes

As important as "selling them" and "getting them to use" technology may be, the end goal is still to see improvements in outcomes. With changes in educational technology, the bottom line has to be determining what happens with student outcomes. An important purpose of this paper is to recommend careful attention to key implementation factors as part of examining outcomes. After all, unless the users have worked through the mechanical problems of use, implemented fidelity configurations, and reduced Self and Task concerns, any assessment of student effects will be misleading.

As a change process researcher, I regularly recommend a paradigm shift when it comes to selecting a research design. Pure treatment and control-group designs rarely, if ever, make sense in schools, or in other organizational settings, for that matter. At its most absurd, the "gold standard" research paradigm demands that one group of kids be taught and another group not be taught to read. In reality, all comparison groups will have some sort of practices in place that address the targeted student outcomes.

A more logical approach to research and evaluation studies is to compare higher to lower levels of implementation. In practice, this entails assessing how far across the bridge each implementer has moved and comparing outcomes each is obtaining. This is the approach used in the mathematics study referenced above (George, Hall & Uchiyama, 2000). In that study, higher-fidelity configurations and higher Levels of Use were associated with significantly higher student test scores.

If some sort of dichotomy needs to be included (because that is what the grant office expects), then compare those who have moved all the way across the bridge (LoU IVA and above) with those who have not stepped on the bridge (LoU 0, I, and II). If a good-quality IC map has been constructed, the right-hand component variations—the "d's," "e's," and "f's"—will represent traditional practices. (This is one of the ways that an IC map differs from typical rubrics.) Comparisons of outcomes can then be made between "a-b" configurations and "d-e" configurations. Either way, the implementation bridge offers a research design that is based in the realities of implementation.

In summary, at this time education technology scholars and practitioners are engaged with some of the most promising and interesting innovations. They also have been confronted first hand with the challenges associated with disappointing implementation efforts and failures to go to scale. In most instances, it appears to this author that the main causes of failure have not been the technology innovations, but rather that the failures have had more do to with underappreciating the challenges of implementation. The needs are so high for schools to improve student outcomes and the promises so powerful with integrated uses of technology that the challenges of implementation must be overcome. Besides, it will be very disappointing if today's efforts to have widespread integrated uses of technology fail and become just another chapter in Larry Cuban's next book.

Author Note

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