Using Lean in the Flipped Classroom for At Risk Students

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ABSTRACT
Schools are working to improve achievement through the examination of instructional practice and the use of instructional technology. This article provides informed commentary on the state of school reform and the need for continuous improvement, instructional improvement and instructional technology improvement. It also presents advocacy for the use of a continuous improvement system called lean as a toolkit for these improvement efforts. A discussion example of an at risk high school’s journey through continuous improvement and the use of a lean tool for analysis for improvement resulting in the innovative use of screen capture technology is shared to highlight one application of the lean framework presented.

Keywords
Lean, Flipped, School Improvement, Instructional Technology, Secondary Education

Introduction
The new millennium is well underway and demands are present for schools to meet the vision of relevance in the 21st century. For example, the Organisation for Economic Cooperation and Development (2008) describes the urgency for major changes to create consequence in schools. These include the need to emphasize lifelong learning and the learning process itself in order to prepare students for the knowledge economy, the need to personalize learning and use formative assessment as well as expanded information sources to prepare students for acceptable levels of global achievement, and the need for more professional collaboration networks to inform educators as to how to fully develop student potential. In addition, the Re-inventing Schools Coalition (n.d.) proposes a vision for relevance that includes self-directed learning and student empowerment, varied use of peer and teacher assessment, and student demonstrations of mastery as the basis for promotion. On a broader scale, Darling-Hammond (2010) advocates for policy reform that will alter schools to the point that “will enable students to learn how to learn, create, and invent the new world they are entering” (p. 3). Furthermore, the National Science Foundation (2008) calls for the use of cyberlearning to transform schools by providing students with “a mix of diverse content via the combined technological capabilities of the Internet, high performance computing, advanced networking, in-home electronics, and mobile communications” (p. 6). Certainly, these ideas are very exciting for the future of schools.

This article presents an informed commentary on the state of 21st century vision for schools. A broad overview of the need for school reform and the use of continuous improvement as a conceptual tool to drive instructional improvement is presented first. This is followed by a discussion of the potential of instructional technology as a tool for change. In addition, a brief presentation of a relatively new body of knowledge and practice for education known as lean is provided along with a description of how a demonstration site, an at risk high school, benefitted from lean analysis to highlight where to improve instruction through screencast technology (Green, 2011a).

The need for school reform and continuous improvement
Understanding what it means for schools to be consequentially significant in this century and further determining how to convert an educational system to such a state is a part of reform work that has occurred in the past two decades under programs such as Comprehensive School Reform (Borman, Hewes, Overman & Brown, 2003), the Coalition Campus Schools (Darling-Hammond, Ancess & Wichterle-Ort, 2002), and the Race to the Top Program (United States Department of Education, 2009). In addition, the National Education Technology Plan (United States Department of Education, 2010) is working to prompt needed change by asking education leaders “to enact revolutionary change; technology-based learning and assessment; engaging and powerful learning content; interactive, collaborative, visual and dynamic lessons…to be more relevant to life and work goals” (online). In this literature, there is advocacy to rapidly advance the bearing of instructional technology for the next century as
improvement work. While the need for school reform is widely recognized and practiced, the journey into the creation and sustaining of change is an area that schools struggle with even though there is shared concern in the educational community. The ability to understand how to implement and maintain change is hard. As Horsley and Kaser (1999) indicated, educational change has a low success rate for longevity and success. Saranson (1990) provided blunt commentary as to why this is so as he points out the self-sustaining nature of schools, based on long-established power systems and long-standing traditions as a countervailing force that, “…almost automatically rules out options for change” (p. 35). Furthermore, reform initiatives have fallen short of touted goals, producing confusion and disheartening key stakeholders. There are, therefore, gaps that are being recognized that exist between the hopes of school reform and the ability to engage in improvement (Dykema, 2002). Continuous improvement as best practice for change navigation in school is well established as a sustainable method of adding value to instruction (Schmoker, 1996). The concept of continuous improvement may well be the key to help schools bridge the divide between desired goals and current reality.

Continuous improvement requires a shared commitment to change. This dynamic is not difficult for schools to establish per se. But, where schools encounter difficulty is with the actual process of continuous improvement and how to do it. The use of continuous improvement is not easy and the issues of achieving school reform through continuous improvement are complicated with many variables and factors as Fullan (2001) described, “The big problems of the day are complex, rife with paradoxes and dilemmas” (p. 2). In an effort to better understand what educational theorists are recommending regarding continuous improvement, two specific factors of interest are examined next, instructional practice and instructional technology improvement.

**Instructional practice and continuous improvement**

In terms of instructional practice improvement, Elmore (2003) provided a description of what continuous improvement is like in a school, as a process of cultural alignment of “norms and values” that impact instructional practice. This description brings up an important concept regarding instructional practice improvement. That is, that whether examined on a micro level, for one student, or on macro level, across a school, improvement hinges on a theoretical commitment to learning as a process of continuous improvement. The theories of organizational learning also help to identify the need for both personal/professional mastery as well as organizational attainment via the process of continuous improvement (Argyris & Schon, 1996; Senge, 1990).

Translating continuous improvement on an organizational level to impact instruction requires the willingness to critically examine reality against theoretical ideals. For example, an examination of instructional practice reveals potential misalignment with educational assessment best practice versus with what is in use, for instance. Unfortunately, instructional practice norms and values tend to rely on the more efficient, exclusively cold cognitive model, which is conducive to high stakes testing. Ferrero (2005) described this shortfall of only measuring cognitive development only in this way as,

> We know, for example, that the mind constructs knowledge—that people learn by connecting new information to existing understandings and conceptual frameworks. We know that teaching needs to attend to both basic and higher-order skills, and to both cognitive and non-cognitive development. (p. 6)

So, while instructional reform is called for universally (White, 1997), it requires an organizational change process like Elmore (2003) provided, which allows for the realignment of norms and values that will improve instruction (Berry, 2011).

Therefore, in the case of any educational practice shortfall, it becomes evident that organizational change process theory is required for continuous improvement so that realignment can occur. For instance, the description that Schmoker (2006) provided depicts a clear picture of the organizational process of teachers implementing new instructional practice by using continuous improvement to better that practice and doing so under the norms of what “authentic literacy” (p. 51) learning entails with emphasis on both content mastery and high level analytical skill. The need to engage in continuous improvement regarding instructional practice is evident in regard to norms and values alignment around the process of learning itself, along with cognitive development and the increased use of
formative assessment. In other words, this work of aligning dispositions and instructional practice to theorists’ work defines what continuous improvement is.

Schools are interested in continuous improvement as both a cultural and structural solution to increasing student achievement. As Schmoker (2006) explained, continuous improvement is not an event, but a collaborative and transparent process of meeting regularly, piloting ideas, refining them, and finally publishing them while training people to implement them (DuFour & Eaker, 1998). Smylie (2010) reinforced this as well and outlines how highly regarded continuous improvement is as both organizational principle and practice.

Resnick (2010) indicated schools must be aware of instructional tools and resources at all levels (from district policy to classroom practice) along with good social capital management for instructional reform to occur. She clarified that this has not been done widely in schools and that there is a gap between the shared commitment to school improvement and the ability to implement. Resnick (2010) stated, “attempts to design education organizations and test those designs empirically in a continuous cycle of improvement are still rare” (p. 195). There is no formula for continuous improvement to be undertaken by school leaders. Elmore (2006) explained:

One does not ‘control’ school improvement processes so much as one guides them and provides direction for them, since most of the knowledge required for improvement must inevitably reside in the people who deliver instruction not in the people who manage them. (p. 58)

Continuous improvement as leadership practice is not unspecified, however. The work of Marzano, Waters, and McNulty (2005) highlighted as principle-based findings which leadership behaviors are helpful to second order change agency and which are not. Again, though, they are careful to explain that they are not presenting a prescriptive approach to continuous improvement or second order change. Blankstein (2010) endorsed this conceptualization by describing continuous improvement as careful, thoughtful and organic work fostered by collective reflection, collaborative work and leadership development.

The school example described later will focus on how continuous improvement has changed the traditional use of time on task for instruction and created new opportunities for focusing on the process of learning and summative assessment work. This was operationalized through the use of screencast technology as instructional technology improvement. Before the example is presented, the need for continuous improvement in instructional technology is described next.

**Instructional technology and continuous improvement**

Central to the vision of the 21st century school is the use of instructional technology. As Daggett and McNulty (2005) stated, “More extensive scientific and technological advances will occur in the next few years than have happened in the last two centuries. Dealing with these advances requires a different education system from the one in which we were educated.” (p. 12). Others envision instructional technology use in ways that provide multiple learning options for students, such as Collins and Halverson (2009) described as, “the new seeds of an education system forming in the rapid growth of learning alternatives, such as home schooling, learning centers, workplace learning, and distance education.” (p. 3). This prediction, if actualized, will surely force an improvement response from the current education system. Furthermore, the National Education Technology Plan (U.S. Department of Education, 2010) set out a vision to use instructional technology as a tool-enabled approach to reform education.

Unfortunately, to date, instructional technology implementation in schools has a scattered record. Zhao and Frank (2003) described the situation as confounding.

Concerns about the slow adoption of technology by teachers are not new. The phenomenon has been studied from different angles from case studies (Cuban, 2001; Shofield, 1995; Zhao et al., 2002) to historical analysis (Cuban, 1996), to large surveys (Becker, 2000a, 2001) (p. 808).

Zhao and Frank (2003) analyzed why this has occurred and indicate how to correct this shortfall by concluding that schools should be viewed as systems and that instructional technology implementation should be properly placed taxonomically within that system as a source of organic organizational growth or continuous improvement. This conceptualization of technology implementation is contrasted with the notion that technology use can be mandated,
funded or supported as an external and disruptive force to an existing system. In other words, their research posited that technology implementation is most effective when implemented as continuous improvement.

To further understand what the 21st century school looks like in regard to instructional technology, Morris and Hiebert (2011) described the need for “shared, changeable knowledge products” that solve common instructional problems by gradual improvement from multiple and accessible sources. The National Science Foundation (2008) encouraged the development of instructional technology under the broader category of cyberlearning, “Cyberlearning has tremendous potential right now because we have powerful new technologies, increased understanding of learning and instruction, and widespread demand for solutions to educational problems” (p. 5). The ability of schools to empower students to navigate learning pathways, make instructional choices, and receive assessment feedback; to enable teachers to facilitate that process of learning with student data management systems and differentiated instruction; and to provide schools with collaboration networks under enterprise architecture is currently under development (Hillberg, Flumerfelt, VanTil & Tierney, 2011). The National Science Foundation (2008) confirmed the importance of moving to whole scale reform in regard to instructional technology as, “Learning support systems can and will be organized along very different schemes than they are today, given the computational services made possible with cyberinfrastructure advances.” (p. 37). It is evident that the future of schools is hopeful in regard to the use of instructional technology as continuous improvement occurs in this area.

The next section provides a brief introduction to lean, a philosophy and method useful when engaging in continuous improvement. A lean tool, the value stream map, is demonstrated as a visual management tool for navigating continuous improvement for the demonstration site presented later that utilized screen capture technology.

The application of lean for continuous improvement in schools

The body of knowledge and practice known as lean is widely regarded in various sectors as best practice for continuous improvement (Robson, 1991; Slater, 2007). Because of this, lean is gaining interest in the educational sector as a useful organizational philosophy and administrative toolkit bundle (Stecher & Kirby, 2004; Barney & Kirby, 2004; Zivkosky & Zivkosky, 2007; Magua, 200; McMahon, 2006; Pawley Lean Institute Website, 2011a; Balzer, 2010). Lean is defined as an approach that requires the commitment of the technical, social and human capital of an organization to continuous improvement for the purpose of identifying distinct ways to create value as determined by the customer and to eliminate waste based on thoughtful examination of its root causes (Womack, Jones & Roos, 1990). Bhasin and Burcher (2005) were clear that to be successful, lean must first be philosophically and culturally framed and then operationalized. They stated, “While lean is concerned about reducing waste, it is also about changing corporate culture” (p. 58) and specify continuous improvement as one of twelve organizational practices for lean manufacturing.

A landmark study conducted in 1988 with a $5 million grant examined best practice from the international automotive factory floor and named that body of knowledge lean (Womack, Jones & Roos, 1991). With a long history of development, originating with the production of goods and lasting over centuries, the term lean is fairly new, but it represents centuries of thinking and tools that advance performance, referred to by Womack (Lean Enterprise Institute, 2010) as “waves of improvement” (online video). Lean is an organizational philosophy and operating system heavily embedded in the total quality work of W. Edwards Deming (Dennis, 2006) and the continuous improvement cycle of Shewhart (1980), the Plan-Do-Check-Act cycle which Deming popularized. Further, Emiliani (2008) emphasized that lean uses two weighted principals; the lighter one being continuous improvement and the weightier one being respect for people. Ransom (2007) in a Lean Enterprise Institute resource testified that lean culture and continuous improvement in turn produces desirable bottom line results as well, “Essentially, it [lean implementation] is a virtuous circle. I would stipulate that the adoption of a lean culture will improve financial performance.” (Slide 2). The most sophisticated lean enterprises have embraced the practice of enacting lean so that it moves from continuous improvement of internal operations to the full stakeholder chain (Burton & Boeder, 2003). In all, lean results in three aims, stakeholder engagement in continuous improvement, stakeholder application of improved paradigms and processes, and organizational respect for empowered stakeholders in the continuous improvement process (Liker & Hoseus, 2008).

To understand the application of lean to assist continuous improvement efforts, there needs to be recognition of the differences between businesses and schools between the structural and resource goals in private versus public
organizations. Furthermore, lean application requires careful translation through contextualization of best practice from one sector to another. Collins’ (2005) view is helpful in this regard as he stated, “In business, money is both an input (a resource for achieving greatness) and an output (a measure of greatness). In the social sectors, money is only an input, and not a measure of greatness” (p. 5). Lean is a business concept, initially used to drive total quality management in production (Womack, Jones, Roos, 1991). It has been and continues to be translated with for K-20 education under initiatives such as Lean Thinking for Schools™ (Pawley Lean Institute, 2011b) and Lean Engineering (Kahlen, Flumerfelt, Siriban-Manalang & Alves, 2011) among others. To date, lean currently is understood as an emerging, yet helpful philosophy and strategy for improvement in education (Lean Education Academic Network, 2011; Flumerfelt & Banachowski, 2011; Flumerfelt, 2011).

An example of lean, continuous improvement and instructional technology

In terms of specific uses of lean in schools to assist with continuous improvement, problems such as ineffective remediation, the lack of developmentally appropriate learning opportunities for students, and inadequate funding provide excellent opportunities for exploring lean thinking and applications. Consider, for example, the concerns expressed over standardized testing and what this means for culturally diverse populations. In terms of lean thinking, the basis for a successful lean enterprise is, in fact, founded on the utmost respect for all stakeholders, especially the employees and the customers, per Taiichi Ohno, the architect of the Toyota Production System, as described by Liker and Hoseus (2008). This means that lean organizations devote time and resources to understanding what is of value to those various stakeholders and then improving their systems to better meet those needs. For culturally diverse students, especially those at risk, our response in education has largely been of the mindset of remediation of students—“let’s fix these students!” Lean thinking is in opposition to remediation processes for students and supports in its place improvement of instructional processes. What is proposed in lean approaches is to fix the root cause of the problem in processes, rather than “fixing” people. Lean problem solving focuses on engaging people to identify process improvements and to create those solutions as a “Let’s fix the processes that do not work for these students!” approach. Lean does not use a one-way standardized formula derived from the top-down, but rather in-house solutions. So then, lean could be extremely helpful for students who suffer at the hands of the shortcomings of our current educational system. The tools of lean allow stakeholders to examine the educational system closely, develop collaborative solutions and participate in continuous improvement processes (Villareal, 2011; Brown, 2011). For the inequities in education that plague some of our students, lean is a viable process improvement approach to be considered.

Lean can be used by schools to examine processes for improvement ranging from the core technology of delivery of instruction to administrative support. For instance, value stream mapping (Keyte & Locher, 2004) is a lean tool that can be used to solicit the views of key stakeholders, such as students, teachers, parents, policy makers, administrators and boards, in regard to what is of value in the instructional delivery process. A student’s instructional day can be mapped out looking at allocations of time and resources for various activities. Based on the views of key stakeholders, decisions would be made as to what is of value during that instructional day and what is not. What is of value is kept and what is not is either improved so that it becomes valuable or it is eliminated.

Figure 1. Key elements for lean value stream map current state, kaizen, future state
Since value stream mapping is one lean tool that might be useful to facilitate continuous improvement of instructional delivery, an example is provided in Figures 1-4. Value stream mapping is illustrated a three step process of (1) visually mapping (Figure 1) an instructional process in its current state (Figure 2) through the eyes of the stakeholder, the student; (2) examining the map for ways to increase value to the student (known as kaizen) and indicating those on the current state map (Figure 3); (3) and finally improving the process from kaizen to create a future state map (Figure 4). Value stream maps examine each step in a process by assigning valued metrics throughout and identifying where improvements can be made. These maps are typically drawn right to left and use common icons, noted in Figure 1.

Figures 1-4 demonstrate how value stream mapping is used to understand what a high school with a growing at risk student population can do to improve instruction (TechSmith, 2011). The example in this article is not presented as a case study, but, rather, as a discussion example of what one high school did to improve instructional practice using continuous improvement and instructional technology. Figure 2 illustrates traditional instructional practice in one high school class (55 minutes) delivered to the at-risk student and how each activity in the class fares against five metrics, important to the at risk student. These five metrics are (1) the ratio of time allocated to task/relational activities, (2) the ratio of time allocated to passive/active learning, (3) the amount of time allocated to new learning opportunity, (4) the amount of time allocated to individualization, and (5) the amount of time allocated to
differentiation. For each class activity or process box, a metric box indicates the status of these five metrics. For each metric box, the results can be totaled and then compared to the ideal results in the key provided. If the actual results fall short of idea results, then possible points of improvement are identified, planned for, deployed, and reassessed, enacting continuous improvement.

Continuous improvement occurred at the demonstration site, the at-risk high school, around several points, as potential areas of improvement were highlighted by kaizen bursts (Figure 3). As each individual process step was examined, improvement options stemmed from the desire to deliver more value and based on achieving better metrics for the student for each step in the process. As indicated, the school decided to use instructional technology to “flip” (Bergman & Sams, 2011) the use of classroom time away from lecture to facilitation of individualized and differentiated instruction. This greatly impacted the metrics by enabling teachers to facilitate learning more during class time and to deliver content outside of class time. Furthermore, the use of learning management software to facilitate online facilitation and support was also identified, resulting again in improvement in classroom dynamics that lead to better metrics.

As the process improvement in the future state, Figure 4 depicts how the school created value by using digital screen capture technology and online learning techniques. Screen capture is a software tool that enables a teacher to record
anything that is on the computer screen, annotate it and add voice over. Once the recording was processed, it was uploaded directly to a video sharing site for distribution through the internet. Online learning was used to provide resources, learning groups, student monitoring and instructional facilitation. The metrics in Figure 4 indicate the impact of these improvements.

As the value stream maps in Figures 2-4 demonstrate, this school addressed the gaps in traditional high school instructional practice by enabling teachers in the classroom to “flip” lecture time into time for higher level engagement by students with teachers. This improvement allowed students to increase processing time substantially and to do so in an environment in the classroom, where teacher and peer support was available. The advantages to digital screen capture also allowed students to review, as needed for remediation or intervention, or not, if mastery was evident. In standardizing the delivery of content through instructional technology, the ability to individualize and differentiate instruction for the student as an instructional practice improvement was evident. This change also created more instructional time overall by providing students with a task they enjoyed and could control, deciding when and where to listen to the daily lectures.

The metrics in Figure 4 illustrated these improvements. This depiction highlighted that continuous improvement work using the lean tool, the value stream map, used metrics of importance to the stakeholder. Of course, these
metrics may not create the only benefits for the improvement solution. For example, this instructional technology solution also provided teachers with the flexibility to create learning groups based on student needs and it allowed the school to select lecture content creation based on strength of delivery by teacher expertise. A teacher-based value stream map could be used to highlight these ancillary improvements.

The initial results of this flip improvement are encouraging. The school worked from a small pilot of 23 at risk second semester students in a government class and used a control group for comparison. In the experimental flipped class, the students increased their online engagement and homework rates from 75% to 100%. Students’ successes increased by 11% in the flipped class. This resulted in an elimination of all students’ class failures. Following the pilot, this improvement has been implemented with the 9th grade class overall and year over year improvements are noted, such as discipline events decreasing by 66%, while failure rates reducing in mathematics by 31%, English by 33%, science by 22%, and social studies by 19%. This demonstration site of continuous improvement in instruction using instructional technology (Green, 2011b) does provoke the need for further study, as these results are impressive.

Summary

Schools are striving to continuously challenge current instructional practices in order to produce improvement, not just change for change’s sake, but by engaging in value added improvement. The ability to engage in continuous improvement is a hallmark behavior for schools striving to achieve the vision of the 21st century school. Daggett and McNulty (2005) endorse these approaches to school reform as a continuous challenge to the status quo as follows,

As the demands to raise standards have become steeper, schools tend to rely on tried-and-true curriculum content and teaching approaches. However, this old methodology was intended for an education system whose mission was to select and sort students, not to move all students to high levels of proficiency. (p. 13)

In other words, as familiar and traditional models of instructional practice come under the lens of reform, schools must effectively engage in continuous improvement. This informed commentary has attempted to link extant literature regarding the need for continuous improvement, instructional improvement and instructional technology improvement as a theoretical basis for creating interest in the translational work of the use of lean as an improvement tool in the educational sector.

Further, an example of one high school’s journey into continuous improvement and how value stream mapping was used to work through process improvement was presented. The academic achievement and behavioral referral improvements experienced in a pilot of flipped classroom instruction using screen cast video technology were impressive. It is hoped that this modest example will prompt further scholarly evidence-based practice and research to inform the field regarding viable organizational approaches to school improvement that link theory with practice.

References


