Digital Teaching Platforms:

A Research Review

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I. Overview

The Digital Teaching Platform is a new educational product category, designed to function as the primary instructional environment in today's technology-intensive classrooms. It supports the teacher with tools for curriculum planning, classroom management, and student assessment. It is designed to operate in a teacher-led classroom as the primary carrier of the curriculum content.

Time To Know® (T2K) is the first complete example of this Digital Teaching Platform. Time To Know provides time-saving teacher tools to streamline classroom management, to create a smooth flow between group and individual instruction, and to support customized activities for every learner. Highly graphic multimedia tools engage students and facilitate teaching and learning of the basic skills and the 21st century skills.

T2K is a next-generation system that allows schools to improve teaching effectiveness and to reap the benefit of their investment in computers and other classroom technologies. Independent evaluations in Israel, where Time To Know has been used for over two years, find improved student engagement and performance, deeper understanding, and more independent learning.

The technology-rich platform uses a one-to-one computing environment to best advantage. It facilitates large group presentations, small-group projects, and individualized practice and assessment. The teacher is fully in control of student activities by making assignments, mentoring individuals, and leading discussions. The pedagogy of the curriculum is designed using principles of guided social constructivism and provides the support for a true transformation of teaching and learning.

This paper describes the Digital Teaching Platform and illustrates it with features from the T2K product. The description of the platform focuses on three elements – the technology, the teacher, and the pedagogy. Each begins with a vignette that depicts the use of the Digital Teaching Platform in a classroom. This is followed by a review of the technology and an analysis of the research from the literature that supports the design. Each section also discusses the corresponding features of T2K.

The concluding section of the paper speculates on the potential of the Digital Teaching Platform and one-to-one computing to transform teaching practice and student learning.

II. The Technology Platform

Vignette

Mr. Jones teaches 5th grade and he is preparing for tomorrow's math lesson on finding common denominators. This is a new fractions concept for the class, so he plans to use the T2K fraction bar applet to have students explore fractions of equal value. The T2K curriculum also includes an animation to introduce the concept and several related practice activities.

Jones opens the T2K lesson planning tool and selects the learning sequence on common denominators. From this collection of activities, he selects an animation and several exercises and adds them to the lesson.

This unit includes an applet that draws fraction bars. Students use it to create fractions with different numerators and denominators. First, they select a denominator, and the applet creates a horizontal bar with the corresponding number of boxes. Then they click any box in the bar to fill it with color; the numerator increases to show the corresponding fraction. Students can also click on a filled box to remove the color and decrease the numerator. By creating two parallel bars with the applet, students can test two fractions for equivalence by comparing the lengths of their filled boxes.

Jones previews the applet and then adds it to his lesson, along with some questions to guide student discussion. He saves his revised learning sequence and assigns the activities to the class.

The next morning in math class, Jones begins the lesson with the animation that shows the "Magic Machine" transforming one fraction into an equivalent fraction -- the fraction 1/2 becomes 3/6. Next Jones explains how to use the fractions bar applet and tells the students to begin their first activity. Students open their laptops. On their student desktop, they see the activity, several practice exercises, and some guiding questions for class discussion.

The students are familiar with the interface, and they immediately open the activity and begin work. They use the fraction bar to create fractions that have different denominators, but are the same length. When they find examples, they save them to the Gallery. Later, the class discusses the examples saved in the Gallery.

The Technology In the Classroom

The Digital Teaching Platform supports teachers and students in classrooms equipped with technology that approaches one-to-one computing. In this one-to-one environment, each student has a laptop with a wireless connection to the network. The teacher also has a networked workstation connected to a projector or perhaps a “smart” whiteboard. Under the teacher’s direction, all of the interactions between teacher and student and among students are facilitated by the cluster of networked computers.

The Digital Teaching Platform delivers the content of each lesson. The Time To Know Digital Teaching Platform contains a comprehensive curriculum of guided learning sequences that include applet activities, multimedia presentations, practice exercises, and games. The vignette illustrates the use of this platform in a fifth-grade classroom. Before class the teacher uses planning tools to prepare; during class he uses multimedia to introduce a topic, an applet to explore a mathematics concept, and practice exercises. After class, the teacher can review each student’s progress, trends in the class performance, and begin the process for planning tomorrow’s lessons.

Teachers can also use the platform to customize learning sequences, to assign assessments to students, and to create reports of student progress. Because each student uses a laptop during class, the teacher can monitor individual progress and communicate with each student unobtrusively.

The students’ workspace is simple and consistent. Students see only the activities that they are assigned, so they are not distracted by materials meant for others or by activities that will be used later. They quickly learn to navigate the interface to find and complete their assignments.

As a Digital Teaching Platform, T2K provides the content of each lesson as well as the tools that teachers and students use to work with that content. Thus the computer becomes a valuable and timely resource for teaching and learning in the classroom. Indeed, the T2K platform supports classroom interactions in a manner similar to print materials, manipulatives, and other off-line materials.

Research

Introduction

The hardware used in the Digital Teaching Platform – laptop computers and a wireless network – is less than 10 years old, and research findings that document this infrastructure’s impact on teaching and learning are sparse. Nevertheless, the one-to-one computing environment has spawned a number of studies; although the results of these investigations are encouraging, the findings are limited and one must draw inferences with care.

Much of the research on one-to-one computing takes a fairly high-level view of computers in classrooms. These studies often compare technology-intensive classrooms to similar classrooms that are not using the technology. The comparisons include little analysis of how the computers are actually used or the part played by the teacher or the instructional software.

Current research is beginning to focus on various contributing factors, moving beyond technology usage to examine precisely how it facilitates teaching and learning. Several studies today have already begun to probe the underlying mechanisms of technology in the classroom. These suggest a common theme: how the teacher uses the technology contributes significantly to the effectiveness of that technology. This paper examines several of these studies into the effectiveness of implementation for technology-based educational interventions. Looking ahead, investigations of one-to-one computing are increasing. The impact of this technology on teaching and learning has been anticipated by researchers literally around the world (see Chan, *et al.*, 2006, for an analysis of the related research opportunities).

<u>Comparison studies</u>

Three studies illustrate the findings and limitations of high-level comparisons. A research team from Boston College has evaluated a wireless initiative in western Massachusetts in which students were equipped with wireless laptop computers. The study examined the student scores on the Massachusetts statewide examination (the MCAS) and found a significant improvement in the technology classrooms across a two-year span (Bebell and Kay, 2008).

A study of California middle school students found that laptop students significantly outscored students in conventional classrooms in the areas of mathematics and language arts (Gulek & Demirtas, 2005). In Germany, a study found that laptop students made greater gains than students in a comparison group on technology literacy (productivity tools; skill in using the Internet; and knowledge of hardware, software, and operating systems), especially for girls (Schaumburg, 2001).

Two recent studies of technology with large numbers of students failed to demonstrate that technology in the classrooms was consistently effective. A four-year evaluation of technology immersion in Texas showed that in several instances the treatment groups outperformed the control classrooms but in other cases the two groups were the same. This study also found that only twenty-five percent of the “immersion” classrooms used technology at a high level, although the level of use and the proficiency of the teachers increased over the four years of the study (Shapely, *et al*., 2009). Also, a study by the IES of the Department of Education found no significant gains in the treatment group of a controlled study (Dynarski, *et al*., 2007).

Effectiveness of implementation

As researchers move beyond simple comparisons of classrooms with computers vs. classrooms without computers, they are finding important underlying variables. In the research on one-to-one computing, studies consistently point to the importance of the nature of the implementation: Was the technology used effectively? Were the teachers proficient with it? How rigorous was the courseware?

A recent review of the research on one-to-one computing (Fadel and Lemke, 2006) found several studies that identified an increasing student engagement in learning. These studies showed that, in technology-intensive classrooms with effective implementation, instructional practices shifted to more collaborative, small-group work; used curricula that was more student-centered and problem-based; and produced more higher-order thinking skills. These gains were predicated on the implementation to the instructional program as designed. Teachers who used the technology effectively were more likely to produce gains than teachers who were unprepared for the technology. School leadership and school culture were strong correlates of that fidelity.

Fadel and Lemke concluded that new studies must pay careful attention to these factors, examining specifically the roles of leadership, professional development, school culture, and curricular redesign. At the same time, the review found few rigorous research studies on the one-to-one model and advised caution in making inferences from this limited scholarly literature.

A more recent study that focused on the one-to-one use of laptops in high school (Zucker and Hug, 2007) also found that technology alone is not enough. The hardware must be accompanied by changes in teaching, testing, and professional development. Indeed, the complexity of the technology was a challenge to successful implementation. In this study, teachers had to learn to manage their classes in different ways; they had to keep the hardware functioning; and they had to find adequate software and learn to use it. The teachers who surmounted these challenges produced the greatest results.

The importance of implementation has been noticed by technology coordinators. In a survey, coordinators of one-to-one computing programs rated their areas of interest. Although teacher professional development was at the top of the list, 64% reported a need for content resources (Wilson, 2008). A preliminary study of the Maine Laptop Initiative, a statewide implementation of one-to-one computing in middle school, found that teachers who were proficient with technology used it more effectively. They were more likely to report that the laptops had a positive impact on students, to collaborate with colleagues and students, and to conduct online assessments (Sargent, 2003).

These findings are highly relevant to the analysis of the Digital Teaching Platform. The hardware and course content, by themselves, will always depend on the teacher's skills with these tools. In recognizing the importance of the teacher, T2K includes an extensive program of professional development that addresses the pedagogy of the platform as well as the technology.

III. Teachers and Students in the Classroom

Vignette

In Jones' math class, students work in pairs using the applet to explore equivalent fractions. As they work through this activity and post their findings to the Gallery, Jones fields questions and mentors individuals. After a number of examples are submitted to the Gallery, Jones asks the whole class to offer ideas about a rule that governs equivalent fractions.

This sparks a spirited discussion, in which different students suggest observations and ideas. Several rules emerge, involving multiplying or dividing numerator and denominator.

Next, Jones instructs students to begin work on their individual assignments. These are selected exercises and game-like activities that give the students a chance to practice with the concept of equivalent fractions. When he planned for this class, Jones assigned specific activities to individual students, based on their interests and capabilities. He knew, for example, that several students already had a good grasp of fractions concepts and were ready for some challenging problems; others needed to take smaller steps and work on prerequisite skills before moving forward. With this in mind, Jones assigned students different activities; the T2K system can also adjust assignments based on past performance.

At this point the students open their laptops, select the assigned activity, and begin work. Each student sees only the activities that have been assigned to him or her. The students work independently, side by side, and usually do not realize that they have different tasks to complete.

As students work through these exercises, Jones monitors their progress by walking around the room. He spends a few minutes helping one particular student and then goes to his workstation at the front of the room, where he reviews a status report of student progress. He notices that the two students who are working collaboratively on a challenging assignment appear stuck, so at his computer he assigns the pair a different activity and then visits them to see why they are having difficulty.

That evening, Jones reviews the student reports on the activity and begins his preparations for the next day. He will continue the fractions work, with a matching game on equivalent fractions. Students will also build fractions by cutting up strips of paper and compare these concrete constructions with their work on the computer.

Technology for Teachers

The Digital Teaching Platform is designed for the classroom. It puts the teacher in charge of the lesson, and it provides the tools and resources that the teacher needs to ensure that the class runs smoothly. These range from multimedia demonstrations that involve the entire class to small group projects and individual assignments. The platform ensures that students understand their assignments and can move quickly from one activity to the next without losing time or momentum.

Time To Know's structured curriculum provides another resource to teachers. This comprehensive curriculum can be customized to address local learning requirements or teachers' professional choices. This aspect of the design of the platform is an important asset for scaffolding teachers who are less experienced in the classroom.

The Digital Teaching Platform also helps the teacher individualize assignments to students. Individualization – matching students to learning activities based on interest and capability – is a key element of personalized learning. In traditional settings, individualization can be logistically complicated and can disrupt the flow of instruction, but with technology individualization is straightforward and can be handled before class begins.

As a Digital Teaching Platform, the T2K product provides these essential tools to teachers. The value of using T2K technology in classrooms is that it facilitates different types of activities, supports individualization, and tracks student progress without disrupting the natural flow of classroom work. Indeed, the T2K platform can enhance that flow.

Research

Introduction

Using a Digital Teaching Platform like T2K in the classroom opens up new opportunities for teaching and learning; but, as reported earlier, opportunities for more sophisticated pedagogy also pose challenges for the teacher (Zucker and Hug, 2007). This section considers the challenges inherent in the task of managing the classroom equipped with this technology. The paper then turns to the opportunities and examines the importance of individualization in student practice and assessment.

The challenge of classroom management

Jon Saphier and Robert Gower, in their seminal work *The Skillful Teacher*, identify six challenges that must be faced in effective classroom management: attention, momentum, time, space, routines, and discipline (Saphier & Gower, 1997). Technology offers many opportunities to orchestrate the choreography of classroom management, and the discussion below shows how the features of the T2K have been designed to aid the teacher in each of these areas.

Attention: Students learn only when they attend to their learning. Teachers must get students on task during class time by engaging them in legitimate curriculum activities. In fact, researchers have documented that time on task is positively correlated with achievement (Bennett, 1978). T2K engages students through its visual demonstrations and animations. The interactive applets challenge them to explore problems and patterns. The LiveText feature scaffolds their reading skills and motivates them to keep reading. At the same time, real-time progress reports ensure that students are working on activities that are productive. All tasks and materials in T2K are designed to be relevant and engaging.

Momentum: The teacher must coordinate the flow of events during class and provide smooth, rapid transitions between activities (Kounin, 1970). Breaks in momentum are a distraction and interfere with students' concentration. T2K helps maintain class momentum by giving the teacher tools for directing students through the transitions from group discussion to individual practice. The "Eyes to the Board" tool signals students at their laptops to stop their independent work and to participate in a large-group experience. The activities within each learning sequence are also designed to flow in a meaningful way.

Space and time: Teachers must organize the physical space of the classroom in order to maintain momentum and routine. They must manage events, regulate schedules, and allocate time appropriately. Teachers must use that time efficiently, and they must set a pace for all activities that meets the needs of individuals as well as the whole class (Stallings, 1980). In analyzing the use of computers in classrooms, Roschelle and Pea depict the ability of one-to-one computers to augment physical space with important information exchanges among students and teachers (Roschelle & Pea, 2002).

T2K and student's wireless computers provide a mechanism for organizing the physical space. Students work individually or in groups. They move to and from the white board in the front of the room. They can easily relocate their computers for each of these activities while still being monitored by the teacher's workstation. Also, the T2K planning tools help teachers use class time most efficiently.

Routines: Classes are managed most efficiently by building procedural routines and using them effectively. Students must know what these routines are and how to engage in them. T2K helps develop these routines by deploying a uniform user interface for all activities and applets. When students open their laptops, they quickly begin to navigate their assignments, even though the activities in those assignments may be completely new to them. These routines also simplify the many transitions during class.

Discipline: From time to time, all teachers must respond to resistant students. Rules must be clear and specific. Positive expectations must be repeated. Students must have a sense of influence on the life of the classroom (Gordon 1974). Students often become frustrated when they are working on assignments that are too hard, and they are bored when their assignments are too easy. By customizing all assignments to students individually and by adjusting these assignments during class, the teacher keeps students working at their optimal level, reducing the number of discipline issues.

The classroom is a complex environment that requires thoughtful preparation in planning followed by a skillful choreography in execution. The six attributes here delineate that choreography, illustrating how the T2K platform support these tasks and, when used effectively, make the teacher more productive. When all this comes together, students operate more independently, making the transitions from one type of activity to the next without disrupting their learning.

The role of individualization in practice and assessment

Extensive educational research documents the importance of guided practice in learning skills and concepts. Recently, a national panel in mathematics education concluded that, "Curriculum must provide sufficient practice and in fact few U.S. curricula do so. Pedagogy should develop proficiency in students. Proficiency means that students understand the key concepts, achieve automaticity, develop flexible, accurate, automatic execution of standard algorithms, and use these competencies to solve problems" (National Mathematics Advisory Panel, 2008).

Research in reading also finds that practice develops skills, especially when coupled with timely feedback (National Reading Panel, 2000). Studies find that frequent feedback to students about their learning yields substantial learning gains (Black & Wiliam, 1998).

The role of practice in developing expertise has been studied extensively. Research shows that *deliberate* practice – practice that is thoughtful and well supported with feedback from a teacher – is essential to developing expertise in many disciplines, including music, sports, mathematics, chess, and surgery (Ericsson, Charness & Feltovich, 2006).

Practice is effective only when it is accompanied by timely feedback. Research in mathematics education finds a value in using technology to administer formative assessments when the assessment results are then used to individualize assignments (National Mathematics Advisory Panel, 2008). Similarly, in reading there is an important role for practice coupled with diagnostic assessment. These assessments can guide instruction on a moment-to-moment basis and can respond to individual needs (National Institute for Literacy, 2007).

Contemporary research also finds a strong connection between assessment and student production. Students must learn to evaluate their own work during the production process; this evaluation must happen during each productive act, including moments of deliberate practice. Students must have tactics they use to modify their work as they produce it. These skills or tactics can be developed with direct authentic evaluative experience, and the instructional system must supply these (Sadler, 1989).

Accurate, timely assessment is also related to effective use of individualized practice. Stiggins (2004) postulates that maximum learning comes from active engagement between the teacher and student; this engagement allows students to decide if they are likely to succeed and if meeting the standards is worth the effort. In other words, students examine these assessment factors on a personal level.

Stiggins concludes that many current assessment practices, especially high-stakes tests, do not provide this kind of information to students. Instructional decisions best occur in a fluid day-to-day instructional environment, not once a year in standardized tests. Using online assessment tools teachers and students can assess individual learning and instructional progress quickly and efficiently. This approach to assessment has additional analytical power for the teacher because the results are both individualized by student and combined into a class analysis. Aggregating data in this way can be critical to planning for the group (Roschelle & Pea, 2002).

Finally, the role of individualization through technology leads to a view of "personalized learning." As Howard Gardner describes it, "Well-programmed computers offer many ways to master materials. Students or their teachers will choose the optimal ways of presenting the materials. Appropriate tools for assessment will be implemented. And best of all, computers are infinitely patient and flexible. If a promising approach does not work the first time, it can be repeated, and if it continues to fail, other options will be readily available" (Gardner, 2009).

This research demonstrates clearly the importance of customizing instruction and practice with tools like those in the T2K platform. Teachers make assignments to individual students as part of the planning process, and they can adapt these assignments during class based on student work and assessment. This keeps the practice and assessment tasks closely linked and helps the teacher keep all students working at an optimal level at all times.

The practice elements can also be combined with other types of activities. Some students can work on a practice assignment while others are using open-ended applets or working with game activities, viewing media, or reading text. While all these activities are underway, the teacher can spend time mentoring struggling students individually. The customization made possible by the Digital Teaching Platform includes both types of activities as well as the developmental level of those activities.

IV. Guided Social Constructivist Design

Vignette

The "Magic Machine" lesson on equivalent fractions challenges students to find a rule for determining which fractions are equivalent. Rather than simply stating the rule and then providing lots of practice exercises with it, the lesson begins with a question and provides students with tools to explore that question.

One student builds fractions with the fraction bar applet. As he creates the fractions, he fills in the blocks for the numerator with a pattern of alternating colors. To depict the fraction 4/8, he creates a bar with 8 boxes and then fills in the first box on the left, the third box from the left, the fifth box, and the seventh box. This creates a pleasant patchwork design. Next he creates the fraction 3/6 in a similar way. But the two fractions bars, filled in this way, are difficult to compare for equivalence by comparing lengths.

After a few minutes of puzzling over this, the student seems to understand the problem – he cannot compare the lengths of the fractions easily. He clears the color from the boxes and fills them in systematically from left to right. This allows him to determine quickly that the two fractions are the same length and therefore equivalent.

In the class discussion, students are asked to come up with a rule that would predict when different fractions were equivalent. Some students notice that nearly all of the examples used denominators of 2 and 3, and they guess that these were the only numbers that work. Others suggest that they test other denominators before reaching this conclusion.

This guided exploration of an intriguing problem using the fractions bar applet provides the setting for the class to explore mathematical properties, to discuss what they are finding, and from those activities to develop a deep understanding of the underlying mathematical principles. The boy who creates the visual pattern illustrates how in the constructivist approach students do not always follow a direct line from problem to solution.

The Technology and the Pedagogy

The design of the Digital Teaching Platform embodies a pedagogical approach. With T2K, this approach is based on the principles of guided social constructivist pedagogy. In the constructivist approach, students work with open-ended tools to explore the principles and concepts of mathematics and language arts. Led by the teacher through this exploration, experimentation, and discussion, students can construct a deeper understanding of these concepts and learn to extend them to new situations.

The applets of T2K, such as the fractions bar used in the vignette, provide the opportunity for constructivist learning. Much like the hands-on manipulative materials of a traditional mathematics class, these applets promote exploration and discovery. In reading language arts, the LiveText function and the interactive book provide a similar exploratory experience.

Constructivist principles also get students involved in solving problems in real-world problem settings. The explorations of equivalent fractions in the vignette illustrate this approach. At the same time, concrete settings can also distract students with superficial elements of the problem (seen in the experience of the student who manipulated the pattern of colors in the fractions applet); or the settings may cause students to develop incomplete theories (hypothesizing that the denominators must be 2 or 3). Nevertheless, at the end of this learning process, students understand the concepts far more deeply than they do when they simply memorize a rule or algorithm.

Finally, the activities within each guided sequence are designed to build these cognitive learning progressions. The development of skills from one activity to the next is fully supported using an understanding of constructivist principles.

Guided constructivism also respects individual differences. The variety of activities and modalities for presenting concepts, the role of practice, and the use of group discussion in T2K are all designed to support different ways of knowing and learning in students.

Research

Introduction

The *social constructivist* theory of learning claims that meaning is developed by the individual; it is not something that exists in the world apart from the individual. Learners construct new knowledge and understandings based on what they already know and believe. Student learning is shaped by developmental level, experience, and socio-cultural background.

The curriculum of the T2K platform is designed with a pedagogy built on constructivist principles. In this section, the paper reviews the research on social constructivism and then reconsiders the T2K design in this context.

The constructivist theory

In the constructivist view, knowledge is embedded in a setting and mastered through authentic, realistic tasks. Learners build a personal knowledge of reality and create novel and situation-specific understandings. Instruction must provide rich, loosely structured experiences that encourage meaning making without imposing a fixed set of knowledge and skills. This guidance can come in the form of coaching, mentoring, or apprenticing (Dede, 2008). Curriculum built on constructivist principles must develop conceptual understandings together with fluency and problem-solving skills in a manner that makes these attributes mutually supportive (National Mathematics Advisory Panel, 2008).

In the constructivist approach, instruction is a process that supports knowledge construction rather than communicating that knowledge. The teacher serves as a guide, rather than as the expert who transfers knowledge to students. Learning activities are authentic and leverage the learners' puzzlement and curiosity that arises when their faulty or incomplete knowledge fails to predict what they observe. Teachers encourage students to reflect on these experiences, to seek alternative viewpoints, and to test a variety of ideas. Student motivation to achieve these goals is determined by factors such as challenge, curiosity, choice, fantasy, and social recognition (Malone & Lepper, 1987; Pintrich & Schunk, 2001).

The National Research Council lists the essential goals of learning in a constructivist approach:

- building a deep foundation of factual knowledge and procedural skills;
- developing conceptual frameworks;
- organizing domain knowledge as experts do;
- improving the thinking processes (National Research Council, 2005).

Student motivation to achieve these goals is determined by a variety of intrinsic and extrinsic factors, such as satisfaction from achievement, contributing to others, and challenge and curiosity (Pintrich & Schunk, 2001).

Researchers whose theories were important in the development of this school of thought include Anderson (1993), Bruner (1960, 1968), Piaget (1967, 1974), Mayer (1977), Norman (1980), Newell and Simon (1972), Palincsar and Brown (1984), and Vygotsky (1986). A number of design strategies based on these theories often aimed to help students understand disciplinary knowledge (Case, 1992; Lee & Ashby, 2001; Hunt & Minstrell, 1994). The theory has been especially influential in mathematics education (Von Glasersfeld, 2007a & 2007b).

Recent writers have analyzed constructivism in specific contexts. Dede reviews studies that apply this perspective to information and communications technologies and finds that these studies, covering a broad range of topics, tend to return positive results (Dede, 2008). Others have articulated techniques for implementing the constructivist approach in day-to-day classroom practice (Fostnot, 2005; Gagnon, Collay, & Schmuck, 2005; Brooks & Brooks, 1999). With respect to classroom practice, Perkins cautions practitioners to approach constructivism with a pragmatic bent, counseling them to concentrate on what works (Perkins, 1999).

The design of the T2K platform

The T2K platform is designed on constructivist principles. It engages students by having them do meaningful tasks in mathematics and reading language arts. It provides open-ended applets that students use to explore specific problems or concepts. In mathematics, these applets provide an environment for exploring specific concepts; the vignette illustrates this with the applet fraction bar. In reading language arts, the LiveText function provides guided support for developing reading skills and the comprehension of text.

The Gallery feature provides a venue in which students post their work and review the work of their peers. The Gallery also serves as a mechanism the teacher can use to report and analyze student work and to let students see it being shared with others. Both implementations of the Gallery can guide class discussion. Long-term assignments stimulate inquiry learning based on student projects. These elements are all important in the constructivist view. Roschelle also points out that technology makes it easier for teachers to target prior understanding, engage students in discussion, and provide frequent feedback. He reminds readers that “teacher implementation of these practices is the main cause of improved student performance,” again raising the issue of program effectiveness discussed earlier (Roschelle, Penuel, & Abrahamson, 2004).

V. The Emergence of the Digital Classroom

Computers in the Classroom: Three Scenarios

In 1993, Larry Cuban wrote an article in the *Teacher's College Record* with the title, "Computers Meet the Classroom: Classroom Wins." In the article, Cuban analyzed the place of technology in education and suggested reasons for the slow adoption of technology at that time. He claimed that the reason was not funding or training or the technology, but rather a misunderstanding of the role of schools in society.

Cuban's essay remains surprisingly appropriate to this analysis of the use of technology in today's classrooms. This section of the paper reviews Cuban's work and applies that review to the analysis of the Digital Teaching Platform.

Cuban posited three scenarios for the future of technological innovation in schools. In the first scenario, the "Technophile" predicts that technology will make schools more efficient and therefore more productive, as computers liberate students and teachers from drudgery and inflexible approaches. These "instructional delivery systems" enhanced with technology will take a central role in classroom practice, transforming it dramatically, and the systems may even grow so intelligent that they can replace the teacher as deliverer of information. Although there were many who supported the "Technophile" view in 1993, there are few supporters today; the development of classroom technology based on artificial intelligence is not advancing in this direction.

The second scenario, the "Preservationist" view, supports the prevailing beliefs about teaching, learning, and the relationships among teachers and students. The educational system is designed to pass on the today's values and knowledge to the next generation and in the "Preservationist" view, technology is designed to support that role. This is exemplified in technology literacy courses and computer science curricula that add technology to the body of knowledge that must be transmitted. Providing software as a part of a textbook adoption or using technology as a tool for test preparation are other illustrations of the preservationist approach. In this view, technology is important but peripheral to the business of teaching students.

A critical element of the preservationist approach is that it maintains a strong role for the teacher as the transmitter of information. Indeed, the use of technology must be adapted by teachers to the "durable grammar of the classroom and school" (Cuban, 1993). As Saul Rockman put it, "What a teacher does with it is more important than what the it is" (Rockman, 1991). The preservationist approach is cautious toward major changes and respects traditional aims for schooling, reinforcing what schools have done for over a century (Cohen, 1990).

The "Cautious Optimists" provide the third scenario. They predict a slow growth of hybrid schools and classrooms in which computers produce steady but gradual changes in teaching and schooling. In this view, "schools can become small learning communities where students and adults teach one another through a deliberate and slow application of technology to schooling" (Cuban, 1993). This scenario also incorporates a neo-progressive element: Schools will become small learning communities in which students and teachers teach one another through deliberate application of technology to schooling. Classrooms develop from teacher-directed environments to work places where peers help one another and teachers serve as mentors.

In looking to the future in 1993, Cuban predicted that the preservationist approach would best describe classroom use of technology in the short run, but that in the longer term the cautious optimist approach would gain ground, especially in elementary schools. Cuban's analysis of technology and his predictions remain compelling in today's world. Certainly, the preservationist approach is the best description of how technology is used today. Technology still cannot provide many of the futurist visions of the technophile and not enough time has passed for the optimist approach to gain much of a foothold, although futurists like Christensen see a technological transformation of schools just around the corner (Christensen, *et al*., 2008).

The Digital Teaching Platform and Schools of the Future

Since Cuban's analysis, the technology platform has advanced in significant ways for education. Today, computers are powerful multimedia machines that have wireless high-speed connections to a global network populated with an immense array of assets. Nevertheless, the use of technology in schools has not changed substantially – it remains a peripheral element to educational practice.

Cuban's analysis can be applied to this review of the Digital Teaching Platform as exemplified by the T2K product. That analysis reveals an intriguing combination of preservationist and optimist capabilities. With its focus on teacher-led classrooms, tools for managing classroom operation, and attention to practice and assessment, the T2K platform is strongly preservationist. These tools and curriculum address the essential features of traditional schooling, such as focusing on learning standards, measuring learning with high-stakes tests, and creating classroom groups of students based on age.

With its student-centered applets, attention to student collaboration, constructivist pedagogy, and authentic student work, the T2K platform is also cautiously optimistic, with a neo-progressive orientation. It supports students exploring phenomena, constructing understanding, and guiding their own learning. It aids the teacher as a mentor and coach.

This finding, that the T2K platform is both preservationist and optimist, is amplified by the examination of four significant innovations that T2K brings to the classroom. Two of these innovations are clearly preservationist in their benefits: the role of individualization and the use of rapid diagnostics. Both show how T2K is designed to prepare students efficiently for high-stakes tests of the accepted standards. Two other innovations, constructivist pedagogy and cooperative groups, move in the direction of cautious optimism by nudging teachers toward mentoring and students toward exploration, creativity and peer collaboration.

Individualization and independence

Perhaps the most powerful efficiency of a Digital Teaching Platform like T2K is its ability to individualize student learning quickly during the course of regular classroom events. This allows students to work more effectively with greater investment in their learning. Research indicates that guided practice must be regularly tailored to the needs, interests, and capabilities of each student and that generic practice assigned to a group is highly inefficient. T2K makes this individualization possible to a new level.

Individualization also gives students a sense of independence – from both the teacher and from the necessity of following along with other students – and that encourages them to make greater effort. This level of individualization is less practical when using traditional classroom materials.

Individualizing education by providing customized learning for each student is a powerful lever for transforming schools. The T2K platform approaches the problem by providing the teacher with tools for individualization. Technophile Clay Christensen agrees with the critical role of individualization but finds the solution in the technology rather than in the teacher's expertise (Christensen, *et al*., 2008).

Diagnostics with rapid response

Assessment is effective as a teaching tool only when it is fitted exactly to the curriculum, it is delivered in a timely fashion, and the results are used immediately to guide the deployment of new lessons. T2K makes all of these requirements feasible. Teachers develop assessments that match what they are teaching. They administer these assessments to students, individuals, groups, or the whole class, at exactly the right time. And they review the results immediately after the students have completed the assessment.

Assessment fits closely with the individualizing capability, adding the critical diagnostic element. This approach to teaching and assessing keeps students on track, motivated, and alert to their progress. These two innovations in classroom practice, individualization and diagnostics, work together to provide efficiency in teaching and learning.

Constructivist teaching with rigorous practice

The constructivist approach in the T2K pedagogy brings a strong element of neo-progressive thinking. This approach places a premium on creativity, deep understanding, and life-long learning. To implement a constructivist approach, however, teachers must pose many open-ended problems, spend less time lecturing, and invest more time in coaching, observing, and questioning.

This pedagogy does not dismiss the need for facility in reading and mathematics, and therefore the role of rigorous practice plays a key role. T2K combines this practice with open-ended problem solving supported with tools, applets, and group discussion.

Blend of individual work and cooperative groups

The combination of constructivist pedagogy and rigorous practice requires restructuring the classroom. Students work individually and as a whole class. But they also join in cooperative groups for many problem solving activities and discussions.

The challenge to the teacher is the choreography required to manage these various groups. T2K provides tools for dealing with these needs. As a result, it nurtures community, sharing and cooperation.

VI. Final Remarks

The use of a Digital Teaching Platform in today's classrooms brings educational technology to a crossroads. The platform provides powerful tools to the teacher for planning and managing lessons, customizing instruction to individuals, and providing quick feedback on all activities. It facilitates the management of groups of students without losing focus on individuals. It frees up the teacher for small group work and individual tutoring. In these ways, the platform respects the role of schools in today's society by teaching to standards and preparing students for high-stakes tests.

At the same time, the T2K Digital Teaching Platform deploys a social constructivist pedagogy and provides tools and content to build on that approach. It features open-ended explorations, student collaboration, shared work, and group discussion. In this way the platform goes beyond the standards and engages students in their learning, preparing them in a deep way for their place in a technology-rich society.

Therefore, the technology of the T2K Digital Teaching Platform supports both – uniform mastery of the world of learning standards and individualized understanding of the world of technology. T2K also supports both innovations through an artful combination of the three elements – powerful technology, a neo-progressive pedagogy, and skilled teaching. The platform is designed for the classroom, but it also provides anytime, anywhere access to learning.

This can transform teaching and learning while maintaining healthy respect for the need to educate all students.

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