Teaching in K-14: what is the best way to teach Digital Natives?

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Abstract

Faculty from the UTEP's College of Education together with the faculty from Canutillo Elementary school was involved for two years in using variety of state-of-the-art technologies in teaching both pupils and future teachers. The evidence acquired, supports the thesis that today's students display different thinking patterns then the students from previous generations. New generation of students is sometimes called Digital Natives. Previous research has shown that these students like to parallel process, prefer random access, shortcuts and games. They easily develop sophisticated computer skills, but at the same time they might not be the best subjects of our current educational system. The important question that arises now: how do we change our pedagogical approaches to teaching variety of disciplines to accommodate the new generation of learners? We will discuss the emerging framework of teaching and learning focusing on Digital Natives.

I. Introduction

Teachers and teachers' educators are constantly searching for new ways to reach their learners. Important question is: who are our learners today? The purpose of this article is to discuss how our experience of teaching mathematics and math pedagogy to future teachers (pre-service students) and pupils in the elementary school led us to support the framework proposed by educational software designer Marc Prensky. His answer to the above question -"Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (Prensky M., 2001).

He believes that students' cognitive abilities changed significantly if compared to the generation of their parents. In his article, "***Digital Natives***, ***Digital Immigrants***," Prensky describes these students as wanting their information extremely fast and being experts at multitasking and networking. Typically, ***Digital Native*** represents a person from the generation that grew up with new digital technology. ***Digital Natives*** prefer parallel processing to linear processing, random access to sequential (step-by-step), graphical presentation of information to just textual representation and, of course, sees technology as a friend. They prefer games to "serious" work.

On the other side of the scale are ***Digital Immigrants***. Everybody from older generations is to some extent a ***Digital Immigrant.*** These people adapt to technological environment at some point, but would never get rid of their "accent". What is more important, Immigrants' learning style is different – slowly, step-by-step, one thing at a time, individually, and above all, seriously.

My personal experience (O.K.) - as ***Digital Immigrant*** - is about the way I was taught to write a programming code (for example, in FORTRAN, PASCAL, C, C++) – I

would always design a flow-chart reflecting the steps of algorithm, and only then covert it sequentially into the programming code. ***Digital Native*** programmer, on the other side, would start writing some program immediately, compile it, debug all the errors detected, and, after repeating this process iteratively, most often would create working program much faster. Both approaches work fine; however, there is a significant difference in the learning styles involved.

"Should the ***Digital Native*** students learn the old ways, or should their ***Digital Immigrant*** educators learn the new?" asks Prensky. He provides a confident answer: "Unfortunately, no matter how much the Immigrants may wish it, it is highly unlikely the ***Digital Natives*** will go backwards. In the first place, it may be impossible – their brains may already be different."

The rest of the paper is organized in the following way: Section II discusses implications for educators; in Section III we describe our observations in Technology-enhanced mathematical classroom; Section IV contains description of successful work at Canutillo Elementary School to ensure that ***Digital Natives'*** needs would be addressed.

II. Implications for educators

The framework and classification Prensky proposed leads to a very important implications for the educators, and especially, for future teacher educators. "Digital Immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language," concludes Prensky (2001).

In 2001 he saw that schools were lagging behind, no clear agreement existed on how to meet this new generation's needs, what that needs actually are, and how they differ from those of previous generations. He suggested that "we need to reconsider both our methodology and our content".

III. Technology-enhanced mathematical classroom observations

Located on the Rio Grande River in the far western edge of Texas along the borders of Mexico, New Mexico and Texas, El Paso is a bustling urban area of 700,000 people, more than 74% of whom are Mexican in origin. The University of Texas at El Paso prepares a large number of bilingual educators to work with the growing Hispanic population.

In the beginning of 2004 the team of researchers from the College of Education and College of Engineering received a grant from Hewlett Packard that allowed UTEP to organize a mobile Tablet PC lab. This lab was readily available for use in the math and math methods classes taught in a field-based environment. We were meeting at Canutillo Elementary School for both math and math methods classes.

First, we will describe how we designed technology-enhanced mathematics and math pedagogy classroom for pre-service teachers. During their senior year pre-service elementary teachers were enrolled in math content and math methods as well as in internships at local elementary schools. Content study involved series of rich math investigations, in-depth discussions on topics in the methods textbook (Van de Walle, 2004) and group lesson preparations and implementations. Students used Tablet PCs to

explore the investigations or projects. This technology allowed students to explore each activity fully without being limited to paper and pencil drawings, wireless capabilities allowed students to receive a fast evaluation feedback through the WebCT discussion and "Discourse" software. Students also developed mathematical lessons and implemented them in local elementary schools. Students created these lessons by applying the concepts investigated in their math and math methods courses and also successfully implemented them with the use of Tablet PCs in their individual and group Micro-teachings. The following diagram illustrates the dynamic structure of the technology-enhanced mathematical classroom.

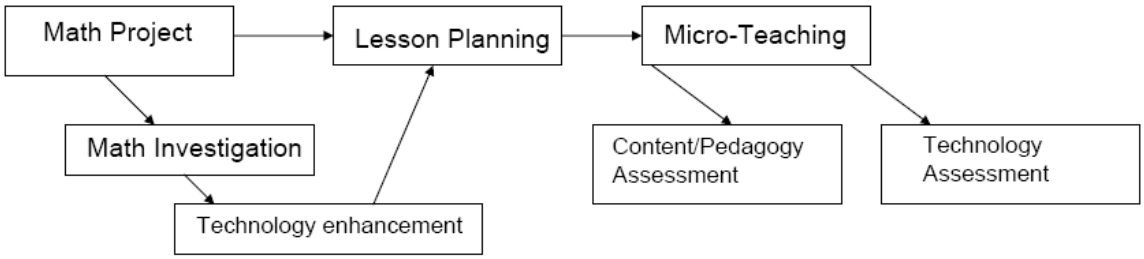

Figure 1. Diagram describing pre-service teachers' integrated study of math content and mathematical pedagogy in field-based context with technology enhancement.

Our observations of students' interactions with computers lead us to the conclusion that some of the future teachers already came from the generation of ***Digital Natives***, while others certainly belong to ***Digital Immigrants***. The proportion of these populations varied from semester to semester. Our observations lead us to the development of assessment rubric to determine to which category a particular student belongs (work in progress). Typical response of ***Digital Natives*** was "working with Tablet PCs was fun", while typical ***Digital Immigrant*** would usually say that "working with Tablet PCs a hard work, and I had to learn a lot about computers".

Pre-service teachers taught mathematical Micro-teachings during regular school time and in the after school program. We confirmed that ***Digital Natives*** engage in multitasking, prefer mathematical tasks in the form of games, and perceive working on Tablet PCs as fun.

One of the interesting outcomes was the discovery that students often formed math ideas and approaches that were unexpected and unwanted by the teachers and the designers of the technology. Specifically, different children used different approaches when solving the same mathematical problem. The most popular ones were not necessarily the same as assumed standard mathematical procedure; children preferred the solutions that are some kind of "shortcuts", requiring less time to get the correct answer. A good example is "Algebra scales" activity from the Library of Virtual Manipulatives - this virtual manipulative activity allows user to solve simple linear equations through the use of a balance beam, instructions suggest to represent equation by placing positive or negative unit boxes together with X-boxes on both pans of a balance beam and then perform the same arithmetic operation on both sides until a user gets expression for X. However, with examples of equation being chosen automatically all the solutions are typically small positive numbers, therefore children usually choose a straightforward

strategy to place X on one pan and put one, two, and so on unit boxes on another side until the balance is reached. This doesn't mean that "Balance scale" representation for equations is inappropriate; rather we saw the need to create variety of different representations for these students. Specifically, we tried to present algebraic equations in the forms of word problems, and then each step in solving such an equation corresponded to a meaningful question in the word problem story, while the shortcut approach was just mindless trial and error without meaningful questions relevant to the story.

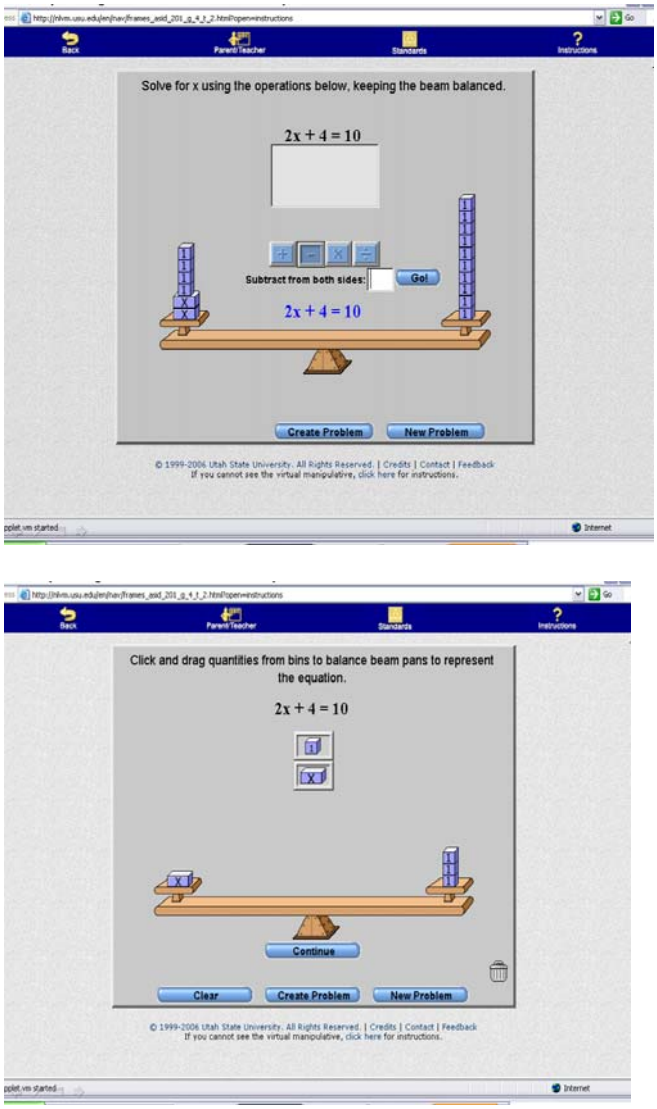

Figure 2. Snapshots describing students' approaches to solve algebraic equation using "Algebra scales" activity from the Library of Virtual Manipulatives.

Our conclusions are that even for ***Digital Natives*** we should combine variety of teaching methods, and use real-life manipulatives together with virtual manipulatives. Both types of manipulatives work only if a student can "see" in a model the concept it represents, or more specifically the relationships pertinent to that concept. In the process

of learning students go through the process of discovering these relationships using manipulatives as a testing ground for emerging ideas (Van de Walle, 2004).

IV. Educators successful efforts to engage *Digital Natives*

Canutillo Elementary School has maintained a strong focus over the past nine years on providing access to a variety of technologies and open-ended software to students and staff. On the staff side, a great deal of emphasis has been placed providing training and ongoing support for staff to become proficient in integrating technology, as per the Technology Applications for the State of Texas, in their daily instruction. The message that has been presented to staff is that becoming proficient in technology integration is not an option at our school, what is an option is how much help a staff member may need in order to reach the desired level of proficiency. On the student side we have worked very hard to provide equitable access to a variety of technologies and to provide students with a project based, constructivist environment. We have worked very hard over the years to provide a great variety of opportunities and experiences for our students that have permitted them to develop advanced skills in technology.

All of this work with students and staff has been supported by the extensive efforts that our Campus Technology Committee has made to successfully write grants that have brought much needed funds to support our efforts. Below is a listing of the grants that Canutillo Elementary School has been awarded over the last nine years.

Southwest Educational Technology Laboratory Technology Applications Program Grant-this was a two year grant that provided approximately $90,000 in training to a cohort of 28 teachers over a period of two years, from 1997-1999. This resulted in the development of training modules and videos that feature the work done on our campus during that time frame.

University of Texas Challenge 98 Grant-Under the auspices of Dr. Jorge Descamps, provided staff in the district two semester long courses on technology integration. Twelve teachers from Canutillo Elementary school took advantage of this. They were provided with a new computer for their classrooms at the conclusion of the two courses.

TIP Grant from the State of Texas 2001 provided $100,000 for the purchase of computers for the classrooms in the building.

INTEL Teach to the Future provided 40 hours of training for approximately 30 teachers over a two year time frame. The trainer was one of our staff members. The grant paid for the subs and for all training materials

Hewlett Packard Grant 2004-provided $35,000 dollars in equipment, stipends for a team of five teachers, and on-line and face to face training with Hewlett Packard personnel. The work done by the staff with the students resulted in an award winning video, titled “The History of Canutillo”.

Hewlett Packard Grant 2005-Provided $65,000 for equipment, training, and travel for a team of five teachers to produce bilingual (Spanish and English) math video vignettes to be posted to the campus website for general use by other staff members. This provided a lab of 15 Wireless Tablet computers and other equipment to be used by the project staff and their students.

Beaumont Foundation Grant 2005-provided $65,000 for the purchase of 30 Toshiba computers with wireless access. Plus two carts in order to create two labs on wheels with 15 computers and a printer on each cart. These were for general use by the entire student population as needed on a checkout by their teachers.

We have also written a number of mini-grants for Service Learning over the past three years that have brought over $30,000 to the campus to fund a great variety of projects that have technology imbedded as part of each of these grants. Additionally, we have been awarded two Best Buy Te@ch Grants for $2,500 each from 2004-2006. We have used these grants to purchase video taping and video editing equipment. We hope that this will be the beginning a well equipped video editing lab that could be made available to other campuses in the district with whom we would collaborate.

As you can see in the information provided above, we recognized the need to create an environment that provided equitable access to training, hardware, and software to all the members of our educational community. We have supplemented extensively the funds and opportunities provided by our school district. We have sought to be pro-active in our push to acquire the skills to support the, ***Digital Natives***, on our campus. We believe that in order for, ***Digital Immigrant***, teachers to stand a chance in seamlessly integrating technology into their instruction and to meet the need of the ***Digital Natives***, they need this level of on-going, constant support.

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