Extending or Transforming Classroom Practices: Examples of Teacher-Defined Activity with Mobile Technologies

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Abstract—In this paper we present two perspectives on the role of the teacher in the implementation and use of a new artefact as a tool for learning: the Personal Digital Assistant (PDA). We report from four classroom studies conducted in two countries (Norway, USA) where the teachers were equipped with PDAs. The key question we explore is the teachers’ pedagogical use of the new tool. We studied the tasks and learning activities planned by the teacher to find out how the current practice was extended or transformed, and how the PDAs contributed. We found that the activities defined by the teachers differed greatly in the two cases. In one case, the activities harnessed the affordances and constraints offered by the tool and transformed the actions. In the other case, the activities drew out and extended the affordances and constraints of a set of tools familiar (and related) to the PDAs. These two different methods of adopting mobile technology in the classroom profile the teacher-defined use of technology (Personal Digital Assistant, handheld or mobile electronic calculator, word processor, etc). The PDA technology has been adopted in schools (the abacus, as “productivity tools,” especially as word processors. In the past few years there has been an increased focus on using information and communication technologies (ICTs) as tools for learning and instruction, both from educational researchers [1-3] and policy makers [4]. Teachers in many schools are expected to adopt, understand and make use of different ICTs in their classrooms. This is not new since throughout time new technology has been adopted in schools (the abacus, electronic calculator, word processor, etc). The PDA (Personal Digital Assistant, handheld or mobile technology) is one of the latest trends. The research reported here provides examples of teacher-defined use of PDAs in the classroom. By teacher-defined we refer to the tasks and learning activities planned and directed by the teacher as part of curricular activities and mediated by the PDAs. Previous studies of the implementation of mobile technologies in the classroom have focused almost exclusively on the learning potential of the new technology, but the teachers’ role has been neglected. Our paper is guided by the following research question: To what extent does the PDA when employed as a tool in the classroom extend or transform existing forms of pedagogical practices?

Shin et al. [5] review several studies of handheld technologies in education. Their review indicates that handheld technologies are used in a variety of subjects across the curriculum. They found that many of the teacher-defined activities were related to science in inquiry-based activities. They mention examples of virus simulation games, collaborative problem solving, scientific fieldwork (using the PDA to collect field data outside the classroom), and visual modeling. They also report that handhelds have been used to teach languages, for writing purposes (such as revising writing) and for math (such as geometry, graphing and algebra). A fourth grade teacher in Ohio, USA, explained how she gave the students the task of creating cartoons about each of the three branches of the US government [6, p. 74].

Mobile technologies have also been used for natural science in situ, like ornithological studies [7, 8]. Curtis et al. [9] describe the teacher defined activities in this area as “tasks that would be difficult, if not impossible, to perform on paper” (p. 24), such as creating animations of scientific concepts like the water cycle.

Penuel et al. [10] report on a project that explored the potential of handheld computers to support classroom assessment in upper elementary and middle school science classrooms. Tatar’s [11] study of 100 teachers who had used PDAs for one school year reported using the PDAs as “productivity tools,” especially as word processors.

For the most part, the previous work shows that the use of ICTs in the classroom has focused more on new educational applications and less on the issues to be addressed for teachers to introduce PDA use into their classrooms.

If we turn to studies of teachers’ “successful” implementation and use of ICTs in the classroom, we find that supportive and collaborative relationships among teachers, a commitment to pedagogically sound implementation or pedagogical models of new technologies, and principals who encourage their teachers to engage in their own learning are viewed as highly useful factors [12]. Furthermore, Dwyer’s [2] longitudinal study of the “Apple Classrooms of Tomorrow” found that teachers who had regular access to ICT in their classrooms over several years experienced significant changes in their classroom practices, empirical study, PDA-roles, sociocultural perspective, technological affordances, tool-mediation.

I. INTRODUCTION

In the past few years there has been an increased focus on using information and communication technologies (ICTs) as tools for learning and instruction, both from educational researchers [1-3] and policy makers [4]. Teachers in many schools are expected to adopt, understand and make use of different ICTs in their classrooms. This is not new since throughout time new technology has been adopted in schools (the abacus, electronic calculator, word processor, etc). The PDA (Personal Digital Assistant, handheld or mobile technology) is one of the latest trends. The research reported here provides examples of teacher-defined use of PDAs in the classroom. By teacher-defined we refer to the tasks and learning activities planned and directed by the teacher as part of curricular activities and mediated by the PDAs. Previous studies of the implementation of mobile technologies in the classroom have focused almost exclusively on the learning potential of the new technology, but the teachers’ role has been neglected. Our paper is guided by the following research question:
instruction practice, but not until they had confronted deeply held beliefs about conventional schooling.

II. THEORETICAL PERSPECTIVES

Our study is informed by a socio-cultural perspective, where learning is understood as mastery and appropriation of cultural tools [3, 13-15]. Tools are cultural, which means they are connected to culture, institutions, and historical development [14, p. 24]. We also draw on human-computer interaction (HCI), in particular affordances and constraints [16, 17], in order to provide a rationale for why certain tools are adopted and others are not.

From a sociocultural perspective, understanding the mediating role of tools is a prerequisite for understanding learning [15]. Mediation refers to the relationship between humans and their objects of activity, which is always supported by tools. Mediation enables collaboration among peers within a context of culture and institutions. Therefore, mediated action becomes the main unit of analysis in socio-cultural research [14]. We have studied PDA-mediated actions in the context of four classrooms. The cultural and institutional dimensions of this context include the other tools in the classroom that are related to the PDA.

Wertsch [14, p. 25, pp. 42-46; 18, p. 66], in an analysis of the Olympic discipline of pole-vaulting, describes how the introduction of a new type of pole raised the issue of whether modern pole-vaulting is an extension or transformation of the old form of pole-vaulting (p. 66). Based on user testing of an end-user tailorable tool, Mørch [19] distinguishes between extension of a tool and transformation in tool use, observing that they are qualitatively different. For example, incremental modifications to a tool can radically transform the task for which the tool was intended. In introducing PDAs as a tool in the classroom, we have a similar situation, and we have to ask whether PDAs transform or extend existing forms of mediated actions. Returning to the pole-vaulting example, Wertsch points out that pole-vaulters sprang to greater heights when using the new poles. Another example is the transformation of writing practices with the emergence of the word processor. Editing tasks like crossing out, revising and cutting/pasting are qualitatively different from writing with a typewriter, or pencil and paper. On the other hand, the word processor as a (hardware) tool can be seen as an extension of the typewriter (e.g. the keyboards are very similar). However, the classroom is a special kind of “learning context.” The teacher has the “power” to define activities related to curricular aims, and new tools are often regarded with scepticism towards that end. For example, the introduction of calculators in mathematics education initiated a still ongoing debate about mathematical skills and the calculator’s “position” as a tool in education [for an in-depth discussion see 13, 14].

There is a point of connection between sociocultural theory and human-computer interaction. When Wertsch [14] discusses tool-mediation, he explains it in terms of how a tool empowers users or enables certain actions. In the vocabulary of human-computer interaction, this translates to the affordances a tool presents to its users. The term affordance was introduced by Gibson [16] to describe perceived and built-in characteristics of more or less usable things in the environment. Norman’s [20] notions of constraints and perceived constraints extended the notion of affordances to be the characteristics that allow a user to “do” while constraints “limit” that doing. In adopting this (HCI) perspective from a sociocultural position, the tool’s affordances are often highlighted. However, this is not sufficient for analyzing tool-mediated action, because when it comes to how tools interact with each other this is determined by both affordances and constraints. We suggest that in order to provide a more complete analysis of the actions mediated by cultural tools like PDAs, both the affordances and constraints of the tool have to be taken into account. Chan et al. [1] describe several aspects of mobile technology that are applicable in learning situations: portability and mobility; social interactivity enabled by peer-to-peer communication; data exchange and face-to-face communication. Each of these is an affordance and a constraint. However, the HCI perspective does not sufficiently take into account the sociocultural context, which is a key factor to understanding mediated action. For example, an affordance in one situation can be a constraint in another [21].

In introducing PDAs as a tool in the classroom, we asked the following question: How do they transform or extend existing forms of mediated actions?

III. DATA COLLECTION

We (first author) collected data in the use of PDAs for educational purposes in four sixth-seventh grade classrooms, two in Norway (Headland Primary School) and two in the United States (Midlands Intermediate School). We will first describe the school contexts and our reasons for choosing these particular schools before we describe the data collection methods.

A. Headland Primary School, Norway

Headland Primary School in Norway was chosen after contacting the Local Education Authority (LEA) for school recommendation. Three schools were suggested, and Headland Primary School was chosen for the following reasons:

i. The teachers and school principal were enthusiastic about trying out new technology.

ii. They were ready to make changes in the technical infrastructure of the classroom.

The study followed the students and teachers at two sixth and seventh grade classes at Headland Primary for three consecutive weeks in one semester and four consecutive weeks in the following semester. There were three main teachers: Owe, Elisabeth and Stephen. The teachers started using the handhelds in April 2003 while the students started using them in June 2003 at the end of their fifth grade. The school had two classes at each level (1-7), and the number of pupils in each class is relatively small. In 2004, the two classes were joined to form one class with 41 children in total. The teachers and students were equipped with Palms that were not connected in a network. There were four desktop computers in the classroom for synchronizing with PAAM (Palm Artefact...
and Archive Manager), for uploading programs and for Internet browsing. All three teachers had taught for at least a minimum of six years, and Owe was the IT-support person for the entire school. None of the teachers had previously had daily experience with using ICT in the classroom. Owe had, however, worked with in-service ICT courses for teachers¹. The school had a computer room that was available for the entire school. The school principal and the teachers’ colleagues also expressed positive views of using the PDAs in the classroom.

B. Midlands Intermediate, Michigan, USA

Midlands Intermediate, Michigan, USA has around 890 students in grades 5 and 6, with a catchment area of up to approximately a 45-minute bus drive. The school was chosen for the following reasons:

i. It contained a sixth grade class, and was participating in the University of Michigan study for the third year, and two fifth grade classrooms in Norway had already been chosen.

ii. Some of the other schools visited had factors that would have made it difficult for me as a researcher coming from a different country to understand. The classroom population at Midland Intermediate appeared to be relatively similar to a Norwegian setting, and as such, and thus it could more easily be understood.

Students and teachers at Midlands Intermediate in Michigan, USA were observed for a period of two weeks in 2003 and three weeks in 2005. There were two sixth grade classes involved in the project at Midlands Intermediate, which at the time (2003) had 25 students in each class and two teachers who worked together in a team, Mrs. S and Ms G. The students and teachers were equipped with Palms/keyboards that were not connected to a network in 2003 and with a pocket PC/keyboard in 2005. The pocket PC also had an Internet card configured, and inserting the card into the slot meant that the students could surf on the Internet and synchronize their work to PAAM. Both teachers had taught for at least a minimum of six years, and had used the PDAs in the classroom for five years as of 2005. During data collection, the teachers stayed in their own classroom (homeroom) and students moved between two classrooms. However, the students had homeroom in one of the classrooms (e.g. 6A had Mrs S. as their homeroom teacher and 6B had Ms G. as their homeroom teacher).

IV. METHODS FOR DATA COLLECTION

The unit of analysis is PDA-mediated actions and interactions, and in this paper, we focus on the teacher-defined activities mediated by the PDAs. Data was collected by means of observation (documented by video supplemented by field notes), on-the-spot conversation with the students, and focus group interviews with the students at the end of the observational period. In addition, at Headland, teacher meetings regarding the planning of PDA use in the classroom were also recorded (mainly audio). At Midlands, the teachers discussed lesson plans and PDA use during their lunch hour, and these conversations were recorded (audio). Data corpus totaled 47 hours of video material. Video observations were first content-logged and then categorized [22]. A selection of the video-categories, based on frequency of occurrence, typicality, a-typicality as well as quality of interaction were then transcribed² and analyzed. Observation and interview material in Norwegian was translated into English by the first author.

V. FINDINGS

Our findings indicate that despite the similarity of the tools, the teacher-defined activities differed substantially across two institutional contexts (Michigan and Norway) as we elaborate below. We will first describe the main PDA-mediated activities organized by the teachers.

A. Teacher-defined activities at Headland Primary, Norway

At Headland Primary the main PDA-mediated activities defined by the teachers included using the PDAs as word-processing devices for writing English sentences (e.g. learning about similes like "as white as snow") as shown in Figure 1. Furthermore, they were used in maths lessons and vocabulary recall using simultaneous beaming, and they also used were used to write weekly logs.

[Image of Figure 1: Flowchart showing PDA use in class]

² Note on transcription conventions (The names of all children in the transcriptions have been changed, as have the names of the schools.)

( ) Short pause
[ ] Overlapping utterances
[...] Taken out
[comments] Researchers comments, movement descriptions etc are placed in square brackets and italicized
The students typed the sentences on their PDA. If they misspelt a word in English, the PDA would highlight the misspelt words and the students could check their spelling either on their own initiative or on being asked to do so by the teacher. Their work was also saved on PAAM, and could be downloaded from the Internet.

The teachers expressed some frustrations with the PDA use. These were mainly related to technological or logistic breakdowns. For example, synchronising data from the PDA to the PAAM could create a “bottleneck situation,” and sometimes PAAM was down or was being backed up. One of the teachers commented that when she was walking around in the classroom to see what the students were doing, it would take a very long time to “go through” everything. One teacher’s complaint was expressed as follows:

“[…] then you are about to give feedback on FreeWrite – in FreeWrite – and it did not work. [I] had to use Notepad, or Memo Pad. I’d given feedback to eight and went back to check and it was all gone.”

The primary source of frustration seemed to be that the teachers would have liked to provide feedback using the same tool that the students were using and to do so concurrently. They also mentioned that it was awkward to correct a single spelling mistake, as this required writing an explanation of the proper spelling of the word rather than simply correcting the misspelled word, such as one would if it were written using pen-and-paper, with a red pen.

During the observations and interviews with the teachers, they commented on their own and their students’ PDA-mediated activities. One of the teachers commented, “I have to get it in that it [the PDA] is not just a playing thing but that it actually can be used sensibly and educationally.”

The teacher here refers to his own perspective on the PDAs as being playthings more than teaching/learning tools, and that the concept of using PDAs educationally needed to be worked on. However, about the students’ use of this technology, the teacher said that when given the choice of using the PDAs or writing in their copybooks, the students would usually choose to use the PDAs. According to the teacher, it was like

“sitting in a quiet office and just hearing click-click [made typing movement with hands].”

When asked in a final interview what programs they had used during the past two school years, the teachers said that FreeWrite and PicChat were used “a lot.” One teacher noted, “It has become a tool, an instrument that works well for many.”

Teachers at Headland have used the word-processing program “a lot.” From the situations we have described, the students used the PDA just like “any other book,” and the teachers only made use of the “book-like” affordances of the device, especially in the English class. They were writing sentences with the word processor and testing each other in their vocabulary skills. This is PDA usage that is “book like” and draws specifically on the word processing affordances offered by the PDA that are similar to book writing.

The teachers’ PDA-mediated activities, however, were in contrast to how they planned to use the PDAs. For instance, during planning sessions, the teachers discussed using animations in science and creating newspapers using the PDAs. In the interview, however, the teachers commented that the students created too many animations and downloaded too many newspapers from the Internet, thus causing problems with synchronisation and storage. The teachers resolved these problems by deleting the program despite their initial plans. The teachers had not previously had experience in using ICTs for educational purposes on a daily basis. What we see here is more of an extended use rather than a transformed use.

B. Teacher-defined activities at Midlands Intermediate

At Midlands Intermediate School, the PDAs were used in Language Arts, Maths, Science and Social Science. The teachers defined activities such as concept mapping. An example of this is how they depicted “the atmosphere” in the science class. This was followed by an animation of the same topic (Figure 2). The students would start by collecting information from their textbooks and searching on the Internet before they presented their work visually and through an animation. They collected data and created graphs, drew concept maps to organize the information, and wrote an essay as the final learning exercise.

Concept mapping was also used in essay writing to better structure the essay. The students were told to have “one idea per paragraph” and for each paragraph to correspond with a node in the concept map.
Figure 2. Example of concept map and screen shots of animation from the Atmosphere project

The teacher also notes that she views drawing on the PDA as a “motor skill.” The teachers’ perspective of technology is that of a visual aid, as an “aid/extension” to memory, a “value” for retention purposes. Is this a starting point that provides a philosophy of use? The teacher also stated that the students use concept maps to “revisit” or go back to their work, a phenomenon that is often uncommon among younger students [23]. This view of technology appears to correspond to the transformation of educational practice in the classroom to a place where tests are not only written, but also consist of an animation (see Figure 2) of a topic that should be factually correct.

VI. DISCUSSION

In comparing the PDA-mediated activity in the two settings, at Headland those activities supported writing and testing. They did not take advantage of concept mapping and animation. In Norway, however, it seems that PDA use stopped at the planning stage. The teachers felt that the students “overused” the tool, which might have been attributed to its novelty effect; nonetheless, the teachers’ perception of the students’ PDA use was addressed by simply eliminating the program altogether. They also referred to the PDA in terms of familiar technologies - books, typewriter. This is in sharp contrast to the classrooms at Midlands. The teachers at Midlands were more experienced in using PDAs than their colleagues in Headland. They were in their fifth year of adapting PDAs to their classroom instruction in 2005. The Midlands teacher had strong opinions on the usefulness of the PDAs as a multi-purpose tool, whereas the teachers at Headland treated the PDAs as a new form of book. We do not know in what specific ways the teachers at Midlands used the PDAs during their first years, but while the Headland teachers were in the first stages of PDA use, the Midlands teachers had already moved on to a more different stage and thus were closer to full adoption of PDAs in their classrooms.

Our data indicates that there are multiple stages of adoption of PDAs into teachers’ classroom practice, and Headland and Midlands represent two different stages. They can be explained as stages of transformation and extension. In one case, the new tool transformed the practice, i.e. the actions defined by the teachers exploited the PDA’s affordances and constraints, and the nature of the actions was fundamentally different from other tools’ ability to perform the same task. In the Headland case, the PDA merely extended older tools, or the PDAs mimicked an older way of using the tool (such as pencil and paper). In doing so, however, the nature of the actions remained unchanged. In other words, in the Headland case it was the affordances of a familiar tool that determined the action, and these affordances were transposed to the PDA. This is not an uncommon phenomenon in the early phases of diffusion of a new technology into a workplace [see for example 24].

Previous studies of use of PDAs in the classroom reported use in many subjects. These studies however do not account for who the teachers are. It was the teacher-defined activities that determined the role of the PDA and its connection to related tools (paper and pencil, notebook, calculator, etc.). In addition to several contextual factors,
the teachers’ views of the PDAs, appears to correspond to how the tools were used.

A lesson learned from this study is that it is not enough to introduce a new tool such as the PDA into the classroom and expect teaching practice to be transformed. Teachers need to be exposed to and be able to reflect on the tool’s affordances and constraints in the context of learning and instruction; otherwise, extension will be the main factor influencing use. Furthermore, the teachers at Midlands collaborated with the nearby University of Michigan in person and on a regular basis. The teachers at Headlands had to collaborate electronically and across different time zones.

In comparing PDA use by teachers in two separate schools located in Norway and the United States, we see different views of what the technology can accomplish. Future studies need to focus on the teachers’ initial perception of the PDA as a teaching tool and whether this changes over time [2]. Questions that need to be answered are the following: Does initial perception of the technology pervade the teachers’ educational use? Furthermore, does transformation of mediated activities need to pass through an extended period?

REFERENCES


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