Dynamic-PDA-Use for Learning: An Undergraduate Student Experience

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Abstract: The paper reports on a one-year case study of Personal Digital Assistant (PDA) use for learning by an undergraduate student in the Department of Mechanical Engineering at a university in Hong Kong. Data was collected through student e-journals and artifacts, observations, in-depth and retrospective interviews. In the data analysis, both categorization and contextualization strategies were adopted to provide a well-rounded account of the inquiry. The research results are presented and discussed. The paper proposes the concept of *dynamic-PDA-use* for learning, and suggests that understanding and adopting this concept in learning will help improve PDA educational practices, and allow dynamic and flexible PDA use for varied learning activities.

Keywords: Context, dynamic, higher education, PDA use, tool

Introduction

In handheld educational application literature, handheld technologies have been used as a technology tool for encouraging classroom collaborative learning [11], supporting lifelong learning [3], enhancing interactivity both in/out of class via a messaging system [9], helping increase student learning motivation and lessen pressure using handheld communication tool [14], and scaffolding learners in context-aware learning [1]. Much research has focused on using designed tools or learning systems on handheld technologies to support prescribed learning tasks, and less attention has been paid to students' handheld device use for their own learning in context [16]. There is, therefore, a need to explore handheld educational uses perceived by students themselves in higher education.

This paper reports on an undergraduate student's perceptions and use of the Personal Digital Assistant (PDA) – a type of handheld devices to support academic studies in the Department of Mechanical Engineering at a university in Hong Kong. In the following sections, this paper reviews handheld application literature, describes the context of the case study, presents the research design and research results, and discusses the research findings and conclusions.

1. Handheld Educational Applications

Patten, Arnedillo-Sanchez, and Tangey [13], based on handheld functional applications and pedagogic practices, develop a framework, in which pedagogical underpinnings are used to analyze the functional breakdown of applications. These applications contain seven categories: *administration*, *referential*, *interactive*, *microworld*, *data collection*, *location aware* and *collaborative*. The authors argue that *microworld, data collection, location*

aware and *collaborative* applications are more educationally appropriate as they build on a combination of collaborative, contextual, constructionist and constructivist principles, but *administration*, *referential* and *interactive* applications involve little pedagogy. Clough et al. [3] did a survey study of adult workers' informal learning using handheld devices. Based on the survey study results, they revised Patten et al. [13]'s framework, and developed a framework of handheld learning activities in informal learning settings. The main categories of learning activities indentified are *referential location aware, reflective, data collection, constructive* and *administrative*. Though these studies provide useful literature of handheld applications in education from different perspectives, the potential of handheld technology cannot simply 'be disassembled into predictable cause-and-effect descriptors that can be counted and correlated' without considering the context in which they are used [6].

2. Context of Handheld Educational Applications

Learning is embedded in social contexts [18]. Lave [7] makes a theoretical distinction between two aspects of social context. What she calls the arena that constitutes the 'objective' social context, to be described in physical, economic, sociological or political terms; setting, on the other hand, is used to refer to the context as experienced by a participant or set of participants with reference to a social context. The former context is also referred to as broader context, and is more constant (Cole, 1996); while, the later context is also referred to as *immediate context,* and is more temporal and dynamic [8]. These contexts emerge from the weaving together of varied levels of contexts to form a particular pattern of learning activities mediated by artifacts or tools [4]. The context-as-weaving metaphor suggests that '[t]he relevant order of the levels of context will depend crucially upon the tools through which one interacts with the world, and these in turn depend upon one's goals and other constraints on action' [[4]. Humans do not act directly on the world; rather, actions are mediated by social-semiotic tools as well as by material artifacts or tools [17]. When a new tool is introduced into the immediate context woven together with broader context, it causes changes to the context, hence shape the learning activities embedded in the context. Handheld devices as tools are considered by many researchers to have the unique characteristics of 'mobility or portability, immediacy, individuality, interactivity, accessibility and connectivity'. These characteristics make handheld educational applications in relation to functions distinctive from other technologies such as desktops or laptops. This technology use is highly dependent on the context in which learning mediated by the tool occurs [15]. PDA tool use can facilitate or constrain learning activities depending on the context in which the PDA tool is introduced because new forms of technology mediation have affordances as well as constraints [18].

Based on the above understandings of context, PDA tool use cannot be studied without considering the immediate context in which PDA educational practices occur. This immediate context is inseparable from interwoven broader context. Therefore, in this research, context is considered mainly in these two interwoven dimensions.

3. Research Design

This one-year (from April 2006 to March 2007) research adopted a qualitative methodology through a case study approach, which 'an empirical inquiry that investigates a contemporary phenomenon within its real-life context' [19]. This study aimed at gaining a deeper understanding of both processes and outcomes of the student PDA use for learning in context.

3.1 Student Biographical Data and Research Context

George (pseudonym), a first-year undergraduate student, was chosen as the case for this study. This study examined *what PDA uses George made for his learning*, and *how these uses supported or constrained his learning* in the context of Department of Mechanical Engineering at University A (pseudonym) in Hong Kong. George was diligent and aimed at obtaining first-class honors Bachelor Degree that only about ten percent out of the 120 students in his year generally get. The learning culture in the department was very competitive. George obtained a higher degree diploma at University B (pseudonym) before he was enrolled by University A. The reason for George to join this research project was that he wanted to try the PDA with a phone function provided by this research study for one-year free use. The PDA was the wireless enabled Dopod 818 Pro. It supports 2 G mini or standard memory cards. George could access the Internet using the PDA on campuses of both University A and University B for free.

3.2 Questions for the Inquiry

The research questions that guided the inquiry are:
- What PDA uses did George make for his learning?
- How did these PDA uses support or constrain George's learning?

3.3 Data Collection and Analysis

Five means of data collection were used over a period of one year: student reflective electronic journals (e-journals), student artifacts created using the PDA as screenshots, face-to-face in-depth interviews, observations and retrospective interviews. Categorizing and contextualizing strategies were adopted to analyze the data collected [10].

The data analysis underwent two stages. First, content analysis using Nvivo software was used to categorize the data collected. Student data sources were initially coded on the broad themes: uses and constraints. Then the themes were recoded into sub-themes. A constant comparative analysis was conducted on data to find sub-themes that initially emerged from student perceptions of the PDA use and learning. A final list of sub-theme codes was placed in matrices along with excerpts from e-journals and interviews. Afterwards, student artifacts, running notes in observations and retrospective interviews were coded and put into the matrix by themes and sub-themes in order to triangulate data. The lists of sub-themes of PDA uses and constraints emerged. In the second phase of data analysis, a more descriptive method was adopted to contextualize PDA uses and constraints in context to understand the 'true story' behind the uses and constraints for learning in relation to the sub-themes. Factors that influenced PDA uses were identified. The results are shown in the following section.

4. Results

The results show that the PDA was used as a package of tools for learning. They are tools for: *multimedia access, multimedia collection, communication, connectivity, representation* and *scheduling*. These tools also constrained learning activities in terms of PDA *small screen,*

slow processing speed, screen freeze, unstable system, and poor recording quality. In the meantime, the contextual factors of *other technology, other people, institution, and community* played important roles in the process of PDA mediated learning activities in varied contexts. The following sections explain the PDA as a package of tools, and the use of the tools in three episodes from George's experience.

4.1 PDA as a Package of Tools

- *Multimedia access tool*: refers to the PDA use for accessing different on- and offline multimedia such as on-and offline dictionary, lecture handouts, and online information for learning support in terms of revision and reference.
- *Multimedia collection*: refers to the PDA use for collecting data such as audio, pictorial, text data in varied contexts for learning support using the Camera function, Notes function, and Recording function on the PDA.
- *Communication*: refers to the PDA use for communication via varied channels such as SMS, phone calls, emails, and MSN.
- *Connectivity*: refers to the PDA use for internet connection, and file sharing and printing by connecting the PDA with other devices such as mobile devices, computers or printers.
- *Representation*: refers to the PDA use for creating representations that demonstrate thinking and knowledge [2].
- *Scheduling*: refers to the PDA use for managing schedules using Calendar, Tasks, or downloaded software.

4.2 PDA Tool Mediation in Context: 3 Episodes

4.2.1 Episode 1: Representational Tool for Peer Learning

George reported that Material Science in his disciplinary study was hard to understand. He was good at it because he learned some of the knowledge when he pursued his higher degree diploma at University B. George mentioned that his classmates often asked him questions about the course, especially during examination period, and he was happy that he could offer some help to them. One time, his classmate asked him about the microstructure of steel in a university canteen. He noted,

> I had no paper on hand at that time. It was hard for me to elaborate on the complicated theory of the structure without a visual diagram... I drew a microstructure of steel for my classmate in Notes on the PDA [See Figure 1]. Though the picture was not well drawn on the small screen, it helped him visualize and better understand the microstructure when I explained the theory to him. (9 May 2006, e-journal).

4.2.2 Episode 2: Connectivity and Multimedia Access for Collaborative Idea Construction

George reported that he attended a summer training course organized by the Department of Mechanical Engineering. In the course, the lecturer demonstrated how to design a model of an object that had a three-dimensional effect. After the demonstration, students were asked

to design a three-dimensional model of any object of their choice in groups using a laptop computer. However, these laptops did not have internet connection. George and his group members did not have any idea of what model they were going to design. George could access the internet by putting his previous phone card to the PDA as he had bought a package for internet connection via GPRS using the phone card. He and his group members connected the PDA to the internet, searched some images, chose and downloaded a few of them in plane figure from the internet to his PDA storage card. Then they transferred the files from the storage card to the laptop computer using a card reader. They referred to these figures, made reflections and discussions on which image would be better as a plane figure of the model, and reached an agreement in the end. Inspired by the plane figure, George and his group members successfully designed 'A Bathing Ape' which has an embossing three-dimensional effect (See Figure 2). 'Though the internet browsing via GPRS was not as fast as that via WiFi, it did help us to find out useful images' (19 July 2006, e-journal).
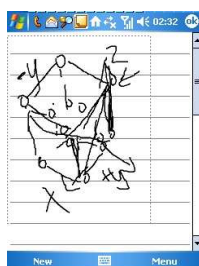
Figure 1. Screenshot of the drawing of the microstructure of steel

Figure 2. Picture of the designed 3-D model of 'A Bathing Ape'

4.2.3 Episode 3: Multimedia Collection, Connectivity and Multimedia Access Tools for Constructing Lab Reports Collaboratively

There were a few courses for lab experiments in the Department of Mechanical Engineering the time when George joined this research project. George often used the PDA as a multimedia collection tool to capture lab results for the reference of writing lab reports after the experiments. George reported that in a lab experiment for the course 'Properties of Material', the microstructure of steel was shown via nanotechnology. Students were asked to use ping pang balls to create a structure that they observed. After piling up the balls, George used the PDA camera to take three pictures from different angles because the three sides of the structure were different (See Figure 3). He then beamed the pictures to group members for the reference of constructing the lab report collaboratively. The beaming speed was acceptable as the file size was small. George noted,

> Using the PDA capturing function, I could record our lab results accurately. Though the quality was not as good as a digital camera, it helped us to visualize, reflect, and draft a well-presented report collaboratively after class. Without it, it was hard for us to draw pictures in such detail, and the research results might be distorted in the lab report without accurate drawings. (20 May 2007, retrospective interview).

Figure 3. Screenshots of the lab results captured from three dimensions

5. Discussions

Through the three episodes of George's PDA-mediated learning activities, it is the tools on the PDA that offered the learning opportunities for George and his group members. Among the six PDA tools identified from George's data in this study, *multimedia access, connectivity and representation tools* have been explored in Churchill and Churchill's case study [2]. In spite of this, many other research studies have investigated the functions of handheld devices for managing tasks, reference, data collection, communication, file sharing among devices, etc. [1] [3] [5] [9]. However, the majority of these studies have investigated the functionalities of the handheld devices in designed learning environments where students used handheld devices for prescribed tasks. Though Churchill and Churchill's study did allow the user to explore PDA affordances, the study aimed at exploring the possible educational capabilities of the PDA from the perspective of a technician rather than the actual exploration and use of these capabilities for varied learning activities from the perspective of students. The six PDA tools indentified from the research data source – George, are by no means exhaustive. There are other possibilities of PDA tool use for learning to be explored in further research studies.

PDA tools could be used individually or in combination to support learning. In the three episodes of learning activities, two of them were accomplished with the help of combined tool use. For instance, George and his group members constructed the lab report collaboratively by integrating the use of multimedia collection, connectivity and multimedia access tools. In addition, the same tools could be used differently in different learning activities. For example, in Episode 1, connectivity tool was used for internet connection to access images for the construction of a model design; while, in Episode 2, connectivity tool was used for connecting devices among group members to share photos of lab results for the collaborative writing of the lab report.

PDA tool use for learning was closely related to learner's willingness and capacity, the chosen PDA tools, and context. In the first episode, George used the PDA as a representational tool in Notes to create the representations of his knowledge of the microstructure of steel. This helped his classmate understand the abstract concept of the structure, and provided 'aids to reduce the mental load' [12]. It was noted that this tool use for peer learning resulted from the inter-related factors of the peer learning activity created by George's friend, George's capacity to perceive and use the PDA as a representational took, George's capacity to take up the responsibility of 'teaching' due to his prior knowledge of Material Science acquired at University B, George's willingness to offer the help. In addition, such a use was also influenced by immediate contextual factors of lack of paper on hand, the difficulty in the course material that made George's classmates raise questions, and broader contextual factors such as the departmental course examination to deal with. Though small screen for drawing was a constraint of the PDA, the tool offered more affordances than constraints for the learning activity.

In the second episode of George's use of the PDA as connectivity and multimedia access tools to help construct the idea of model-making, the connectivity of the PDA to the

internet provided opportunities for George's group to access and refer to the multimedia images that inspired them to design their own model. In the model-making activity, the immediate context in which PDA tools were introduced was concerned with the goal-oriented model-making activity, George's previous experience in using GPRS, availability of a phone card with GPRS connection capability, other group members, the lecture's permission of allowing the student to use the PDA, and the constraints of internet access via WiFi. The broader context of the faculty training program intertwined with the immediate context, influenced the way in which the tools were introduced, hence changed the model-making learning activity.

In the last episode where George and his group members collaboratively did a lab experiment, the PDA as a multimedia collection tool was used to capture the lab results, and then the PDA as a connectivity tool was used to connect George's PDA with the handheld devices of his group members to share the photos of lab results. Finally, the PDA as a multimedia access tool was used to refer to the photos for visualization, reflection, discussion and construction of the lab report in George's group. The three tools were integrated into and transformed the lab experiment learning activity. Nevertheless, in the immediate context in which learning occurred, it was the group lab experiment task and the evaluation of the task via the lab report that motivated George and his group members to take advantage of the tools as they wanted to achieve good results in the course; other handheld devices among group members, George's and his group members' willingness to make use of the tools also provided the opportunities for them to make such uses. The broader context such as the departmental curriculum of the course design, the competitive culture among students for better grades in order to get a first-honor degree was interwoven with the immediate context to impact the active use of the PDA tools for this learning activity.

In both Patten et al. [13] and Cough et al. [3]'s handheld learning activity frameworks, the functional applications are correlated with pedagogic practices. However, the case study reveals that the learning activities mediated by the PDA tools were not as clear-cut activities as described by Patten et al. and Clough et al. These activities were far more complex, temporal, dynamic and flexible depending on the immediate context consisting varied factors such as the hands-on tasks, the goal, willingness and capacity of the student, other students, the lecturer, PDA tools, the constraints of the PDA and physical conditions. This immediate context was intertwined with broader context such as departmental factors and community learning culture. It is noted that the PDA as a package of tools mediated the student's learning. However, if the tools were not used by the active and capable agent, they themselves could not support learning activities, and if the context that did not enable effectivities of the tools, learning could not happen. Therefore, the process of the PDA uses was dynamic interactions among the three factors: the agent, the PDA tools and the context. Learning can be examined through the learner (agent) active engagement in learning tasks using the PDA as meditational tools in the social cultural context that support the learning. Dynamic PDA uses are the interplay among the dynamic (active) learner, dynamic PDA tools perceived and used (possibilities of the PDA tools perceived and used for learning.), and the dynamic (supportive) context. The paper proposes the concept of 'dynamic-PDA-use' for learning, and encourages such a use in pedagogic practices.

6. Conclusions

This empirical longitudinal research investigated into the PDA use for learning from the perspective of an undergraduate student at a university in Hong Kong. The research results show: (a) the PDA could be used as a package of tools for different learning tasks. These

tools include: *multimedia access, multimedia collection, communication, connectivity, representation* and *scheduling*; (b) the use of these tools also constrained and shaped learning activities in terms of PDA *small screen, slow processing speed, poor sound quality, low ring volume, screen freezing, unstable system, poor recording quality, poor calculating software, etc.*; (c) these tools were used individually, or used together with one or more other PDA tools for varied learning activities; (d) the same tools could be used differently for different learning activities depending on the context in which they were used. The paper concludes that dynamic PDA uses for learning are closely related to the dynamic learner (agent), dynamic tools and dynamic context. The paper proposes the concept of *dynamic-PDA-use* for learning, and suggests that understanding and adopting this concept in learning will help improve handheld educational practices, and allow dynamic and flexible PDA uses for varied learning activities.

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