

Experiences in use Tablet PC to Support Student's Activities:

Five Years of an Exploratory Study

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Abstract— Since 2006 we are studying the use of Tablet PCs in academic environment to support learning activities in and out classrooms. This article resume a five years of Tablet PC use in many learning activities, since 2006 until 2011, describing how this device was used. In the exploratory study, the student deals with some interaction problems that are described here. One conclusion is the difficult to find software for Tablet PC that offer functions to support the broad of student's activities, but the main contribution is the perception of the usability decrease when use software designed to desktop PC in Tablet PCs.

Keywords—Hardware/software systems for mobile communications, computing support learning activities, usability, pen-computing.

I. INTRODUCTION

The recent technology forwards minimize part of the commons problems in the mobile computing: connectivity, length and processor capacity. This possibility brings a broad of new applications made to support many areas, inside this areas we can highlight the education. One of the mobile devices that are gained repercussion in this scenario is the Tablet PC, a device with height is similar to a notebook and have an input device similar a pen.

The paper and pen metaphor implies that tasks performed before in paper, like draw or manuscript writing, can be more natural in the Tablet PC than in the another computing devices. So, educational applications for contexts where paper and pen usually are presents can benefits from this new interaction style and from pen-computing, it offers better use experiences for teachers and students.

Backon [1] says that the keyboard allows a rapid typewriting and do texts structured by topics, but only pen can allow a creativity increment, better flexibility and a natural record of the think development process and rationale in all stages (ideal requirements for the educational environment), aging like a direct hand extension. For example in the resolution of complex problems with a large calculus solution, by using applications is possible to record all the steps and draw diagrams that explain the problem resolution, step by step.

When move the pen in the screen, the pen trace should result in electronic ink that must be treated by the application to be rendered and stored. But desktop applications, that running in the Tablet PCs, do not treat electronic ink, so it is

necessary special applications, applications that treat electronic ink, to have benefices of the pen interaction style.

But more than treat electronic ink, witch more attributes differs desktop applications and Tablet PCs applications? Which design issues can be extracted from these attributes and used in the design of good usability applications for Tablet PCs?

To answer these questions, it is necessary collect and analyze the use of Tablet PC applications that support the user in the educational context, a student. So, the initial question is which available applications can be used in the student's day a day activities? Which functions are important to support these activities? Intrigued by these questions, we started to do an exploratory study with real use the Tablet PC and some applications to support students activities. The main objective of this paper is brings some answers to these questions describing this exploratory studies until 2011 that began in the December 2006.

Section II shows the adopted methodology for the exploratory student and its context, and Section III presents the Tablet PCs models used in the study, and Section IV describes the used applications in this period. Section V presents a resume of the use and the main problems the u dealt. Section VI brings some design issues based on the related problems. The conclusions are presented in Section VII.

II. METHODOLOGY

The exploratory study goal is observing and describing how the Tablet PC can be used to support students day a day activities. So we used the following methodology:

- Identification of student activities in and out classrooms;
- Identification of Tablet PCs applications that support the identified activities;
- Use the collected applications for Tablet PC in the activities;
- Analyze the use and collect the student opinion;
- Extract interaction problems.

The study is related with the winning project [2] submitted for the 'Higher Education HP Technology for Teaching Grant Initiative Recipients' [3], an international awards where the best project receive financial support to equip a classroom with Tablet PC and do the proposed research project. The winning project was written in 2006 by a group of researches from UNICAMP interested in study

the use of Tablet PC in high education. This work is related with this project, that dispose a Tablet PC for integral use.

III. TABLET PCs AND USED MODELS

The Tablet PC is a computing device designed to “imitate” a notebook, allowing the user interact with a pen. Resuming, the Tablet PC has the following hardware characteristics:

- (i) Pen sensitive screen;
- (ii) Screen that allow different positions (Fig. 1);
- (iii) Wireless network access by WLAN and bluetooth technology;
- (iv) Microphones and embedded loudspeakers;
- (v) Keyboard (some models the keyboard are detachable);
- (vi) Batteries.

In this exploratory study, we used two HP Tablet PC models, both models have processors similar with the laptops in them build year. The first model, used between 2006 and 2008, is a HP/Compaq TC1100 (Fig. 1) [4] with a 1.2GHz processor and 1 Gb of RAM and a 10.4” screen. Initially equipped with Windows XP Tablet Edition, after it was change for Windows Vista with Portuguese manuscript recognizer. After, we adopted Linux operation system Ubuntu distribution.

The second model, a HP TouchSmart TX2-1040br (Fig. 2) [5] bought in December 2008, has a 2.2 GHz dual-core processor with 3Gb RAM and a 12” screen. The installed operation system was Windows Vista with Portuguese manuscript recognizer. This model has the design more similar to HP laptops but equipped with the hardware described to Tablet PC, and have a touchscreen.

IV. APPLICATIONS FOR TABLET PC

Passed by 8 year that the Tablet PCs are commercial explored, but there is few applications for them yet that can be used in the educational context. Comparing the software production for smartphones and the software production for Tablet PCs, we can see that the Tablet PC ones is timid yet.

During the study case time, tree software for Tablet PCs were used: Adobe Acrobat Professional [6], Windows Journal [7] and Jarnal [8]. All these software are for doing annotations or writing manuscript text.

The Adobe Acrobat Professional (Fig. 3) is a proprietary software that allows the creation of .pdf files and the use of some tools to typewriting text edition and doing annotations using the Pencil tool for manuscript text and the Highlighter tool for highlight parts of the text.

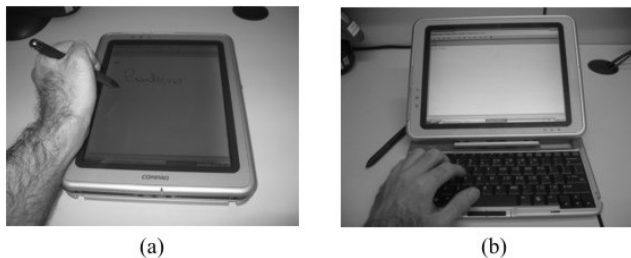


Figure 1. Different positions to use the HP/Compaq Tablet PC model TC1100.

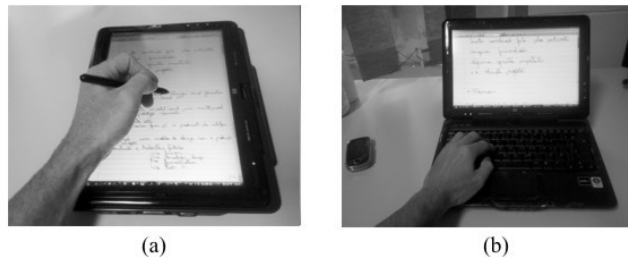


Figure 2. Different positions to use the HP Tablet PC. model TouchSmart TX2-1040br.

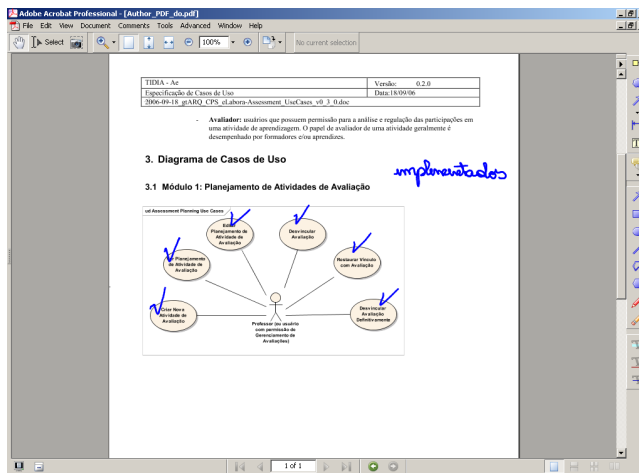


Figure 3. Example of Adobe Acrobat Professional to do annotations.

The Windows Journal (Fig. 4) is a software that comes with the Windows XP Tablet PC Edition and allow do manuscript annotations with tools to change the characteristics of the pen like fat width and color, and some functions like highlight, select and erase annotations, and commons applications functions like new file, open file, save file, copy, cut and paste text and annotations, and insert figures and text editor functions, like add or remove pages.

The Windows Journal save in a proprietary format (.jnt), and to be viewed in a desktop computer needs a special application, called Windows Journal Viewer, a software to visualize the electronic ink saved in the .jnt file. Windows Journal Viewer is distributed freely for Windows users.

The Jarnal is an application written in Java programming language with functionality similar to the Windows Journal, but it is multiplatform and free to use. Among the text editor functions and manipulate the electronic ink, Jarnal allows include files in the background so that is possible do annotations direct over the document. This function allows to use as background files like papers our presentations and highlight import parts of the text with the Highlighter tool (Fig. 5).

V. TAKING NOTES WITH TABLET PCs

The first contact with the Tablet PC occurred in a Human-Computer Interaction classes, where the students were challenged to design applications to this device considering usability attributes. One of the applications developed was the Interactive Logic Notebook [9]. But the

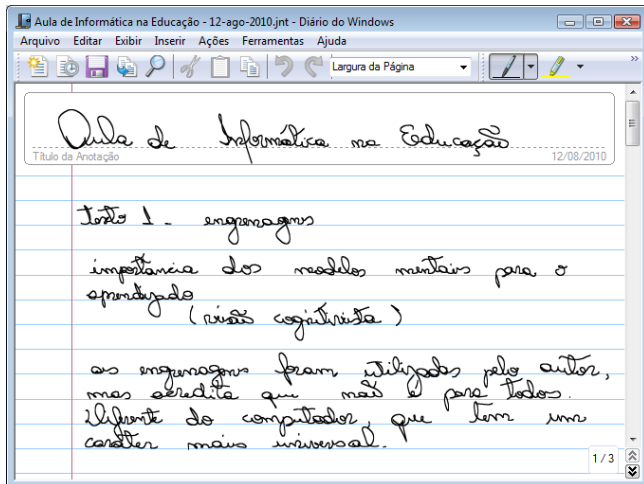


Figure 4. Example of Windows Journal to do annotations into classes.

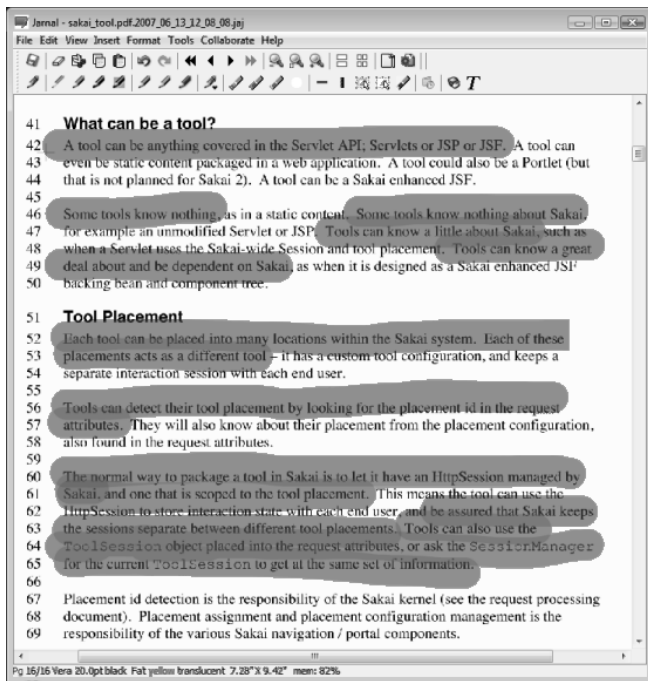


Figure 5. Example of using Jarnal to highlight text.

real use of the Tablet PC to support student activities occurred between 2006 and 2008, when we used the Tablet PC to do classes annotations and do exercises from Theory of Computing, Software Engineering, Distributed Systems and Informatics Applied in Education courses.

The first used model of Tablet PC was available for the students in December 2006, month without classes at UNICAMP. To stimulate the use and acquire experience in use Tablet PC and software, the student decided to use the device to support her in research day a day activities.

The first task the student used the Tablet PC was analyze an use case document available in .pdf format verifying which use cases about an application was implemented conform specified or identified points to update the document when the difference was result from a decision

process to change the design. The student’s goal was doing marks in the text to signalize points that need to be updated or points where the implementation needs to be reviewed.

The chose software was Adobe Acrobat Professional, because the goal was do annotations in an existing .pdf file. Some interactions problems where find in this use, resulting in the adoption of another tool to make this kind of activity in classroom.

The first problem dealt by the student when she used the Adobe Acrobat Professional was the reception of input data to render the electronic ink. In the manuscript writing, the letters were rendered in a sharpened form and sometimes only a trace was showed. Maybe this problem was result from the device do not match the hardware requirements that the software needs, so the Adobe Acrobat did not received all the points to draw correctly the electronic ink. This problem occurred mainly in a short time to start the writing. To resolve this problem, the student pressed the pen against the screen, waiting one or two seconds and start to write the word. But some letters become hard to recognize, because the forgotten points that compose the electronic ink. The solution adopted was written more slow.

Another interaction problem was related with the electronic ink selection function that the Pencil tool have. Pressing the pen near an existing electronic ink, the software interpret this action has a electronic ink selection. This way make hard write letters like “i”, “j”, “k”, “t”, “ç” in the manuscript way and accentuation, that require more than one trace to written the letter. When the users will write the second trace trace for one of these letters, the first trace usually is moved to other position. The user strategy was begin the second trace so far so that the second trace was recognized has a new electronic ink and not has a selection for the existing trace. But this strategy works fine with letter “t”, and does not work to write the dot for the letters “i” and “j” and write the cedilla for letter c.

Another problem deal with the student is related with the scroll bar position, disposed in the right corner. For a left-handed person, the case of this student, when interact with the scroll bar the arm embarrass the content visualization that are moving, become hard to put the content in the wished position. Another problem is the scroll bar width, that for the use with a pen must be more fat. Using the scroll bar in the default width, the student had the tendency to cross the scroll bar borders when the pen was in the second half of the screen. The pen cross the bar borders because the movement of the fist over the screen (the movement is not a straight line). When the pen cross the bar borders, the software back the visualization to the content part viewed before the scroll operation.

To scroll, the user adopted another tool that the Adobe Acrobat Professional has, the Hand tool. This tool allow press in any part of the content and scroll up or down, allowing change the document visualization. The users said the use of this tool is more efficient form to scroll the document.

To shared this use experience, the student written a manuscript text using the Jarnal application with the intent to publish the text in the Messaging Board tool of TelEduc environment, used as a communication platform among the project team. But the Internet browsers do not support

electronic ink or the Jornal format, so the student tried to publish the annotations as pictures, because her wanted to maintain the manuscript way for her readers. To convert the annotations made in the Jornal application in pictures, it was necessary save the annotations in a .pdf format (the Jornal does not have functions to convert annotations in pictures, but have functions to save the annotations in .pdf format), open the saved file and copy page by page using the Adobe Reader's Instant Photography tool. After the selection and copy operations, the student paste this content in a image editor and save the file as a picture format (.jpg). So the images are uploaded to the platform as attached files and referenced by the .html file as image to be viewed by the readers. This activity was considered too hard to do and abandoned lately.

The Tablet PC pen interaction differs from the interaction styles that laptops have (keyboard, track pad) and shows a great potential to facilitate the activity of do annotations in Theory of Computing classes, because in this discipline is necessary adopt symbols that not are in the QWERTY keyboards.

In Theory of Computing classes, exercises lists was shared with students using the .pdf format. As the exercises list is a sequence of problems enunciation without space among them, this become impossible to resolve the exercises using the document as background. So the student resolve cut the enunciation exercise and past in a Windows Journal archive (Fig. 6). The student needed to adjust the pasted object dimensions to become more readability in the zoom used to resolve the exercise (page zoom). After did this steps, the student resolve the exercises. The student justify this work answering her wants to have a map between exercise and resolution for future study., for example, for an exam.

Using the problem enunciation with the resolution can facilitate the resolution, because it is possible highlight parts of the text that are important to the solution or use pictures available in the enunciation (Fig. 6). The digital content allows duplicate items that need to be more than one time in the resolution, the case of the graph draw in the Fig. 7, when the enunciation ask to the students verify how many short-ways the graph has. The student duplicated the graph picture instead of draw it.

In problem resolutions, more than the answer, is important to have the record of each step until get the answer [1]. In some resolutions, some parts needs to be duplicate to show the rationale, as the case of the Fig. 8. The exercise asks a spanning tree for the given graph. The use of the Tablet PC was specially important to use copy and paste functions, turning the answering this exercise more fast because many parts did not need to be rewritten.

A common practice among students is share classes annotations and resolutions from exercises. This practice occurs in Theory of Computing course among the student that used the Tablet PC and the others one. So her sent this annotations by e-mail in the .jnt format. But the other students needed to install the Windows Journal Viewer application to view the file content, and asked to shared the annotation in a more popular format that not require a software installation, like .pdf format. The students adopted this format for all annotations sharing.

To explain different resolutions, doubt points or indicate errors in the shared resolution, the students that did not have a Tablet PC used to typewrite text artifices when use e-mail

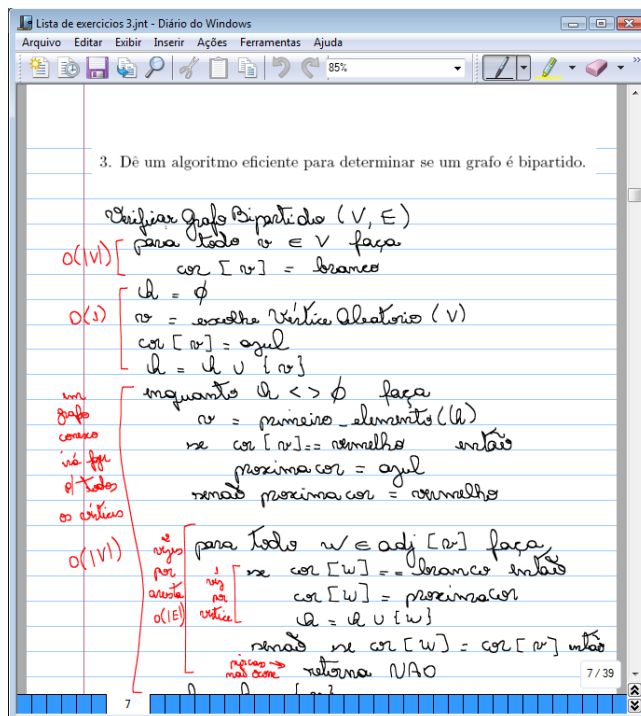


Figure 6. Example of manuscript using Windows Journal when resolving Theory of Computing exercises.

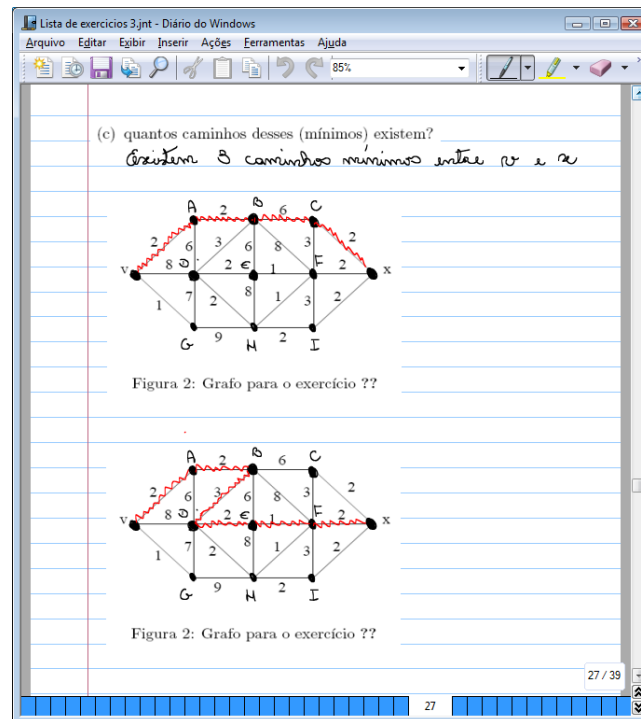


Figure 7. Example of annotations in duplicated enunciation part to resolve an exercise.

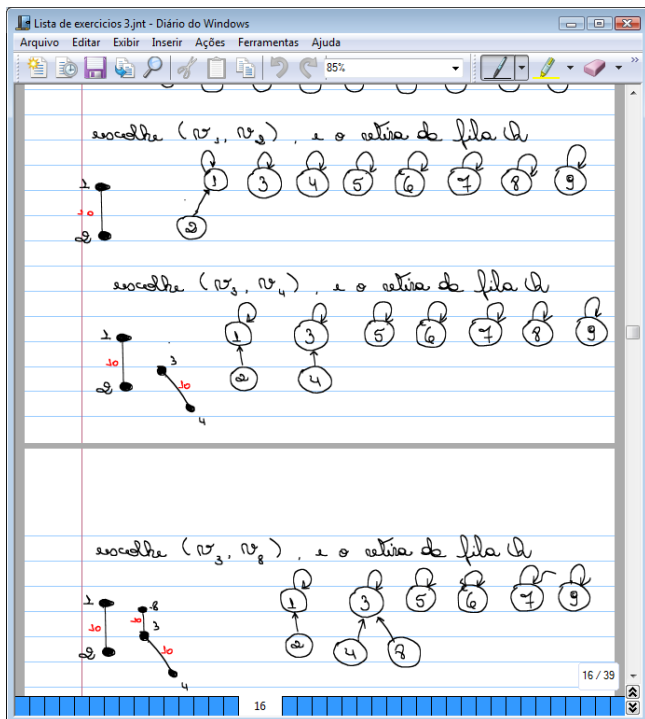


Figure 8. Example of use the copy and paste functions to duplicate annotations.

or to print the documents for do annotations with pen in meeting.

In the next course, Informatics Applied in Education (cursed in the first semester of 2008), the student used the Windows Journal (Fig. 9) to taking classes annotations, using the theme classes in the file name when save. The use of Windows Journal is justified by the better performance in receive the data input and convert into electronic ink, so the result letter is more closer than the other applications.

The Jarnal was used in the Informatics Applied in Education course to support the peer review activity. The peer review activity consist into read a text written by another student and points out how to improve the text. The available text was used as a background document, where the student did the annotations (Fig. 10).

VI. USABILITY PROBLEMS OF THE ADOPTED APPLICATIONS

Analyzing the user interaction, it is possible identify some usability problems in the used applications. The first one described by the student is related with use the same tool to do manuscript text and select electronic ink. Considering manuscript letters, allowing select inks with the tool used to write it turns hard write letters composed by more than one trace, or have points or accentuation. So, one design issue for Tablet PC is avoid unify functions for write and for select in one tool.

To compose the traces of electronic ink, the application needs treat all input data emitted by the pen, composed by pen position on the screen and the pressure. For the letter do no be shaped and the manuscript in Tablet PC be more similar to the manuscript in paper with a pen, the application

needs treat all the events generated by the pen. Techniques for pour rendering of the electronic ink while writing and a high fidelity rendering after the the writing can be used to not loose data.

One of the differences between Windows Journal and the other applications (Jarnal and Adobe Acrobat Professional) is the buttons inside the Windows Journal tool bars are softly bigger than the buttons of the other applications (Fig. 11), this make more easy to select a tool with the pen.

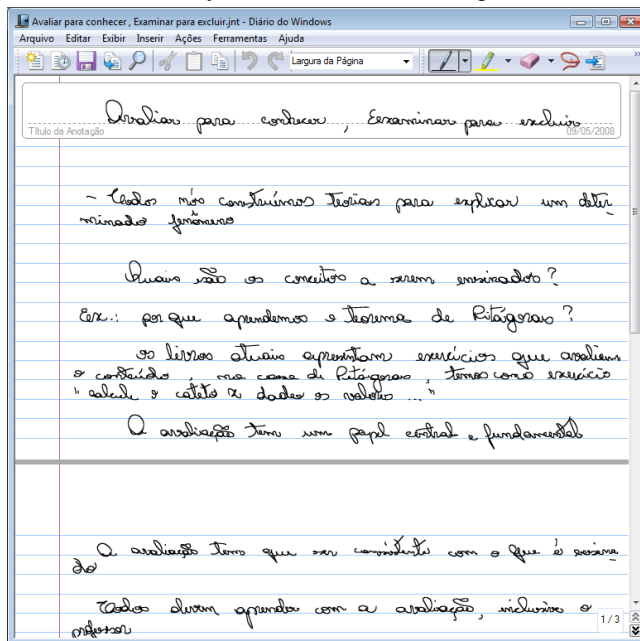


Figure 9. Example of use Windows Journal into Informatics Applied in Education classes.

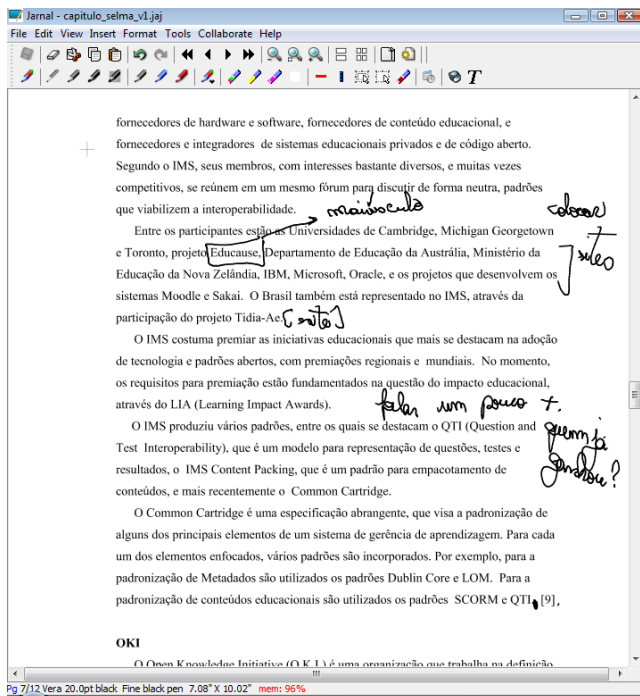


Figure 10. Example of Journal use to do annotations in a text.

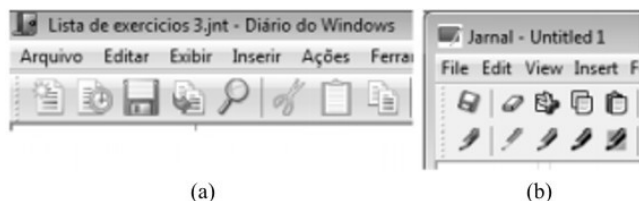


Figure 11. Dimensions between buttons into Windows Journal (a) and Jarnal (b) Tool bar.

Analyze the options to erase electronic ink into the Windows Journal and Jarnal applications, we perceive that the Windows Journal offers two kind of erase forms, while the Jarnal offers only one. The form offer by both applications is erase all the traces that the erase tool have contact. The Windows Journal offers too another way of erase electronic ink that erase only parts of the trace, allowing a better fine adjust of the writing.

Activities that needs collaborations among students are commons in educational context. So, the applications needs make easy the communication of many devices, by file transfer or by Internet. It is important do not restrict the communication only between Tablet PCs, but consider the possibility of many devices used like desktops, laptops and smart phones.

And for motivate the use of an application, the application needs have functions that explore the potential of digital artifacts. In this case, functions to copy, cut, paste and move the electronic ink. These functions turn motivational factors to adopt these applications.

We believe that these described issues must be considered in the design of Tablet PC applications, with the goal to explore the pen interaction and minimize usability problems.

VII. CONCLUSIONS AND FUTURE WORKS

The Tablet PC is a computing device designed to be similar to a notebook, and the main hardware to be used in the interaction is a pen.

For five years, we did an exploratory study where two models of Tablet PCs are used to support a graduate student activities. The main use was do classes annotations in classroom, highlight part of texts and doing exercises.

The Adobe Reader Professional, Windows Journal and Jarnal applications were used in many periods as annotations editors. Many available functions was used like color, annotation selection, copy, paste, cut of annotations and pictures.

When the pen moves over the screen, it generates input data for the applications that need to be used to generate the electronic ink. Desktop applications does not manipulate the

electronic ink, resulting in loose of the Tablet PC potential because the pen is used only as a pointer device. In this case, the use of pen as a pointer device in desktop applications, there are usability problems.

We present and discuss some of them, like the dimensions of user interface components, the use of one tool to writing and selecting electronic ink and the difficult to see the content when user needs to cross the screen with her hand. The discussed issues plus the needs to explore the interaction style used by the users turns hard the design applications for multidevices, mainly when we need to consider many interaction styles.

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REFERENCES

- [1] J. Backon, "Student minds and pen technologies: A wonderful pedagogical marriage", in *The Impact of Pen-based Technology on Education: Vignettes, Evaluations, and Future Directions*, D. Berque, J. Prey, and R. Reed, Eds. USA: Purdue University Press, 2006, pp.1-11.
- [2] R. J. de Azevedo and H. V. da Rocha. An annotation-based tool for collaborative learning using mobile technology. *Tablet PC Technology at UNICAMP Project*. Available at: <http://www.ic.unicamp.br/~rodolfo/tabletpc/>, accessed November, 2011.
- [3] HP Technology for Teaching 2006 grant. 2006. Available at: http://www.hp.com/hpinfo/socialinnovation/us/programs/tech-teaching/hied_global.html, accessed November, 2011.
- [4] HP Compaq Tablet PC TC1100 – North America/U.S. Quick Specs. 2005. Available at: http://h18000.www1.hp.com/products/quickspecs/11755_na/11755_na.html, accessed November 11, 2011.
- [5] HP TouchSmart tx2-1040br Notebook PC (NL266LA) especificações. 2009. Available at: <http://h10010.www1.hp.com/wwpc/br/pt/ho/WF06b/321957-321957-3835812-3835813-3835813-3837256-3937928.html>, accessed November, 2011.
- [6] Adobe Acrobat Professional, 2011. Available at: <http://www.adobe.com/products/acrobatpro.html>, accessed November, 2011.
- [7] Windows Journal. Available at: http://en.wikipedia.org/wiki/Windows_Journal, accessed November, 2011.
- [8] Jarnal. Available at: <http://jarnal.wikispaces.com/>, accessed November, 2011.
- [9] A. C. da Silva, V. A. Neris, J. Daltio, M. Weinfurter, H. Zanetti, and H. V. da Rocha, "Caderno Interativo de Lógica – uma aplicação para TabletPC de apoio ao ensino de lógica de primeira ordem", *Proc. Simpósio Brasileiro de Informática na Educação (SBIE 06)*, SBC, Nov. 2006. Available at: http://200.169.53.89/download/CD_congressos/2006/SBIE_2006/msoftware/ms.html, accessed November, 2011.