Using a Tablet-PC to Provide Peer-Review Comments

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Abstract

This reports describes our initial exploration in using a Tablet-PC to provide peer-review comments in the first year Computer Science course. Our exploration consisted of an informal evaluation of how students write comments on other students assignments using three different methods: pen and paper, a Tablet-PC, and a desktop computer. Our ultimate goal is to explore the effect that interface style has on the quality and quantity of the comments provided.

1 Introduction

The Tablet-PC represents the latest generation of personal computers. Its form-factor is like a laptop computer but uses a pen and a touch sensitive display to afford interaction in a pen-driven style. Microsoft has updated its Windows operating system, and created new applications to make use of the pen in new and creative ways [8].

The Tablet-PC has the potential of impacting education in the following ways. First, pen-based computers can be used in creative ways in the classroom to enhance the teaching and learning environment [3], similar to what has been done with PDAs [6]. Second, pen-based computers can be used in the classroom for note-taking [7] and sharing these notes with others [4]. Finally, Tablet-PCs are smaller than desktops with monitors, and thus can be used in a traditional lecture-based classroom in ways that complements lectures [2, 1].

Here we report an informal study to observe how students use the pen in a Tablet-PC to provide feedback on an object-oriented design created by other students. Peer-review has been found to be a good way to help students learn from each other and to increase their understanding of coding and design issues

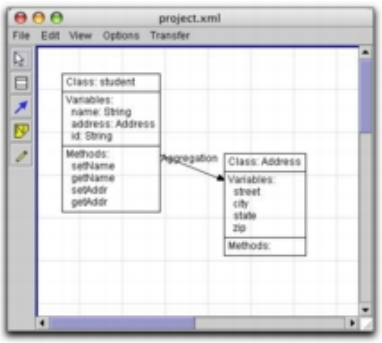

Figure 1: minimUML Tool

by exposing them to alternative designs, and giving them more experience in reading other student's work [5].

We used minimUML (see figure 1), a Universal Modeling Language (UML) tool that we have built to support the teaching of object-oriented design in the first year of a Computer Science curriculum. MinimUML is a simple design tool that implements a very small subset of UML. It allows the creation and modification of class objects and the connections between those objects. Annotations are allowed in the form of text notes (stickies) and free-form line drawings. With the pen, these free-form drawings can include hand written comments, as well as gestures to highlight parts of the interface.

2 Our Study

To compare the effect of the use of a pen-based interface with other methods, we conducted an informal study where we asked students to review three object-oriented UML designs. The review was conducted based on a series of design guidelines given to the students. They were informed to provide feedback to the creator of the design using these design guidelines by identifying parts of the UML design that were positive (i.e. a good use of a particular design guideline) or negative.

We had a total of 9 participants, all Computer Science students at Virginia Tech; 7 were Seniors, 1 Sophomore, and 1 Graduate student. The study was conducted from April 19-27, 2004. Participants came to our usability lab, signed the consent form, were given instructions, and then proceeded to do three UML design reviews. The total session lasted about 1.5 hours. The study was approved by the Institutional Review Board.

We divided the participants in three groups. One group used a tablet PC with the pen input. A second group used a desktop PC with a mouse as the pointing device. The third group used paper and pencil to provide the feedback.

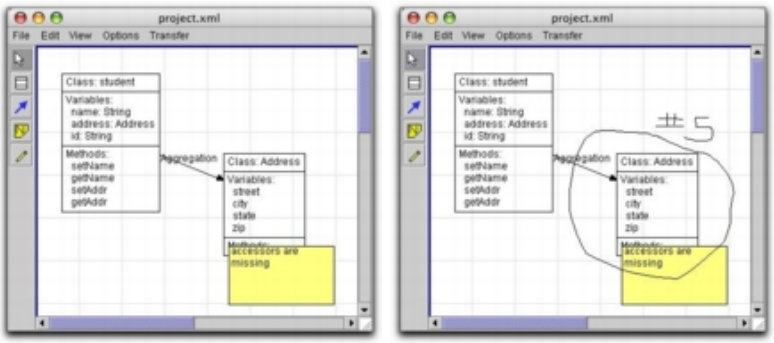

Figure 2: Examples of how comments are created using a sticky note and free-form annotations.

2.1 Writing Comments with minimUML

Our UML tool allows commenting of a UML design in two ways. The tool supports the use of "comment boxes" which resemble Post-It notes; we call these "sticky" notes. The user can place these notes anywhere in the design and type a text comment inside of the note. The notes can be moved to anywhere in the screen and can be collapsed into a small icon.

The tool also supports the use of free-form drawings. When the tool is used with a mouse, the free-form drawings can be used to circle or to draw an arrow to point to areas of the design. But, when used with a pen, the free-form can be used as a form of digital ink where the reviewer can write comments directly in the UML design. The free-form drawings can be selected and moved to anywhere in the design, much like the sticky notes can. Figure 2 shows two examples of comments in minimUML.

3 Findings

For this study, our goal was to observe the effect of the choice of platform had on the comments provided by the participants. The nature of the study was observational; our goal was not to validate a hypothesis or to find statistically significant results. The results reported here, therefore, are descriptive in nature.

3.1 Definition of Review Comments

We counted the number of comments provided by each participant in each design. There are two counts to report. The first, called here Number of Blocks, is the number of comment blocks done by each participant. This refers to the number of sticky notes added in the desktop, or the number of handwritten notes entered by the participants. This is different from the second count, the Number of Comments, in that a single Block can have several Comments. For

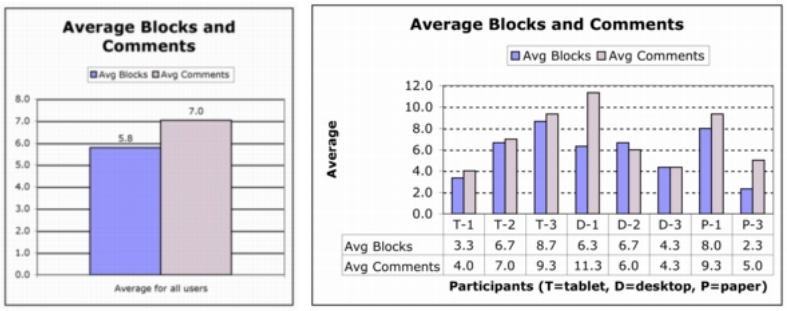

Figure 3: Average blocks and comments for all participants in all platforms (left) and average comments per participants (right)

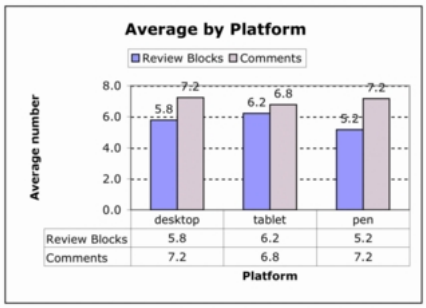

Figure 4: Average comments per platform

example some participants entered various comments in a single sticky note.

This distinction between block and comment is also found in the tablet and pen condition. Often, a single block includes arrows to point to two different parts of a UML design, we interpret this as a single review block which provides two review comments.

3.2 Number of blocks and comments

The first observation we make is that the number of comments provided was similar across all participants and across all platforms. No single platform (paper, tablet, or desktop) produced more comments than the others.

The following figures shows the average number of blocks and comments for the whole study, and per participant (Figure 3), and for each platform (Figure 4).

3.3 Structure of Comments

Although the quantity of the comments provided did not vary across platforms, the structure of how the comments were provided did change. This section

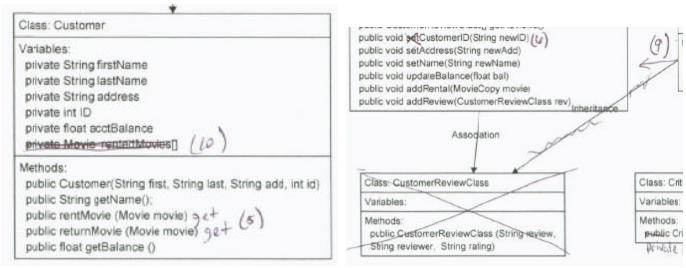

Figure 5: Examples of the detailed editing comments provided in the paper condition

describes some observations on how the comments were provided.

The comments provided by the students included some or all of the following characteristics.

Detailed Editing Some comments included very detailed editing instructions. In some cases, the reviews included crossed-out words, or even crossed-out letters within names. This was observed mostly with the paper interface (see Figure 5 for examples), but was also found a few times in the tablet condition.

Figure 5 shows the level of detail of the markup afforded by the paper version. Note on the left of the figure, how the reviewer crossed out lines of code, and at times even crossed out just a few letters (top right).

Free-form drawings Free-form drawings, in our study, came mostly in the form of arrows to point out parts of a UML diagram, or circles enclosing areas discussed. In the case of arrows, it is interesting to know that in the desktop condition, they were only used to supplement missing UML relationships and were never used to signal a part of a UML document discussed with comments. That is, the arrows drawn in the desktop condition never took a deitic role.

Figure 6 show examples of how arrows were used in the desktop condition. Notice that in both graphics, the arrow is there to represent a missing UML association. At no time were arrows used in the desktop condition to highlight or mark a part of a UML diagram. They were always used as UML associations.

Arrows and circles were used in the other two conditions to identify UML components referred to by the comments. This was never found in the desktop condition, but was very typical in the paper and tablet condition. Figure 7 shows examples of how the pen in the paper condition is used to highlight parts of a UML diagram (e.g. see the circle drawn around the Database class object). Also, arrows, circles and brackets were used in the tablet condition, as shown in the right hand of the figure.

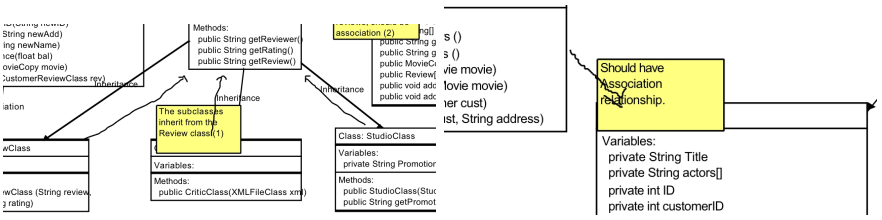

Figure 6: Examples of the use of arrows as representatives of missing UML associations in the diagrams

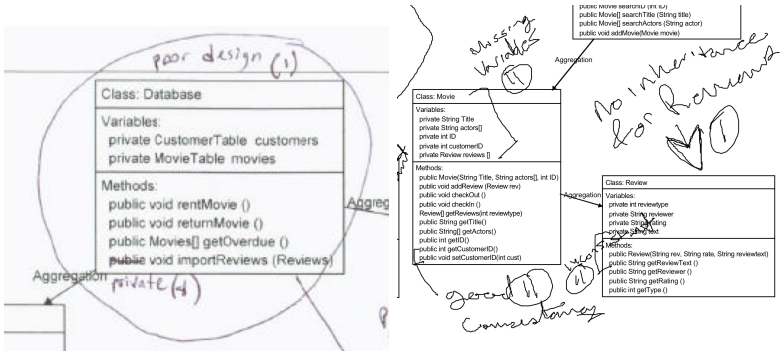

Figure 7: Examples of the use of arrows in paper (left) and tablet (right) conditions

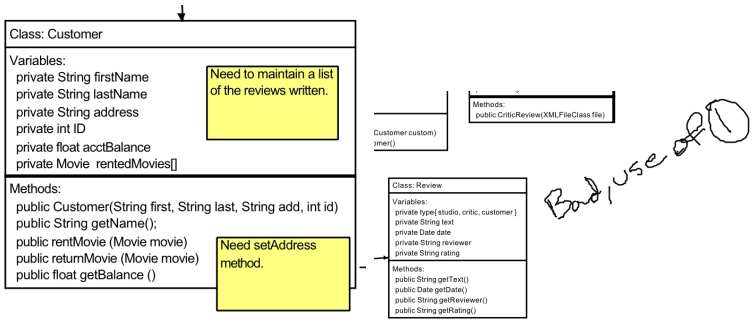

Figure 8: Examples of collocation of comments in the desktop (left) and tablet (right) conditions

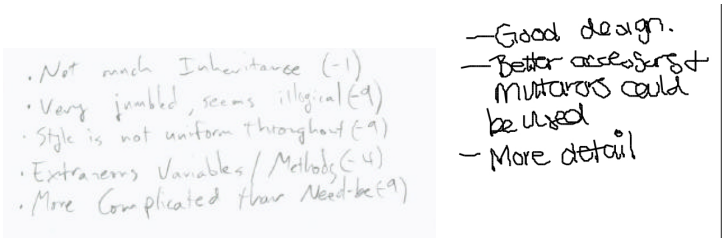

Figure 9: Examples of general comments in the paper (left) and tablet (right) conditions

Collocation of comments Comments written by the reviewers were connected to the different UML parts by either gestures (e.g. see discussion of arrows above) or by collocation. The collocation of comments without arrows was more typical in the desktop condition, but also appeared in the other two conditions.

For example, Figure 8 shows on the left two sticky notes located proximal to the area that they refer to. The top sticky has a comment regarding a missing field definition ("Need to maintain a list of the reviews written"), and the bottom one refers to a missing method (the setAddress method). On the tablet condition (right of the figure), the comment show how class "Review" is a "bad use of" guideline 1.

General Comments Finally, the two conditions that used a pen (paper and tablet) afforded the inclusion of general comments. These were comments that were written on the margin of the document being reviewed, as a way to summarize the findings. Figure 9 shows examples of general comment provided by a reviewer in the paper condition (left) and one in the tablet condition (right).

4 Conclusions and Future Work

This preliminary study allowed us to explore the impact that platform choice had on the structure of comments provided in a peer-review context. The observations made have allowed us to define a more controlled experiment that will be carried out in the summer of 2004 to assess the effect of platform in a controlled laboratory setting.

In general, we found that the most natural medium for providing comments was the paper/pen. However, that medium also invited more editing-style comments, which were not necessarily appropriate for the task at hand.

The Tablet-PC allowed the participants to provide comments that resembled the paper format, while avoiding the detailed level of comments (editing comments) afforded by the paper format.

The Desktop format was the most restrictive of all. Arrows in free-form were used only to represent missing UML associations and never as a deictic reference. Furthermore, the comments were always provided in stickies but never as free-form annotations. There were no "summary comments" provided in this condition.

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