Classroom Presenter: An Evaluation of Tablet PC Software for Learning Environments

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Chapter 1

Introduction

Our team performed a study of learning techniques in the classroom. We evaluated the effectiveness of tablet PCs as a learning device, and specifically the Classroom Presenter software package. By assessing performance on quizzes and measuring classroom interactions like asking questions, submitting feedback, and responding to questions, we effectively gauged the utility of tablet PC software in the classroom. The results of this study should motivate (or dissuade) the use of tablet PC software for instructors.

1.1 Hypothesis

We structured an experiment around the hypothesis that tablet PCs enhance traditional learning by providing efficient tools to perform learning tasks like note-taking and browsing. We predict that students using tablet PCs will, overall, learn and perform better academically than those without the technology.

Chapter 2

Procedure

Our team chose to perform an experiment as our data collection technique, using notes taken by us as participant observers, notes taken by the participants themselves, and tests. This method was chosen because it allowed us to compare tablet PC learning against traditional learning in a controlled environment.

2.1 Structure

The data collection procedure consisted of two independent lectures with one instructor and several students. Both lectures used the same slides and covered an obscure topic: the sport of fencing. We chose an obscure topic so that no student would have a significant background knowledge advantage over any other student. At the end of both lectures, all students took a short quiz. Both lectures were approximately 30 minutes long and the quiz featured 13 multiple choice questions about the material covered in the lecture. A description of the difference in the lecture format is described in the sections below.

2.1.1 Control Group

The first lecture was the control group and was modeled after the traditional learning environment. The instructor used a tablet PC to display slides using Classroom Presenter software. Slides were displayed using an overhead projector and each student was given a printed copy of the slides. The instructor annotated notes on the slides using the tablet PC and asked the students to respond to questions at specific points. At the end of the lecture, students were given about 5 minutes to review their notes and prepare for the quiz. Then the students' notes were collected and the quizzes were passed out. Students were given as much time as needed to complete the quiz.

2.1.2 Experimental Group

The students in the second lecture were the experimental group and used tablet PCs. The instructor used the same materials as the first lecture, but each student had a tablet PC displaying the slides using Classroom Presenter software. The students were given a brief tutorial on how to use the Classroom Presenter software before the lecture started. During the lecture, instructor annotations were very close to what they were during the first lecture. The same questions were asked at the same points. Students were encouraged to use the electronic submission capability at one point near the end of the lecture, but during all other points, students were free to respond to questions in any way they desired. After the lecture, students were given about 5 minutes to prepare for the quiz. Just before the quizzes were passed out, the students were asked to save their notes and we collected their tablet PCs.

2.1.3 Other Data Collected

Before the lecture, students were given a learning style test that consisted of 70 multiple choice questions. This test was used for analysis of test results after the experiment. During

the lecture and quiz, each student was assigned a number that was linked to his or her quiz score and the notes that he or she took. Additionally, each question asked or answered by a student was noted by members of our group in the back of the room for a comparison of classroom interaction versus quiz performance. We observed the following metrics:

Hand raises. This metric counted the number of hand raises per student.

Questions. This metric counted the number of questions per student.

Answers. This metric counted the answers given aloud per student.

Distractions. This metric counted the number of distractions per student, which can include talking amongst themselves, looking around, and falling asleep.

Comments. This metric counted how many times a student made a comment.

After the lecture and quiz, for the experimental lecture group only, students were given a questionnaire about general tablet PC presentation software and which features the students perceived as useful/helpful. Not all of the features in the questionnaire were available in the Classroom Presenter software, but many of them were.

Chapter 3

Results

3.1 Test Results

The purpose of the experiment that we have conducted is to test how well Classroom Presenter enhances learning in the classroom. As mentioned earlier, we hypothesized that the students using Classroom Presenter on the tablet PCs would perform better on tests compared to students using traditional learning methods. When the experiment took place, we found that students who used tablet PCs for the first time were very excited by the new technology. They seemed more interested in playing around with the tablet PCs than learning the material. From this observation we predicted that students who use tablet PCs would do worse on tests than students who only use papers and pencils.

However, the test scores supported our original hypothesis. On average, students who used Classroom Presenter (Group A) scored 71% on the quiz while students who did not have access to tablet PCs (Group B) scored 66%. The highest score for Group A was 84.6% while the highest score for Group B was 76.9%. The lowest score for Group A was 53.9% while for Group B was 38.5%. Evidently, the use of Classroom Presenter increases students test scores by 5% on average. The difference between the highest scores of the two groups

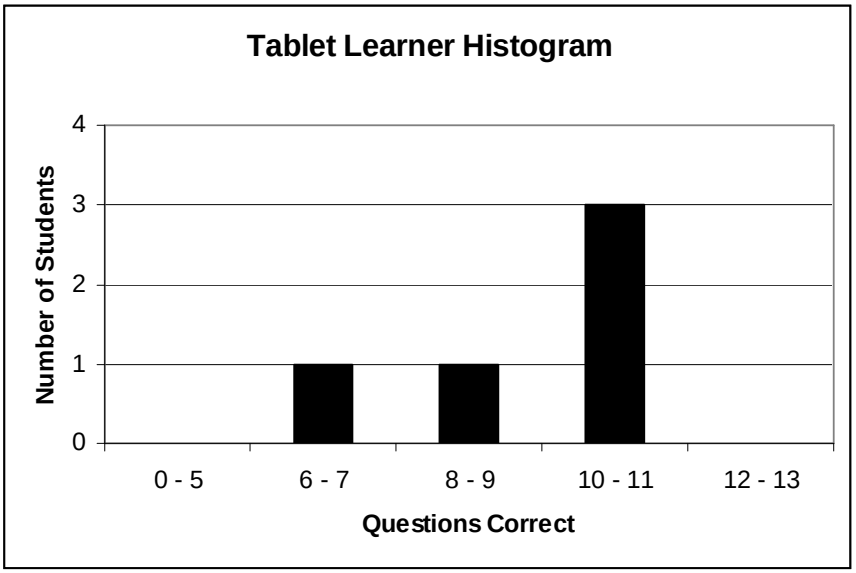

Figure 3.1: Histogram of scores for students using tablet PC

is 7.7% and the difference between the lowest scores is 15.4%. Still, the difference between scores could be due to individual capabilities and not entirely a result of using Classroom Presenter.

An important factor that must be considered is Group A had 5 students and Group B had 10 students. The number of students who were using papers and pencils doubled the number of students who were using tablet PCs. This could skew the test results. Maybe the grade distribution would be different had we used the same number of students for both groups. However, taking the average score should help us ignore the fact that the groups had an unequal number of students.

3.2 Observations

Besides looking at test scores, we also took notes of student interactions in the classroom. From looking at these notes, we noticed that there were only two students from Group A

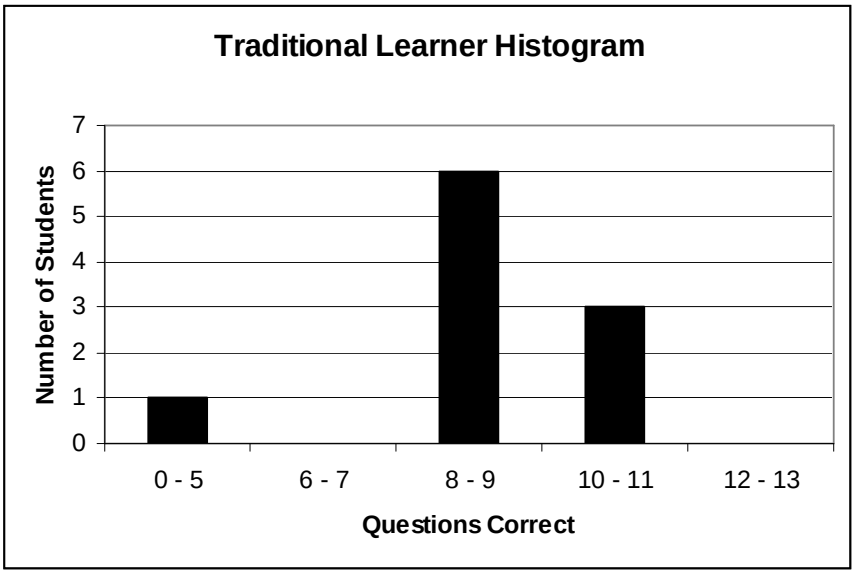

Figure 3.2: Histogram of scores for students not using tablet PC

Thursday 2/22/07 Non-Tablet					
Student #	Hand Raises	Questions	Answers	Distractions	Comments
4			1		
5				3	1
6	1	1	11	2	1
7			1		
8			1	1	
10			1		

Table 3.1: Day 1 observations

Tuesday 2/27/07 Tablet and Non-Tablet*					
Student #	Hand Raises	Questions	Submissions	Distractions	Comments
3				1	
5				3	
6				4	
7			1, 2		
9	1	1	2, 2		
10*					
11*					
13*					
14*				1	

Table 3.2: Day 2 observations

that submitted electronic feedback to the instructor in the classroom. These two students happened to score the highest out of all the students from both Group A and B. This fact does not directly indicate that the feedback submission feature from Classroom Presenter helps students learn better. However, it shows that the software allows students to be more focused and engaged in the classroom, which could eventually help them learn the material better.

On another note, two students from Group A were very distracted with using the tablet PCs for the first time. They were seen doodling, writing notes to each other, and talking during the experiment. Subsequently, they scored the lowest out of all the students in Group A.

There is one student from the non-tablet PC group that perfomed counter to our expectations. This student answered the most questions during lecture out of all the students in this experiment. But the test score shows that this student only scored 69.2% on the quiz.

Let $T(x)$ be the test score of a student x.
Let $L_s(x)$ be the learning style score in the area s of a student x.
Let u_r be the r^{th} user in a group.

$$\frac{\sum_{i=1}^{n} T(u_i) \times L_s(u_i)}{\sum_{j=1}^{n} L_s(u_j)}$$

Figure 3.3: Weighted average of test score based on learning style

Even though this score is not bad compared to the lowest score, which is 38.5%, the student did not do as well as expected. Considering the data gathered, we can not conclude whether or not more involvement in the classroom would help students learn better. However, this topic is outside the scope of our experiment and we do not plan to explore this route any further.

3.3 Learning Styles

Each student that participated in our experiment also took a learning style test. Based on their answers, the test assigned a numerical score in each of the following categories: visual, verbal, aural, physical, logical, social, and solitary learning. We related these strengths to how well the students in both groups (the tablet PC group and the non-tablet PC group) performed on the fencing test.

To do this, we computed a weighted average of how well a student's strengths relate to their fencing test score. For example, a student who scores a 10 in visual learning style will have twice as much influence on the average test score as a student who scores a 5. The formula we used to compute the average test score is shown in Figure 3.3. The results of this evaluation for each learning style area are shown in Figure 3.4.

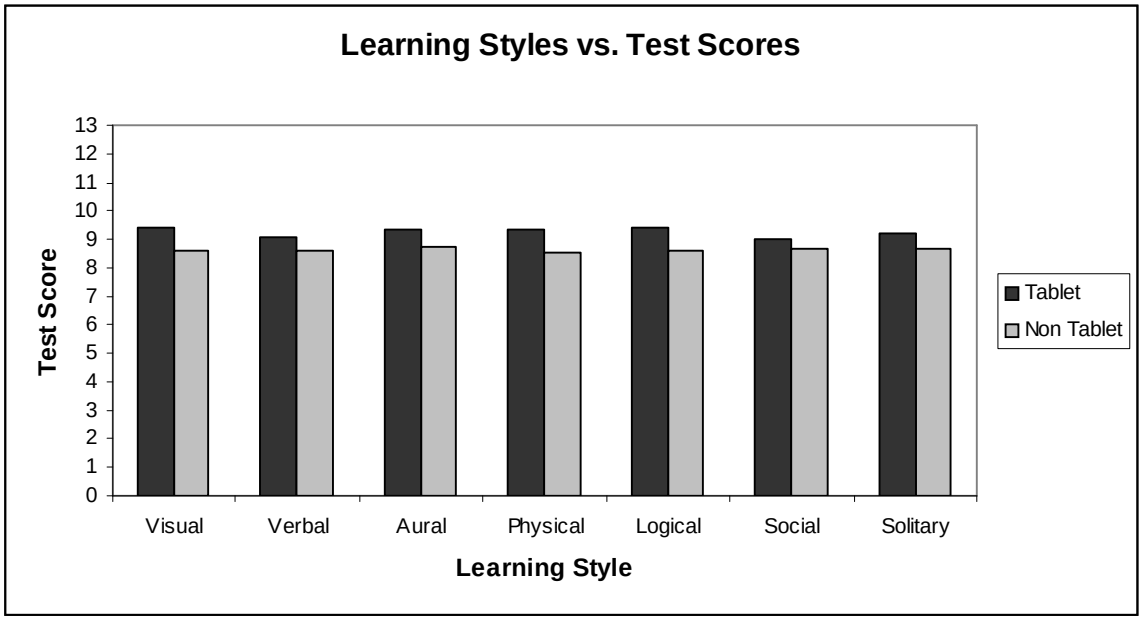

Figure 3.4: Learning styles related to test performance and tablet PC usage

The graph shows that students using the tablet PC, on average, performed better on the fencing test in all areas of learning. This, unfortunately, is a skewed result because the tablet PC users performed better on the test regardless of learning strengths.

3.3.1 Weakness of this metric

There is one inherent weakness of this metric that we could not avoid. Since we are performing a weighted average, the denominator of our function equalizes the test score (which has a maximum of 13). Since we are comparing two groups to each other (the tablet PC group and the non-tablet PC group), the ideal case would have learning style scores average to about the same for both groups. This would mean that, for example, the non-tablet PC group on average is equally as strong in learning areas as the tablet PC group.

We came up with alternatives to try to mitigate this weakness. We considered using only the top 3 learning scores of each student and do a comparison based on learning preference

rather than learning strength. We also considered only counting students who rated higher than a certain threshold for each learning style. But these solutions would make our small sample size even smaller.

Due to the small sample size, there were certain areas of learning that were represented more strongly than others. With a larger sample size, the learning strengths of the different groups should, in general, be equal. Unfortunately, the scope of this project limited our sample size. We found that any metric that we came up with would suffer from the problem of our small sample size. We believe the metric we used, though somewhat flawed, was the best choice because it does not discard user information and includes all the data that we collected. In addition, this same metric would work well if we were to repeat this experiment with a sufficiently large sample size.

3.4 Lecture Differences

A main goal for the two lectures was to make the content as identical as possible. It is not possible to have two completely identical lectures under our circumstances, so the differences between the two lectures are discussed here.

3.4.1 Instructor's Perspective

A 30 minute lecture is difficult to reproduce. A main objective was to reproduce the same instructor annotations as they are likely to draw attention from students. This was accomplished for the most part. A few slides had some minor differences, but most of the annotations were the same between the two lectures.

A more difficult challenge was to reproduce the spoken words used by the instructor. This was much less successful. While the same main points were still summarized, the words used had some variety. Also, the second lecture seemed to take less time than the first. This

is likely the result of the first lecture providing experience to the instructor, making the second lecture run more smoothly.

Student interaction was also a difference between the two lectures. There were a few questions that were posed in each lecture, but the first lecture had a student who frequently answered questions. This vocal student made it more difficult to get all students involved in the lecture.

The second lecture also included an electronic answer section. The interaction involved here was different than the first lecture which used traditional vocal answers to questions. There was no way to determine who was answering the questions during the lecture, so there was no good way to ensure all students were involved in the lecture.

3.4.2 Student's Perspective

Note-Taking

The first noticeable difference can be found in student notes. All tablet PC users took notes while only 40% non-tablet PC users took lecture notes. The first question that arises is: does the tablet PC encourage note taking? While these numbers can suggest this, the sample size remains too small to draw any solid conclusions. The group may simply have been composed of fervent note takers that are note necessarily representative of a real student population.

Interestingly enough, those that took the most notes did not necessarily do well on the test. Several factors influence this. Those that did not do well may perhaps just be regurgitating the instructor's annotations and lecture and not really comprehending the presentation. Also, the test came immediately after the lecture, which is not a standard test delivery method. This may have catered more to a subset of students with stronger lecture comprehension skills.

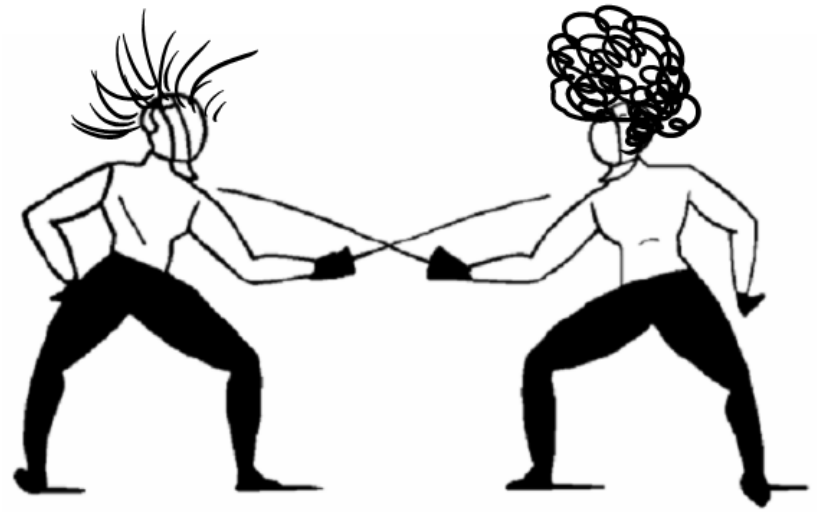

Figure 3.5: Student Doodle

Doodling

Another difference gleamed from the notes showed that while zero non-tablet PC student doodled on their notes, 40% of tablet PC users drew pictures that did not pertain to the lecture. Figure 3.5 shows a doodle of a tablet PC student that does not pertain to the lecture. Does the tablet PC encourage doodling? It provides a wider palette of colors than is normally available to a student during a lecture, which might tempt the doodler in a student to come out. However, more conclusive evidence requires a larger sample size. In any case, this poses an interesting avenue of research.

The role of color

As noted previously, color played a large role between the two lectures. Students without tablet PCs were often limited to pencils or pens of a single color while students with the tablet PCs had a palette of about ten colors. While test scores do not show that those who used more colors necessarily did better, this avenue might be one to explore further since colors can help with recognition. In particular, had the test been delivered later and the

experiment administered over a longer period, it would be interesting to see if scores reflect a preference for colorful notes.

3.5 Usability

As mentioned before, the participants of this experiment were given a learning style test to determine their learning style preference. In addition, they were also given a tablet PC survey. The survey lists the features that a typical tablet-based presentation system would contain and asks participants to rate how useful they think each feature is on a scale from 1 to 5 (the survey can be found in the appendix). By giving participants both the survey and the learning styles test, we are trying to see how well features from tablet-based presentation systems match the needs of different learners.

From the data gathered for the participants, we calculated the average rating of the tablet features for each learning style. We weighted the rating of each participant with his/her respective score on the learning test for each category. Then we take the average of these weighted ratings to produce the average rating based on each learning style. Because our sample size is so small and the variance in the ratings for different learning styles is not very significant, we decided to concentrate our analysis on extremes. For each tablet PC feature, we will only look at the learning style that gives the highest and lowest rating for those features. The viewer can consult the graphs for more information on other learning styles.

3.5.1 Instructor Annotations

Looking at Figure 3.6, solitary learners have the highest rating for the usefulness of instructors writing additional notes on top of slides. The students that find this feature the least useful are the social learners. The difference between the preferences of these two types of

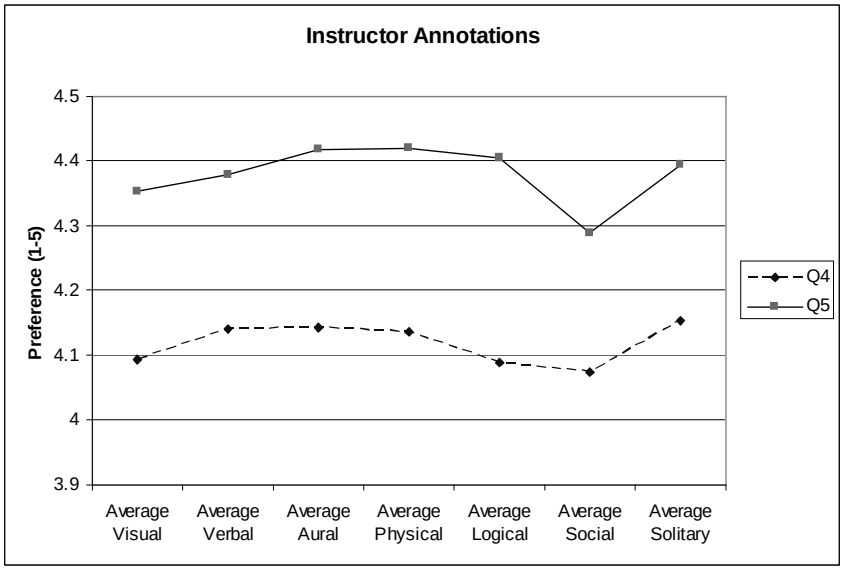

Figure 3.6: Instructor Annotations

learners is only 1.58%. Also, for the ability of capturing instructors handwritten notes, physical learners seem to have the highest rating while social learners have the lowest rating. The percentage difference between the ratings of the physical and social learners is 2.63%. As you have seen, the difference between the ratings for the different learners is very minimal. Most students have about the same preference when it comes to instructor annotations.

3.5.2 Instructor Feedback

As shown in Figure 3.7, social learners expressed the highest preference for being able to receive instant electronic feedback from the instructor during lecture. Solitary learners, on the other hand, gave this feature the lowest rating. The difference between these two groups is approximately 7.84%.

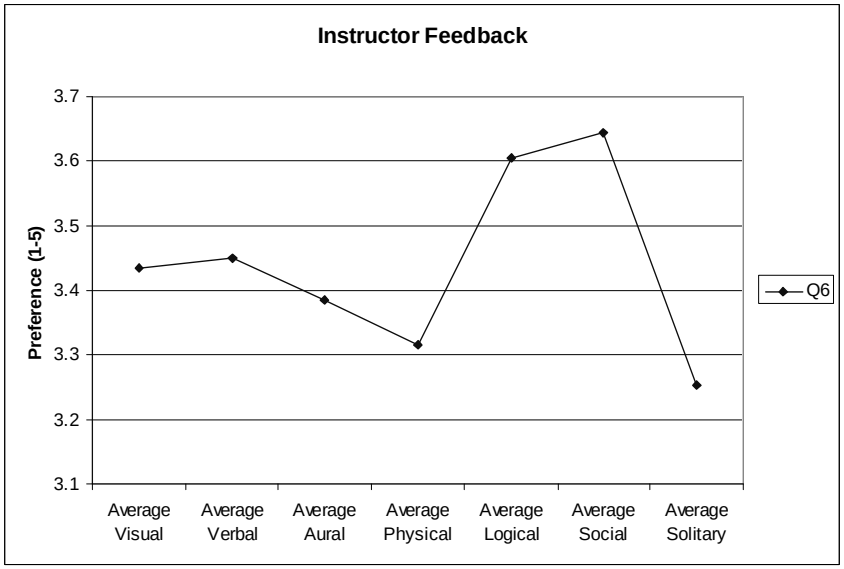

Figure 3.7: Instructor Feedback

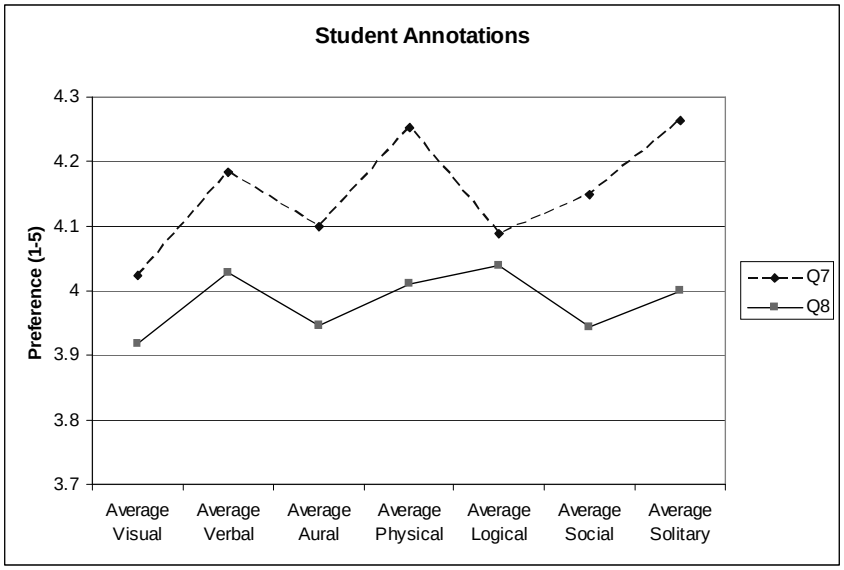

Figure 3.8: Student Annotations

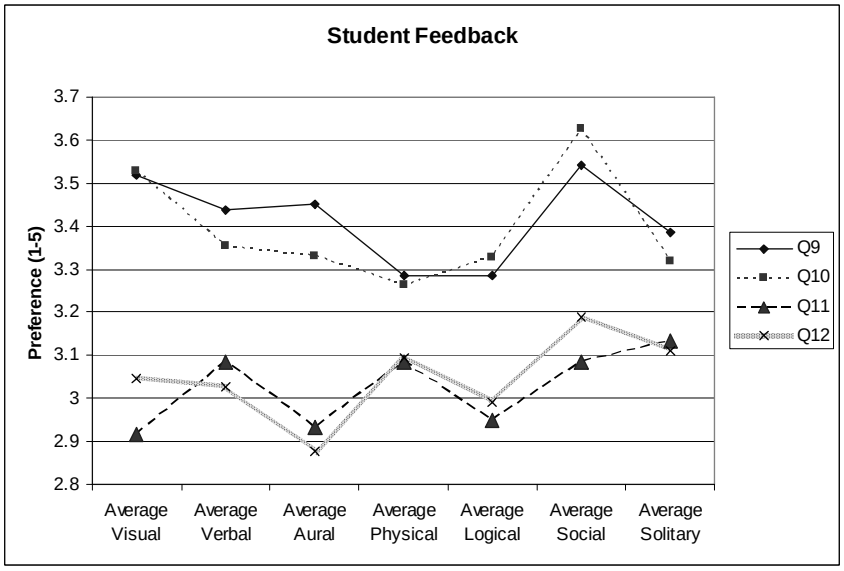

Figure 3.9: Student Feedback

3.5.3 Student Annotations

As shown in Figure 3.8, solitary learners gave the highest rating for being able to write additional notes on top of slides. Visual learners gave the least rating for this feature. The difference between these two groups is 4.80%. As for the feature of having separate views for instructor annotations and student annotations, logical learners gave the highest rating where the visual learners gave the lowest. The difference between these two groups is 2.44%.

3.5.4 Student Feedback

As shown in Figure 3.9, the ability to send instant electronic questions to the instructor during lecture (Q9) seems to be correlated to the ability to send anonymous electronic questions to the instructor during lecture (Q10). Social learners gave both of these features the highest rating while physical learners gave them the lowest rating. Although it appears that questions 11 and 12 of the tablet PC survey are also correlated, upon further examination, it is clear that these features appeal to different types of learners. For example, solitary

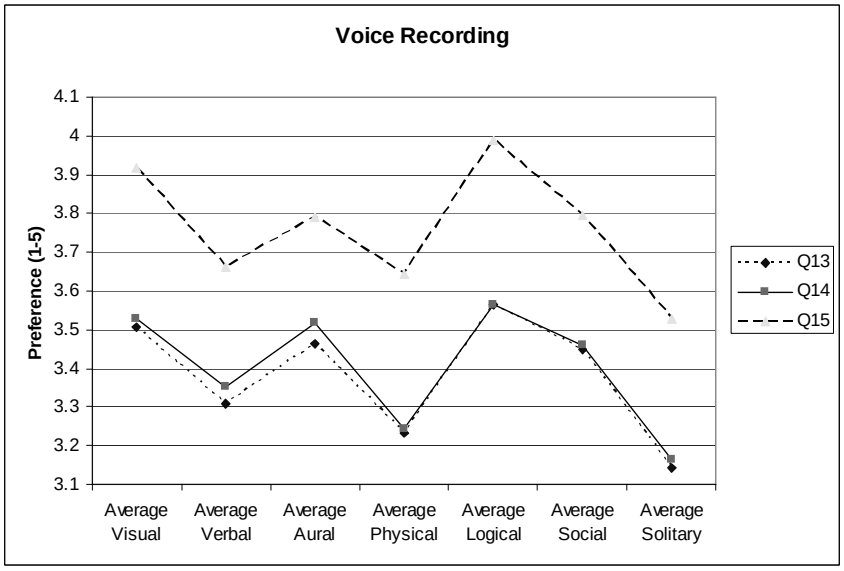

Figure 3.10: Voice Recording

learners gave the ability to take real-time quizzes on a tablet PC and then submit them to the instructor electronically (Q11) the highest rating while social learners showed the highest preference for instructors sharing students electronic submissions to the class via the tablet PC (Q12). Similarly, visual learners gave the lowest ranking for the test-taking feature while aural learners showed the least preference for the submission-sharing feature. The capability to send anonymous questions to the instructor via the tablet PC showed the largest percentage difference between the highest and lowest preference ratings: 7.26%.

3.5.5 Voice Recording

As shown in Figure 3.10, there are three features mentioned in this section. The first feature is being able to record instructors voices during lecture. The second feature is having synchronized voice with lecture notes. The third is converting instructors voices to text. For all three of these features, logical learners gave the highest ratings whereas solitary learners gave the lowest. The difference between these two groups for the first feature is 8.43%. The

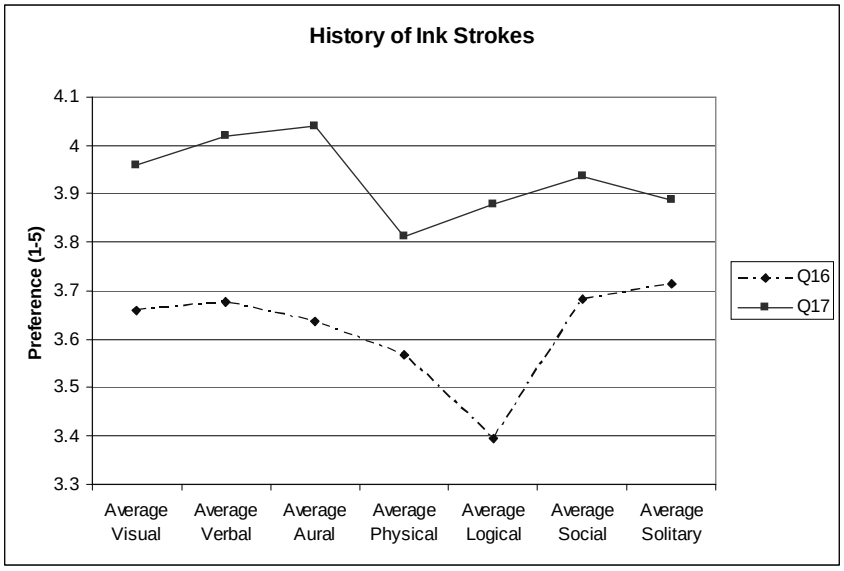

Figure 3.11: History of Ink Strokes

difference for the second feature is 7.99%. And the difference for the third feature is 9.25%.

3.5.6 History of Ink Strokes

As shown in Figure 3.11, solitary learners gave the ability to review notes in the order they were written by using the tablet PC to replay the notes stroke-by-stroke the highest rating. Logical learners gave this feature the lowest rating. The difference between these two groups is approximately 6.36%.

In addition, Figure 3.11 reveals that aural learners rated the capability of ink strokes to change color over time to differentiate notes taken during different periods of the lecture the highest while physical learners rated this feature the lowest. The difference between these two groups is approximately 4.57%.

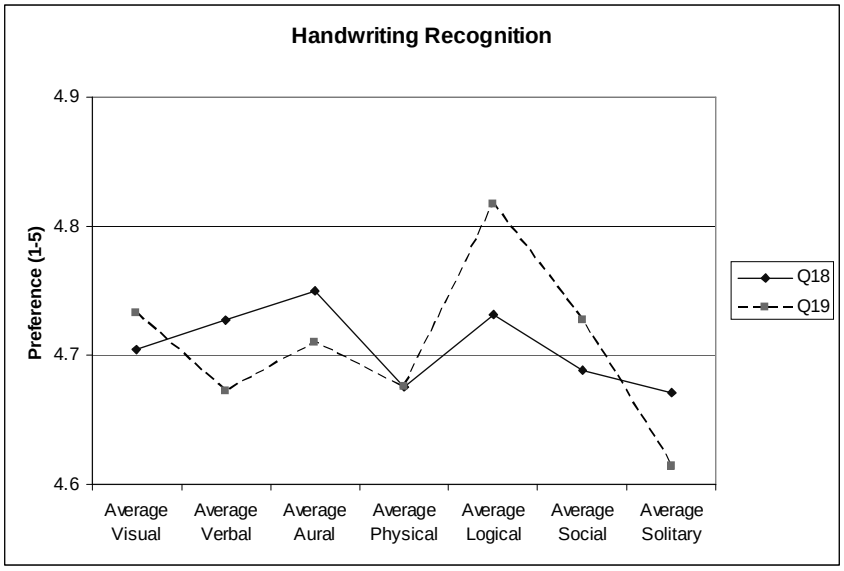

Figure 3.12: Handwriting Recognition

3.5.7 Handwriting Recognition

As shown in Figure 3.12, when it comes to being able to convert handwritten notes to printed text, aural learners gave this the highest rating compared to solitary learners. However, the difference between these two groups is only 1.57%. As for being able to search through handwritten notes for key words, logical learners gave this the highest rating and solitary learners gave this the lowest. The difference is 4.06%.

3.5.8 Electronic Whiteboard

Looking at Figure 3.13, we can see that aural learners rated having access to blank slides to take additional notes the highest while solitary learners gave this feature the lowest score. The approximate difference between these two groups is 1.86%.

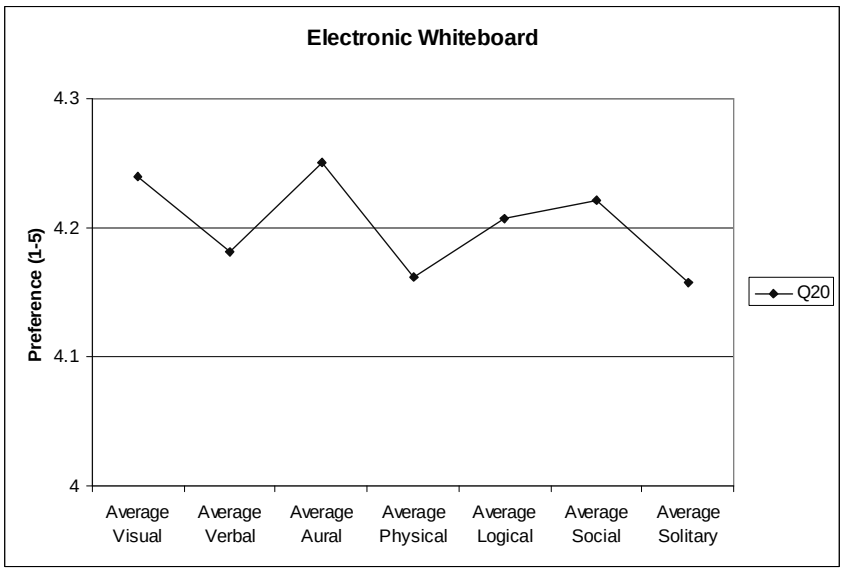

Figure 3.13: Electronic Whiteboard

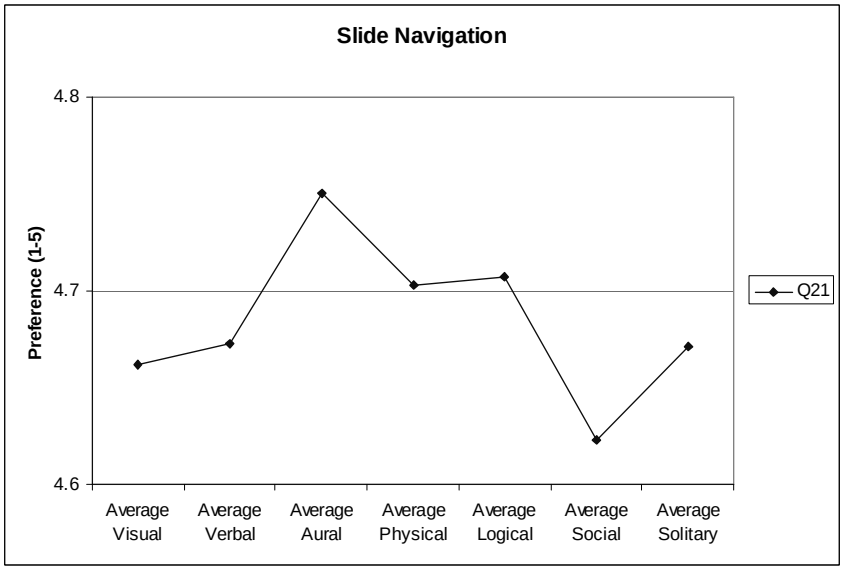

Figure 3.14: Slide Navigation

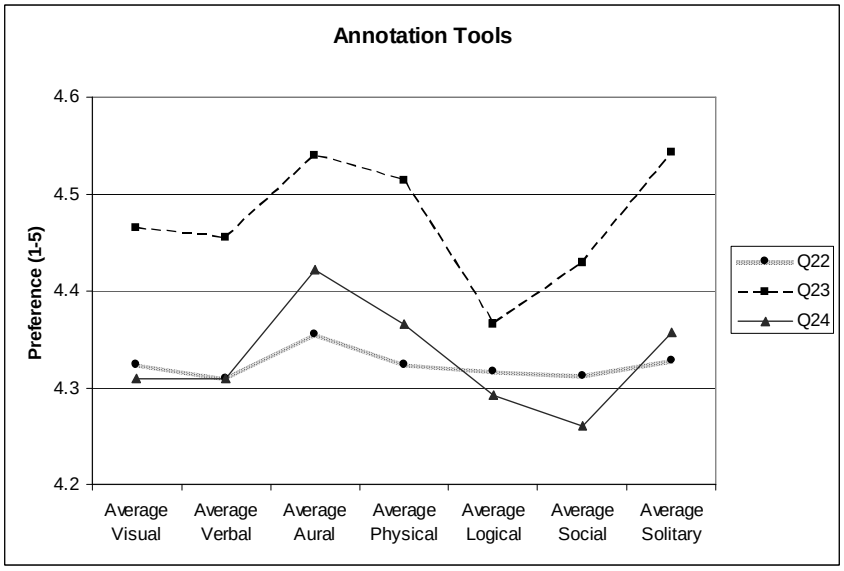

Figure 3.15: Annotation Tools

3.5.9 Slide Navigation

As shown in Figure 3.14, for the feature of being able to navigate freely through the slides, aural gave this feature the highest rating whereas social learners gave it the lowest rating. The difference between these two groups is 2.53%.

3.5.10 Annotation Tools

As shown in Figure 3.15, three features are analyzed in this section. The first feature is the ability to highlight keywords or ideas using the tablet PC. The second feature is the ability to erase ink marks or strokes written using the tablet pen. The third feature is the ability to change ink color when taking notes. Aural learners gave the first and third features the highest rating while solitary learners rated the second feature the highest. Verbal learners, logical learners, and social learners rated these three features the lowest, respectively. The percentage differences between the maximum and minimum ratings for the annotation tools features were all under 4%, and therefore considered minimal.

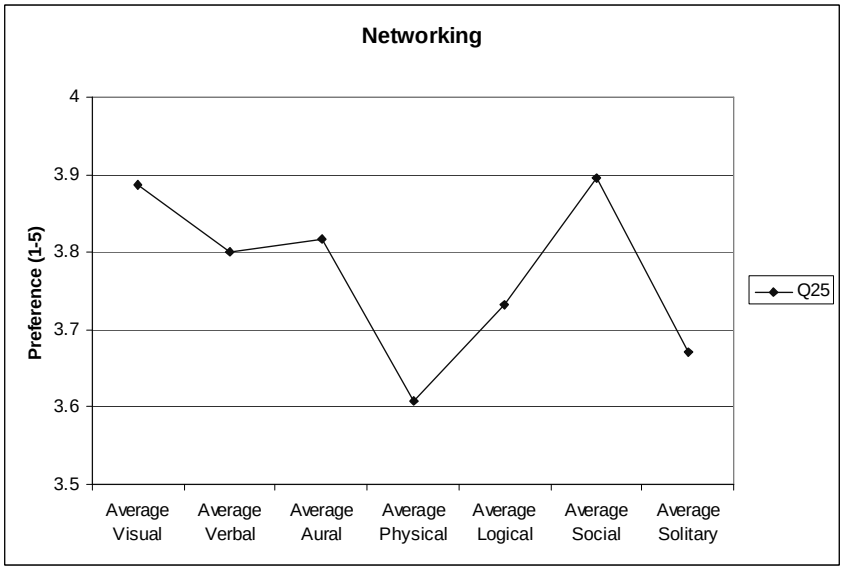

Figure 3.16: Networking

3.5.11 Networking

As shown in Figure 3.16, for the feature of being able to create a network of tablet PCs, social learners gave the highest rating whereas physical learners gave it the lowest. The difference between these two groups is 5.76%.

Chapter 4

Conclusions

Overall, the experiment that we conducted went pretty well. Everyone was cooperative and everyone put in effort in trying to learn the material and taking the assessment test at the end. If we ever conduct another experiment in the future, we hope for the instructor to incorporate more use of the pen to annotate the slides during lecture. The instructor could come up with more interactive activities, like group work, to encourage students to work with others using the tablet PC. Also, the instructor could pose more questions to the students to get students to participate.

As a data collection technique, we think that the focus group is a very suitable choice for our topic. In order to evaluate how well Classroom Presenter functions in the classroom, we need to see actual instructor and students making use of the software. Simply creating a survey or using other techniques will not give us actual data to prove whether or not the software improves learning.

Though the technique is a good choice, there are some suggestions that we would incorporate if we were to conduct a similar experiment in the future. First of all, it is better if the experiment involves a larger group of students. It would be best if we had two sections of the same class. Class A would use Classroom Presenter with tablet PCs for the first half

of the quarter while Class B would not have access to the tablets. They would then take their first midterm and the grades would be recorded. After the midterm, Class A would give the tablets to Class B and Class A would not use the tablets for the second half of the quarter. Again, the two classes would take a second midterm and their scores would be recorded. By following this scenario, we would ensure that the students would have enough time to become comfortable with using the tablets as a learning tool instead of as a new toy. Also, the two midterms can be used to compare how well the students perform with and without using Classroom Presenter. In the experiment that we conducted, there is always a possibility that students using the tablets had a higher aptitude for learning compared to students not using the tablets. By following the scenario outlined above, it would help us eliminate this factor because the same students are experiencing learning with and without the use of the software.

In terms of usability, the following features were found to be the most useful by participants of all learning styles:

- Q18 Automatic conversion of handwritten notes to printed text
- Q19 Ability to search through handwritten notes for specific keywords
- Q21 Ability to navigate through lecture slides independently of the instructor

Of the features mentioned above, only Q21 is currently implemented by Classroom Presenter. As a result of our research, we would recommend the first two features (Q18 and Q19) be added to this software. The following features were found to be the least useful by participants of all learning styles:

- Q11 Ability to take real-time quizzes and to submit them electronically
- Q12 Ability to view other students electronic submissions on their own tablet

The following features exhibited the greatest difference (7% and above) between their maximum and minimum preference ratings:

- Q6 Ability to receive instant electronic feedback from the instructor
- Q10 Ability to send anonymous electronic questions to the instructor
- Q13 Ability to record instructors voices during lecture
- Q14 Synchronization of recorded instructors voices with the current slide/notes
- Q15 Ability to translate instructors voices to text

Unfortunately, we did not find a strong correlation between maximum or minimum ratings and their corresponding learning styles for any of these features.

Appendix A

Classroom Presentation Systems for Tablet PCs

This survey is centered on the different features that tablet-based presentation systems have to offer. Please answer the following questions based on either your personal experience with using the tablet PC or your preference if you were to use a tablet PC.

- Have you had experience with using a tablet PC in the classroom? If No, please skip questions 2 and 3.
- What type of courses are you using the tablet PC for?
- What software do you use to capture notes in the classroom?

On a scale from 1 to 5, please rate the following features based on your preference when using the tablet PC in the classroom lecture environment. 1 = strongly not useful, 2 = not useful, 3 = no preference, 4 = useful, 5 = strongly useful

Instructor Annotations

- Using the tablet PC, instructors can handwrite additional notes on top of slides to illustrate difficult concepts or to give explanations of important ideas
- Capturing instructors handwritten notes during lecture using the tablet PC

Instructor Feedback

- Sending instant electronic responses to students questions or comments during lecture

Student Annotations

- Handwriting your own digital notes on top of lecture slides using the tablet PC
- Separate views for lecture notes with instructors annotations and lecture notes with your own annotations

Student Feedback

- Sending instant electronic questions to instructors during lecture
- Sending anonymous electronic questions to instructors during lecture
- Taking real-time quizzes or assessments on the tablet PC and submit them to the instructor electronically
- Instructors share students electronic submissions to the class via the tablet PC

Voice Recording

- Recording instructors voices during lecture
- When reviewing lecture notes, recorded instructors voices are synchronized with the slide you are on and the notes that you took during class
- Using speech recognition capabilities to convert instructors voices to text

History of Ink Strokes

- Reviewing your notes in the order that you wrote them by using the tablet PC to replay the handwritten notes stroke-by-stroke
- Ink strokes change color over time to differentiate notes taken during different periods of the lecture

Handwriting Recognition

- Handwritten notes using the tablet PC are automatically converted to printed text
- Using the tablet PC to search through handwritten notes for key words

Electronic Whiteboard

- Having access to blank slides to take additional notes

Slide Navigation

- Navigating through all lecture slides without being restricted to the slide that the instructor is lecturing on

Annotation Tools

- Highlighting key words or ideas using the tablet PC
- Erasing ink marks or strokes written using the tablet pen
- Changing to different color ink when taking notes

Networking

- Peer-to-peer networking of tablet PCs to allow you to share applications or chat with your instructors or other students

Bibliography

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[3] Phan, N. Correlation Between Learning Styles and Classroom Presentation systems *(draft)*. Master's thesis, California Polytechnic State University, March 2007.