

Impact of Lecturing with the Tablet PC on Students of Different Learning Styles

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Abstract - Using the tablet PC as a lecturing device offers the instructor a new set of tools upon which their teaching can be based. Since the general student body consists of many different types of learning styles, these new tools can provide a means to reach a wider range of students than the traditional blackboard-based lectures. However, as a first step towards assessing the effectiveness of the tablet PC as a teaching tool, it is important to determine if it is well received by students of all learning styles. It is the purpose of this paper to report on the impact of the tablet PC on the students in four different courses, which were given over a period of three semesters. This impact was measured through a survey which was completed by the students at the end of each term. Overall, the students in all courses (a total sample size of 280) were quite positive about the use of the tablet, with 56% of the students stating that “The technology of the tablet...greatly improves my learning experience.” It was found that there were no statistically significant differences in how the students of different learning styles responded to the use of the tablet PC. In fact, all learning style groups reacted quite positively to its introduction into the classroom. However, some results indicate that a large group of students have a preference towards a more active classroom. This shows that if the tablet PC is to be an effective means of teaching, its advantages must be leveraged to facilitate an active-learning environment.

Index Terms – Tablet PC, learning styles, technology in the classroom, student perceptions.

INTRODUCTION

The tablet PC (TPC) is increasingly becoming a more common device in engineering classrooms, as it provides the instructor with an extended set of educational tools. Even as a direct replacement for the traditional blackboard it has many advantages [1-6]. One of the most important of these is that the TPC enables the instructor to seamlessly switch between a standard “blackboard” type interface to any one of many multimedia programs or materials to enhance the presentation of difficult subjects. Objects such as videos, java applets, animations, web pages, complex graphics, and relevant course software can be drawn upon to improve the classroom experience and student engagement.

From the perspective of the audience, the TPC allows the instructor to maintain a connection with their students

since they do not have to turn away to write on the board. As well, the instructor’s notes are more easily seen by the students, since the lighting of the projected image is usually better and the overall size of the image is larger on the screen than on the board.

In addition, the TPC can support many of the fundamental principles of good pedagogy [7]. For example, interactive classroom response systems can be easily added to a traditional lecture. With these systems the instructor can pose a question to the class, which each student can answer electronically through their personal hand-held response unit (a “Clicker”). These systems are an excellent way to provide prompt feedback to the students, which is a one of the hallmarks of effective education.

When the TPC is being used in the classroom by the instructor and the students, it is possible to significantly improve the classroom interactivity through software such as Classroom Presenter, DyKnow Vision, Microsoft OneNote, and others. With this type of software, the students can engage with the material more closely, by annotating their own answer to a question posed by the instructor and electronically submitting this answer to the instructor. This method of using the TPC has demonstrated great benefits to the students, however, it requires all students to have a TPC [8-10]. At the University of Toronto, the vast majority of students do not have TPCs, so the focus of this paper will be on the instructor-only method of lecturing with the TPC.

While it is clear that the TPC has many advantages over the traditional blackboard approach, however, there are some drawbacks from an instructor’s point of view which should be noted. From the author’s experience one of the most significant drawbacks is that there is essentially only one “board” to work with as opposed to the four to six boards that many classrooms have. This limits one’s ability to quickly highlight an earlier point, or refer back to a diagram that was discussed previously. It is possible to zoom out, but generally the students find the text very difficult to read if more than one page is shown at a time. One can easily scroll back to a previous page, but it is not as simple as pointing out something on one of the boards.

Another less significant drawback with using the TPC is the occasional technical problem that arises. At times the TPC operating system will crash, or the projector system may not be available. Since these types of events can occur, it is important to have a plan to teach the material in an alternate way. Nevertheless, in the author’s experience of using the TPC in roughly 200 lectures over the past two

years these type of problems have only occurred three or four times.

There have been many recent papers that have discussed the use of TPCs in the classroom using an instructor-only method. Many of these report that the students generally respond positively to the use of the TPC as a teaching tool [1-6]. However, there has not been much effort to consider how this technology impacts students of different learning styles. This is an important question, as one must ensure that their teaching method does not alienate a particular type of learner. In [11], initial survey results were reported, which indicated that the student preference for how the TPC is used depends on their learning style. The purpose of this paper is to continue this investigation and take a more critical look at this question. Therefore, this paper will present survey results from a much larger sample which was taken in four courses over three terms.

METHOD OF TPC USE

For the four courses which this paper is based upon, the TPC was used in essentially the same way. The instructor was the only one using the TPC and it was used primarily as a replacement for the blackboard. The students were provided with skeleton notes prior to the lecture to ease their note-taking burden. These notes were used in the lectures as a guide and the instructor annotated over them. When appropriate, extra multimedia objects and software demonstrations were incorporated into the lectures. For the most part, there were no specific attempts to incorporate active-learning techniques into the lectures. This means that these survey results are a good indicator of how the use of the TPC for lecturing compares with the traditional blackboard-based lecturing approach.

OVERALL STUDENT RESPONSE

The TPC was used in four different courses in the Department of Electrical and Computer Engineering at the University of Toronto. These courses were:

- MAT298F: Linear Algebra and Differential Equations (Fall 2007)
- ECE320F: Electromagnetic Fields and Waves (Fall 2007)
- ECE221S: Electric and Magnetic Fields (Spring 2008)
- MAT290F: Advanced Engineering Mathematics (Fall 2008)

The previous paper [11], focused on the student survey results from MAT298F and ECE320F. This paper will include the results from ECE221S and MAT290F and will take a closer view at all of these results.

In all four courses a survey was taken towards the end of the term which asked the students to respond to questions dealing with their *TPC-based lecture experience*, their *TPC-based lecture notes*, and their *overall experience of the TPC-based lectures*.

The questions dealing with their lecture experience that were based on a Likert scale were:

- “Does the use of the tablet make the lectures a more enjoyable experience?”
- “Do you learn more from the lectures?”
- “The pace of the tablet-based lectures is:”
- “Do the additional visual aids enable you to understand the material more clearly?”

The results for these four questions are shown below in Figure 1. These figures include the results for all four courses, which have a total of 280 responses. It can be seen that the students were overwhelmingly supportive of the additional visual aids and many of them felt that they learnt better in the TPC-based lectures. They also felt that the usual pace of the lectures was reasonable, which was likely due to the fact that skeleton notes were provided and the instructor annotated over these notes.

Perhaps the most important result of this part of the survey is the fact that the students generally rated the TPC-based lectures as more enjoyable than the blackboard-based lectures. Since the ultimate goal of any lecture is to actively engage the students with the material any technique which enhances their enjoyment will help them to become more naturally interested in the material. It appears that the added functionality of the TPC provides for this opportunity.

The students were also asked three other questions, the results of which are shown in Figure 2. The majority of students indicated that they would prefer the TPC to be exclusively used in the classroom (55%), however there was a significant number (36%) which preferred a balance of TPC and blackboard use. This is an important indicator that care must be taken in how the TPC is used, so that all students are supported in an effective way.

The students were also quite positive about the use of the skeleton notes, with only 21% indicating that this was no different than their note-taking experience in traditional blackboard lectures. It is important to observe that not all students make use of these notes. From the comments given for the “Other” category, some students preferred to write down everything themselves. It is also interesting that 6% of the students found the single-panel limitation of the TPC difficult to deal with.

In rating the overall use of the TPC technology, many students (56%) indicated that it made a significant improvement to their experience. The students were also asked to provide their overall assessment of the effectiveness of the TPC as a teaching tool and were given a Likert scale with ratings of 1: “Not effective at all”, 2, 3: “Somewhat effective”, 4, 5: “Very effective”. Again, the students rated the effectiveness quite highly, with 74% of the students selecting 4 or 5. About a fifth of the students (21%) chose “Somewhat effective”, showing that 95% of the class had an overall positive view on how the TPC helped them in their learning.

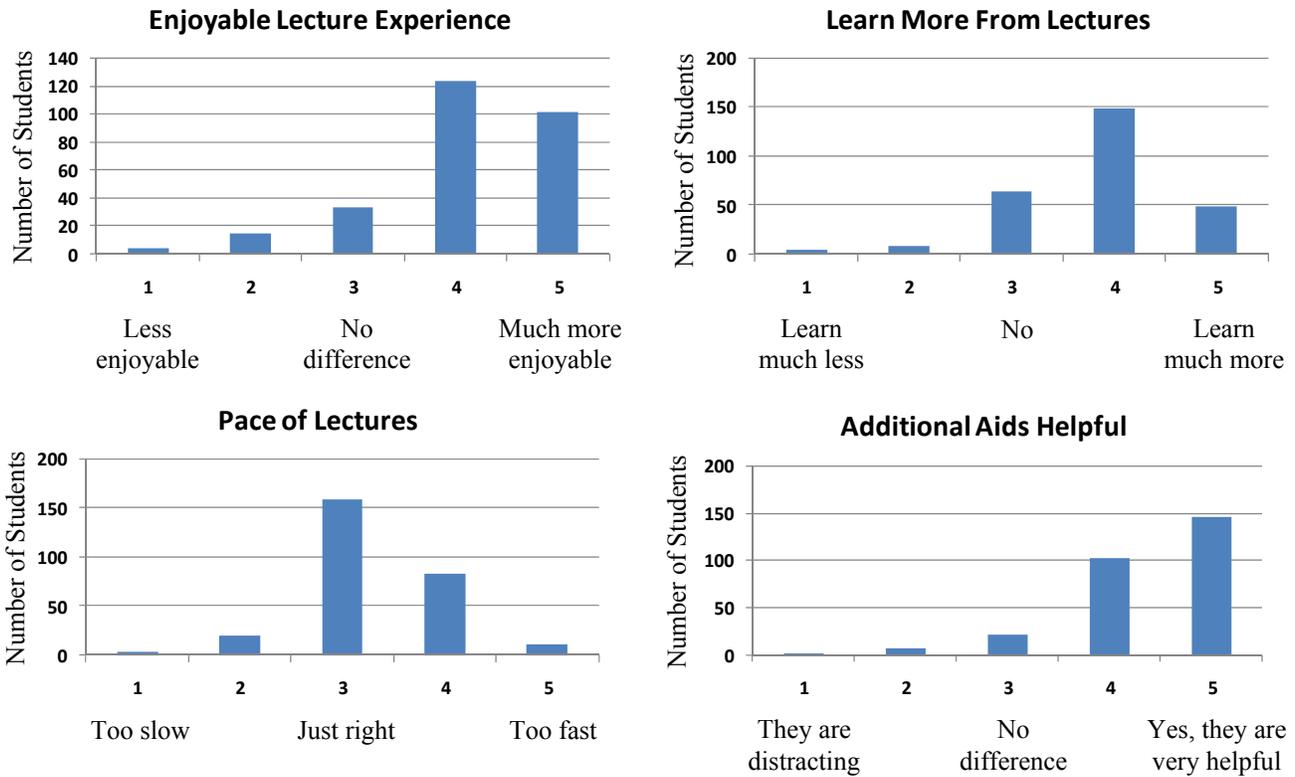


FIGURE 1
THE STUDENT RATING OF THEIR LECTURE EXPERIENCE

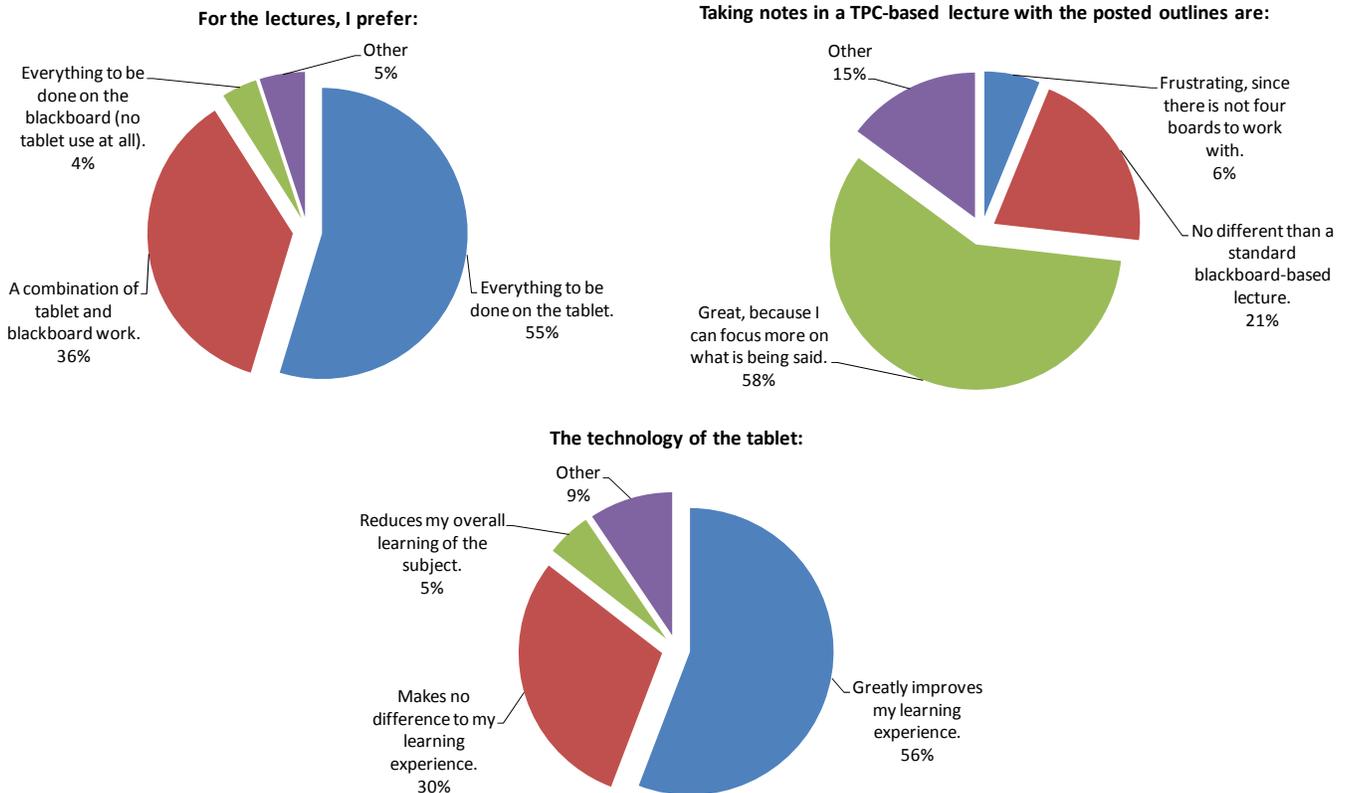


FIGURE 2
THE STUDENTS' LECTURE PREFERENCE, AND THEIR RATING OF NOTE-TAKING AND THE TECHNOLOGY OF THE TPC

IMPACT ON DIFFERENT LEARNING STYLES

It is clear that the student body as a whole were quite enthusiastic about the use of the TPC. As part of these surveys, the students were also asked about their dominant learning style. The surveys given in the first three courses (MAT298F, ECE320F, and ECE221S) simply asked the students to assess their own learning style based upon short descriptions of what characterizes the visual, auditory, and kinesthetic modalities of learning. They were given the option of selecting more than one option if they felt that they could not choose a primary mode. For the most recent course (MAT290F) a proper assessment of their learning style was included. This assessment was based upon an instrument developed by Austin [12]. It consisted of 17 questions and was based upon the Kolb learning style theory.

The breakdown of learning styles is given in Tables I and II. These distributions are similar to what has been observed in other studies involving engineering students. When tested using the Index of Learning Styles (ILS), the majority of students generally prefer taking in material visually, while they process material best through active experimentation [13]. Therefore, it makes sense that for the first group (Table I), 81% of the students stated that they learned best through visual and/or kinesthetic means. In addition, when tested using the Kolb theory, the dominant styles are often convergers or assimilators with divergers and accommodators being less represented amongst engineering students [14]. It can be seen that this is also the case for this group of students. In the end, the most important observation of these results is that each class consists of a wide variety of different learning styles. This is why it is so important to make sure the way in which the TPC is used in the classroom addresses the needs of all the different learning styles.

Table III contains the responses for each learning style group to the questions discussed above. At first glance it may appear that there are some differences in how students of different learning styles responded to use of the TPC. Indeed, the conclusions that were made from the initial set of results were based on the fact that the different styles had different mean results [11]. However, based upon an analysis of variance (ANOVA) for this multi-course data, there are no statistically significant differences in the responses of the different learning style groups. This fact is promising as it indicates that this method of using the TPC for lecturing is generally liked by students of all learning styles. Of course this does not demonstrate that it is an effective method for students of all learning styles, and this is a research question which is yet to be answered.

Even though each learning style group responded relatively the same to the use of the TPC, there were some differences when they were asked about their preferred method of lecturing. The results of this question for the key learning style groups are shown in Figure 3. It can be seen that the visual learners had a greater preference for the TPC-only lectures (60%) as compared to the kinesthetic learners

(49%). For the students who completed the Kolb-based assessment, the data for the assimilator group was compared to the students in the other three categories. This is because assimilators generally appreciate the traditional lecturing approach, due to its inherent order and logical presentation [16]. However, the other three types of learners are usually best served by a more active approach. For example convergers often learn well by being given the opportunity to “take things apart” and see how things “work”, while divergers benefit from group work or discussions about the material at hand and how it fits into the larger picture. For accommodators, self-discovery is important, so the “think” part of a think-pair-share exercise would help them to better process the information being presented.

TABLE I
LEARNING STYLE DISTRIBUTION (MODALITY THEORY)

Learning Style	MAT298F (89), ECE320F (40), and ECE221S (99) (2007/2008)
Visual	38% (86)
Kinesthetic	25% (58)
Visual/Kinesthetic	18% (41)
Visual/Auditory	8% (18)
Auditory	3.5% (8)
Visual/Auditory/Kinesthetic	3.5% (8)
Auditory/Kinesthetic	0.5% (1)
No Learning Style Selected	3.5% (8)

TABLE II
LEARNING STYLE DISTRIBUTION (KOLB THEORY)

Learning Style	MAT290F (52) (2008)
Assimilator (Reflective Thinking)	29% (15)
Convergers (Active Thinking)	27% (14)
Accommodator (Action with Reason)	19% (10)
Diverger (Reflective Action)	10% (5)
No Definitive Learning Style Specified (Ties)	15% (8)

If considered from this point of view, the group of assimilators have a greater preference for either the use of the TPC or the blackboard (total of 53%). While the remaining students have a combined preference of only 43%.

It seems from these two sets of results that the students who would learn best through a more active approach, i.e., kinesthetic learners, convergers, divergers, and accommodators, have a stronger preference for a change in

the lecturing mode during each class. This indicates that what they are looking for is not just the visually-enhanced version of the traditional lecture format, but something more engaging.

CONCLUSIONS

It is clear that the tablet PC offers many advantages over the traditional blackboard approach to improve the overall learning experience of the students. It enables the instructor to engage the students more thoroughly through the use of added multimedia content. Indeed, the survey results presented here for a large sample of students (280 students) demonstrate how students greatly appreciate the added visual aids, with 90% of the students indicating that they were “helpful”. As well, the vast majority (81%) of the students clearly stated that they found the TPC-based lectures more enjoyable than the blackboard-based lectures. These results demonstrate that, in general, the TPC has a very positive impact on the students.

The main purpose of this work was to present how the students of different learning styles responded to the use of the TPC. In considering the mean value of the responses for the Likert-scale based questions, it was found that there were no statistically significant differences between the different learning style groups. This is a good indicator that the introduction of the TPC as a lecturing device does not alienate a particular type of learner. However, it was also found that the group of learners which benefit from active-learning exercises had less of a preference for a TPC-only lecture over their visual or assimilator counterparts. This shows that the many advantages that the TPC provides are not enough if simply used to replace a traditional lecturing format. Instead, these advantages must be leveraged to provide a learning environment which is valuable for all students. Ultimately, the effectiveness of the TPC will be measured by how it is used to meet the learning outcomes of the specific courses and program that it services, and how well it is used to facilitate an active learning environment.

TABLE III
SURVEY RESPONSES BASED ON LEARNING STYLE

Question	MAT298, ECE320, and ECE221 – 2007/2008				MAT290 - 2008				
	Visual (86 – 38%)	Kinesthetic (58 – 25%)	Visual/Kin. (41 – 18%)	Total (228)	Accom. (10 – 23%)	Assim. (15 – 34%)	Converger (14 – 32%)	Diverger (5 – 11%)	Total (52)
1) Does the use of the tablet make the lectures a more enjoyable experience? (5 – Much more enjoyable) (3 – No difference) (1 – Less enjoyable)	4.27 (0.76)	4.05 (0.93)	4.20 (0.87)	4.16 (0.88)	3.78 (0.67)	3.73 (0.96)	3.79 (1.25)	3.80 (0.84)	3.80 (0.98)
2) Do you learn more from the lectures? (5 – Learn much more) (3 – No) (1 – Learn much less)	3.90 (0.82)	3.67 (0.63)	3.68 (0.91)	3.82 (0.80)	3.67 (0.71)	3.40 (1.12)	4.14 (0.77)	3.80 (0.45)	3.84 (0.9)
3) Do the additional visual enable you to understand the material more clearly? (5 – Yes, they are very helpful) (3 – No difference) (1 – They are distracting)	4.51 (0.73)	4.38 (0.75)	4.49 (0.60)	4.45 (0.71)	4.00 (1.12)	4.13 (0.92)	4.36 (0.84)	4.00 (0.71)	4.14 (0.94)
4) The pace of the tablet-based lectures is: (5 – Too fast) (3 – Just right) (1 – Too slow)	3.35 (0.66)	3.28 (0.70)	3.27 (0.78)	3.28 (0.71)	3.56 (0.73)	3.21 (0.89)	3.21 (0.8)	3.40 (0.55)	3.26 (0.75)
5) Overall, my assessment of the tablet as an effective teaching tool is: (5 – Very effective) (1 – Not effective at all)	4.14 (0.74)	4.04 (0.80)	3.98 (0.89)	4.07 (0.84)	3.11 (0.78)	3.60 (1.06)	3.57 (0.85)	3.60 (0.55)	3.55 (0.9)

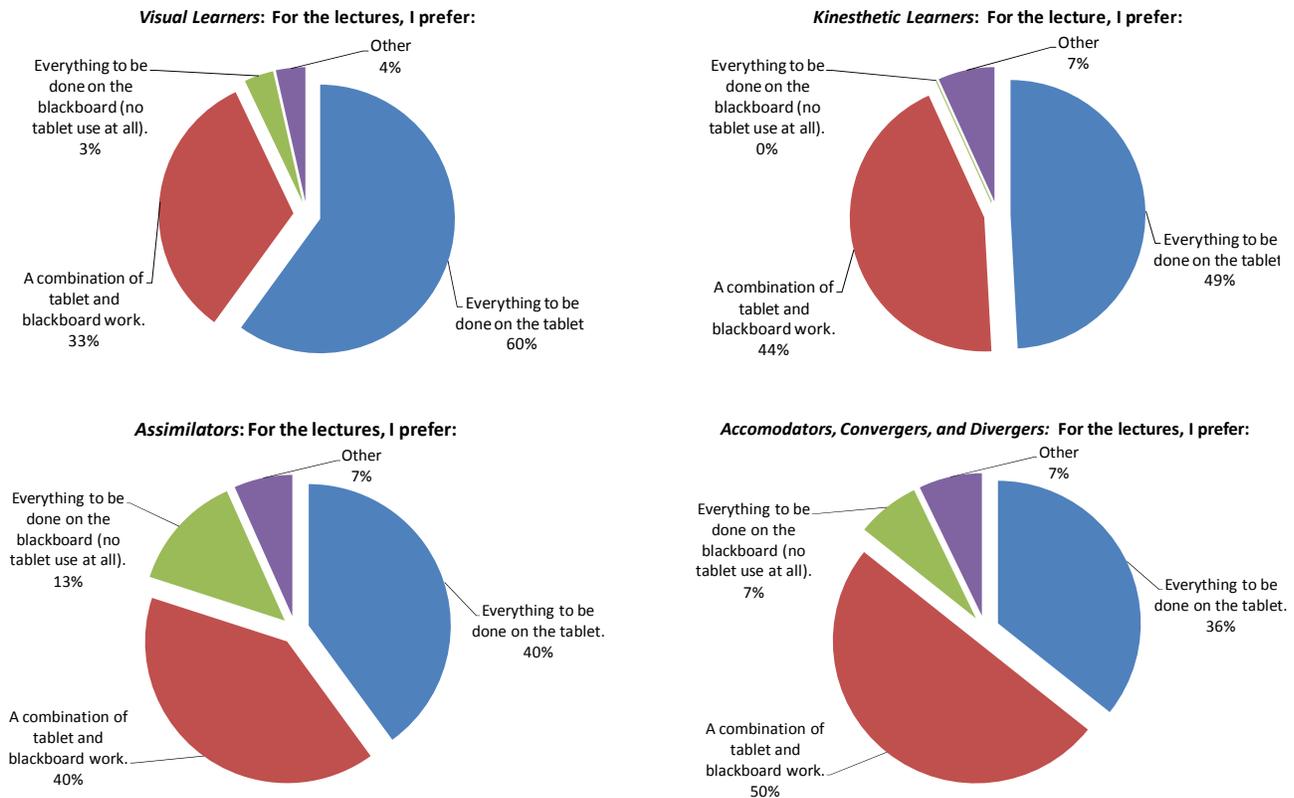


FIGURE 3
THE STUDENTS' LECTURE PREFERENCE FOR DIFFERENT LEARNING STYLES

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