Tablet PC Support of Students' Learning Styles

Shreya KOTHANETH
Industrial and Systems Engineering, Virginia Tech
Blacksburg, VA 24060, USA

Ashley ROBINSON
Computer Science, Virginia Tech
Blacksburg, VA 24060, USA

and

Dr. Catherine AMELINK,
Division of Student Affairs, Virginia Tech
Blacksburg, VA 24060, USA

ABSTRACT

In the context of rapid technology development, it comes as no surprise that technology continues to impact the educational domain, challenging traditional teaching and learning styles. This study focuses on how students with different learning styles use instructional technology, and in particular, the tablet PC to enhance their learning experience. The VARK model was chosen as our theoretical framework as we analyzed responses quantitatively and qualitatively of an online survey. Results indicate that the tablet PC does cater to all learning styles.

Keywords: Learning Styles, Tablet PC, VARK, Instructional Technology, and Higher Education.

1. INTRODUCTION

In the context of rapid technology development, it comes as no surprise that technology continues to impact the educational domain, challenging traditional teaching and learning styles. If employed correctly, instructional technologies, in particular, have been found to benefit the learning experience by aiding conceptualization, applying knowledge, and facilitating dialogue [1]. Research has shown that it is important to understand learning styles and profiles of students in order to have the most effective teaching and learning experience. Studies have found that multimedia technology have a positive effect on a classroom of students with different learning styles by neutralizing differences in performances [2]. This study focuses on how students with different learning styles use instructional technology, and in particular, the tablet PC to enhance their learning experience.

2. BACKGROUND

Learning Styles

The concept of learning styles originated in the 1970s. It has been defined as different approaches to learning. Some researchers argue the most effective instructional technique is to first identify learning styles and then adapt their instructional method to each learning style [3]. Others suggest that there is no single efficient teaching method; educators should instead use a variety of instructional techniques [4,5]. In this technological era, it is important to understand the relationship between learning styles and the use and acceptance of technology.

Various instruments have been developed to understand learning preferences. The Learning Style Inventory [6], was developed by Kolb, to identify and categorize participants into four learning styles; Diverging, Assimilating, Converging, and Accommodating [6]. The Dunn and Dunn Learning Style Inventory [3] is based on the notion that students have learning style preferences which are divided into twenty-one variables that affect learning in five categories: Environmental, Emotional, Sociological, Physiological, and Psychological [3]. The Myers-Briggs Type Indicator [7] divides learning preferences into four dichotomies, which results in sixteen possible psychological learning types, including Extroversion versus Introversion, Sensing versus Intuition, Thinking versus Feeling, and Judgment versus Perception [7].

One of the most popular models is Fleming's VARK model [5], which divides learners into four categories: Visual (V), Auditory (A), Reading/writing (R), and Kinesthetic (K) (See Figure 1). Visual learners are those who learn best with visual artifacts. Auditory learners are those that learn with oral stimulations. They learn by

talking and listening. Reading or Writing learners prefer printed words to gain knowledge. Kinesthetic learners are those who learn by experience. They learn by real world examples and by application. Learners can also be multi-styled, making use of two or more learning styles [5]. Since this model is extremely popular and widely used, we have chosen this model as our theoretical framework.

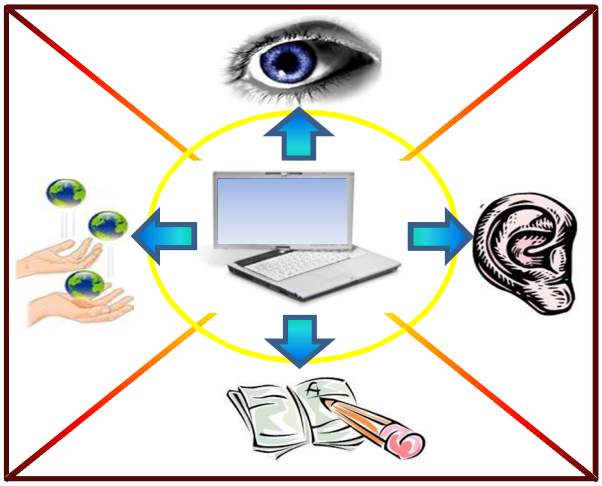

Figure 1: Conceptual model depicting relationship between students' learning styles (VARK Model) and the use of tablet PC

Instructional Technology

The rapid ascent in computer technology and the Internet has contributed to increase in using different media for education. Instructional technologies can range from using software like PowerPoint, to hardware like laptops and tablet PCs in the classroom. These media can improve the teaching and learning experience. For instance, Moore [8] found that the use of instructional technologies led to an increase in three types of interactions: between the students and learning material, students and instructor, and among the students. Various technologies have also been identified as useful for students who belong to Generation Y, who are characterized by their high use and dependency on technologies [9]. Some researchers go so far as to claim that teaching will eventually only be conducted by technology and multimedia instructional techniques as they are far superior to standard instructional techniques [10].

Tablet PCs

The tablet PC, in particular, is becoming a very common tool in higher education. For instance, Pennsylvania State University [11], University of Toronto [12], and University of Alaska Anchorage [13] are all examples of universities who have starting using the tablet PC in some of their courses. The tablet PC is like a standard laptop, with a keyboard for typing as well as a stylus for scribing. The screen can be rotated and collapsed, so that a stylus can be used to make handwritten notes and drawings in a similar fashion to pen and paper. The addition of the stylus is the main difference between the tablet PC and other slate-like devices such as the iPad. Tablet PCs afford rich graphics that aid in visualization. The built in speaker and microphone not only enable richer audio presentations, but affords audio recording for future playback. The electronic inking (e-inking) capability of the tablet, which enables users to write on the tablet with a stylus as if it were an ink pen, provides open-ended note-taking capabilities. The slate conversion features enables users to read/write on a flat surface, simulating notebook reading/writing. There is also tablet PC based software that enables students to create and interact with their learning environment [14].

With the increasing trend of tablet PCs and slate like technologies, there is a need to understand the relationship between learning styles of students and use of the technology in the classroom. The College of Engineering, at Virginia Tech, started the Tablet PC Initiative in 2006, which requires all incoming engineering freshman to purchase and use a tablet PC in class. All classrooms have access to the University's wireless network. This study uses the College of Engineering at Virginia Tech as a forum to understand better how the tablet PC is used by different types of undergraduate engineering students. Using software that enhances Tablet PC features such as Microsoft OneNote [15] and DyKnow [16] are common among Virginia Tech students. Microsoft OneNote is software that supports extensive note taking, note sharing, audio recording, e-inking, and collaboration capabilities. DyKnow is classroom interactive classroom software that contains such features as polling, lecture slide annotations, audio recording, e-inking, and collaboration.

3. METHOD

An online survey was sent to all undergraduate students enrolled in the College of Engineering at Virginia Tech, after approval by the Institutional Review Board (IRB) as part of the engineering curriculum assessment process. This questionnaire, designed using expert review, elicited information on how they study, organize material, use the tablet PC among other things, and took approximately 15 minutes to complete. To gather qualitative data, we also asked students the following question: "Consider how the Tablet PC has been used by your different instructors. In your experience, what activities are best supported with the Tablet PC?" The survey obtained a usable response rate of 18% with a total of 1090 students. All the students were enrolled either in or after Fall 2006, which implied that they were affected by the tablet PC initiative.

Flemings' VARK model served as the theoretical framework for the analysis. Of the all the questions sent in the original survey, seventeen questions were selected on their ability to elicit use of the tablet PC relating to the four learning styles. Some items used a four-point Likert scale with anchors 1-Never, 2-Rarely, 3-Occasionaly, and 4-Frequently. Other items used a five-point Likert scale with anchors 1-Never, 2-Rarely (once or twice a semester), 3-Sometimes (several times a semester), 4-Frequently (five or more times a semester), and 5-Very frequently (almost every week). The questions were coded as V, A, R, or K. See Table 1 for more details.

Visual questions were based on students' use of charts and diagrams to better understand course material. Auditory questions related to making use of the tablet's audio recording abilities to record lectures and also discussing the course material with their peers. The reading and writing questions captured the student's use of the tablet's e-inking feature to take and review notes. Kinesthetic questions were based on students' interactivity with the course material.

Data from the survey was analyzed using descriptive statistics. In addition, qualitative responses of the students were analyzed using content analysis, specifically thematic coding, to gain a further understanding of how students with different learning styles used the tablet PC.

4. RESULTS

Quantitative Analysis

Our results, in Table 1, indicate that tablet PC usage in the classroom addresses all learning styles. Highest mean scores were reported for using the e-inking capabilities of the tablet PC to help illustrate points made in class and mark slides, and using web-based sources to apply concepts in class.

Qualitative Analysis

Visual Learning: Several students indicated that they liked using the tablet PC to create visual representations of their notes. They reported that it helped with creating diagrams and for sketching assignments. Students also reported that the tablet PCs allowed professors to enhance their teaching experience by adding visual artifacts to their notes. They said, "Used e-ink to write out examples or show drawings and such. Drawings are best supported."

Auditory Learning: Software like DyKnow and OneNote was used to record lectures which were helpful for review. According to one student, "Group brainstorming or planning sessions work well with a shared OneNote page." Another student commented, "DyKnow and OneNote are both just lovely. I am a huge DyKnow fan. I like how the pen strokes can be replayed using DyKnow and the voice recording is a very useful tool as well."

Learning Style	Mean	SD
Visual		
* E-ink to create diagrams	2.16	1.09
* Shared electronic whitespace with other students	1.56	0.83
Helped illustrate points made in class	3.31	0.95
** I made simple charts, diagrams, or tables using the Tablet PC to organize course materials	2.22	1.23
Auditory		
* Shared notes/slides with other students	1.94	0.98
* Shared electronic whitespace with other students	1.56	0.83
* Audio recording of lectures/discussions using OneNote	1.23	0.59
Reading/Writing		
* E-ink to mark slides provided by the instructor	2.39	1.17
* E-ink to take notes using OneNote	2.30	1.08
* Imported web-based information into notes	2.00	1.10
* E-ink to take notes with another program	1.93	1.06
* Special note take capabilities of OneNote	1.69	0.97
** I study by reading my notes over and over again	2.90	1.24
** I make lists of important items for this course and memorize the lists	2.26	1.18
Kinesthetic		
* To respond to interactive class exercises using polling/voting	1.77	0.88
* To respond to interactive in-class exercise using written responses	1.74	0.91
** I try to apply ideas from web-based sources to other class activities such as lecture and discussion	2.42	1.14

Table 1: Questionnaire Result Means and Standard Deviations. **Used a five-point Likert scale with anchors 1-Never, 2-Rarely (once or twice a semester), 3-Sometimes (several times a semester), 4-Frequently (five or more times a semester), and 5-Very frequently (almost every week). *Used a four-point Likert scale with anchors 1-Never, 2-Rarely, 3-Occasionaly, and 4-Frequently.

Reading/Writing Learning: A majority of students indicated that the tablet PC was useful for note taking. Tablet PCs were also found to be useful in classes that involved a lot of equation writing. One student reported, "Tablet PC is good for taking notes. Taking notes on the actual slides that a professor is teaching from is much more beneficial than simply taking notes in paper

notebook. The tablet is also convenient in that it allows you to take notes without having to print out the lecture slides."

Kinesthetic Learning: Students indicated that the ability to swivel the monitor helped them to collaborate with each other. Students also liked that they could transfer their drawings and sketches easily using the tablet PC. The use of interactive software, such as DyKnow [16] and OneNote , in class made the class a lot more engaging and students reported enjoying taking polls in class. Students said that, "Activities involving polls and giving responses to the teacher are best supported with the Tablet PC."

5. DISCUSSION

The quantitative and qualitative analyses reveal that the tablet PC can be beneficial to all learning styles. Visual and reading/writing learning style features were used the most. This can be attributed to the fact that lectures are still the most popular teaching styles thus automatically cater to auditory learners. The main benefit of using a tablet PC in class is to supplement the lectures with visual and reading/writing artifacts. Reading and writing are natural affordances of the tablet due to the slate conversion option and the stylus.

The qualitative analyses revealed that students use additional features such as recording the lectures. These features will also be useful in an online course, where the instructor is remote. Software like DyKnow [16] and OneNote [15], can be used to make the class more interactive and thus be helpful for kinesthetic learners.

It is important to acknowledge that the lower mean scores (means below 3.00 for a 5-point Likert scale and below 2.00 for a 4-point Likert scale) can be attributed to what's also been biggest barrier to the Tablet PC Initiative at Virginia Tech, the lack of continued use of the tablet PC by faculty members in all the engineering classes. While tablet PCs have been extensively used in the freshman classes, their use in class by faculty members drop extensively in the senior classes.

One limitation of this study is that the survey was designed to gain an understanding on the use of the tablet PC but not specifically on the learning styles of the students. In addition, the hardware of the tablet PC could also aid various learning styles; however, we did not investigate this question. We recommend that questions related to the tablet PC's hardware (e.g. touchpad/mouse, keyboard, size, etc.) be included in any future study.

6. CONCLUSION

Our results show that the tablet PC is useful for students who possess any of the VARK learning styles. However, success of tablet use in the classroom ultimately depends on efforts to prepare engaging lectures using the technology [17]. This is apparent in the lower kinesthetic means, which heavily depends on interaction of students in the lecture. If instructors do not implement interactive features such as polling and short response questions, kinesthetic learners will be at a disadvantage, because they 'learn by doing' and will not have the opportunity to use the technology to engage with the course material. The lecture should also be visually engaging and also be made available to students so that students can read and annotate their notes. Instructors can audio record their lectures using features of the tablet PC and let students access it for future playback. While it is evident that the tablet PC can cater to all learning styles, we envision that they will better support VARK learning styles as instructors as well as students become more comfortable with tablet PCs and their features.

7. REFERENCES

[1] J. McKendree, K. Stenning, T. Mayes, J. Lee, and R. Cox, "Why observing a dialogue may benefit learning," *Journal of Computer Assisted Learning*, vol. 14, 1998, pp. 110-119.

[2] F. Karakaya, T.L. Ainscough, and J. Chopoorian, "The Effects of Class Size and Learning Style on Student Performance in a Multimedia-Based Marketing Course," *Journal of Marketing Education*, vol. 23, Aug. 2001, pp. 84-90.

[3] R.S. Dunn and K.J. Dunn, *Teaching students through their individual learning styles: A practical approach*, Reston, Va: Reston Publishing Company, 1978.

[4] M. Sprenger, *Differentiation through learning styles and memory*, Thousand Oaks, CA: Corwin Press, 2003.

[5] N.D. Fleming, "I'm different; not dumb. Modes of presentation (VARK) in the tertiary classroom," *Research and Development in Higher Education, Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australasia (HERDSA), HERDSA*, 1995, p. 308–313.

[6] D.A. Kolb, *Individual learning styles and the learning process*, Cambidge, Ma: MIT Press, 1971.

[7] I.B. Myers and M. McCaulley, *Manual, a guide to the development and use of the Myers-Briggs type indicator*, Palo Alto: Consulting Psychologists Press, 1985.

[8] M.G. Moore, "Three types of interaction," *The American Journal of Distance Education*, vol. 3, 1989, pp. 1-6.

[9] W. Strauss and N. Howe, *Generations: the history of America's future, 1584-2069*, New York: Morrow, 1991.

[10] J. Gandz, "The death of teaching: the rebirth of education," *Ivey Business Quarterly*, vol. 62, 1997.

[11] S.G. Bilen, D. Lee, J.I. Messner, H.T. Nguyen, T.W. Simpson, A.A. Techastassanasoontorn, and R.F. Devon, "Tablet PC Use and Impact on Learning in Technology and Engineering Classrooms: A Preliminary Study," *Workshop on the Impact of Pen-based Technology*, West Lafayette, IN: 2008.

[12] M. Stickel, "Effective Use of Tablet PCs for Engineering Mathematics Education," *ASEE/IEEE Frontiers in Education*, Saratoga Springs, NY: 2008.

[13] K. Mock, "Teaching with Tablet PCS," *Journal of Computing Sciences in Colleges*, vol. 20, 2004, pp. 17-27.

[14] P. Hamilton and E. O'Duffy, "Digital education usage models for the classroom of the future," *Proceedings of the 4th International Conference on Virtual Learning*, 2009.

[15] Microsoft, "OneNote 2010," 2011.

[16] Dynamic Knowledge Transfer, "DyKnow," 2010.

[17] M. Stickel and S.V. Hum, "Lessons learned from the first-time use of tablet PCs in the classroom," *Frontiers in Education Conference, 2008. FIE 2008. 38th Annual*, IEEE, 2008, p. S1A.