



From Black boards to Digital boards: Students and Professors experience Challenges and Remedies

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Abstract

Since the early days of education, there has always been a challenge about the appropriate medium for the interaction between the instructors and students in the classroom. In this study, the efficiency of use of tablets, as an alternative for traditional black and white boards, has been investigated. The advantages and disadvantages of this medium are elaborated and the experience of the both professors and students toward the use of tablet has been recorded using carefully prepared questionnaires in more than ten engineering classes in two universities. Both undergraduate and graduate courses are targeted and effort has been made to identify challenges in using this technology.

In addition, several remedies are proposed based on the students and professors comments to improve the efficiency of the use of tablets. The paper ultimately proposes an optimized method for use of tablets in engineering classrooms which can improve both the teaching and the learning experience in universities.

Introduction

Through the long history of teaching and learning, the medium of the interaction between the educator and learner has evolved from merely oral interaction between teacher and students to the recent tablets and smart devices. Advances in technology have played a significant role in developing new methods and devices for interaction. Table 1¹ summarizes a handful of devices used during such an evolution since 1650 and a brief description of how they work.

The advent of computers is by far one of the most important turning points in this field. Computers and subsequently internet provided the educators with a treasure trove of materials, images and already developed media to be used in their classrooms. Several softwares began to develop to enhance the presentation abilities and simplify the process of preparation of presentation. One of the most popular of such softwares is Microsoft PowerPoint which was officially launched on May 22, 1990.² The user-friendly environment of PowerPoint and the simplicity it offered for presenters' to prepare the material in comparison with the alternative

methods such as boards or overhead projectors soon made it one of the most commonly-used softwares of the era.³⁻⁷

Table 1- The evolution of presenting technologies in classrooms¹

1650	1870	1890	1930
			
Hornbook	Magic Lantern	Chalkboard	Overhead Projector
Wooden paddle with lessons nailed to it, it is believed to be the first classroom staple.	First slide projector, it illuminated large glass slides onto cloth screens.	Once black, but now green, this teaching-tool breakthrough allowed teachers to write lessons for the entire class to copy.	It allowed teachers to write their lessons on transparencies prior to class.
1980	1999	2010	2010
			
Plato Computer	Interactive whiteboard	ipad	Convertible Tablet PC
First used by school administrators and counselors, the computer quickly trickled down to the students for word processing and learning games.	This board connects a computer to a digital projector, allowing presenters to change the images on the screen with a pen.	A tablet with multi-touch input screen introduced by Apple Inc. with the purpose of paperless classrooms.	A fully functional computer running on full windows operating system with a rotatable screen and a digitizer pen as an extra input device.

Many educators began to use PowerPoint as their primary medium to teach in classrooms and many universities equipped their classrooms with projectors.^{3-5,8-15} Shortly after the debates over the pros and cons of slide-based presentation began to rise. Advocates of powerpoint mention various reasons for its usefulness. One of the main advantages of using PowerPoint slides is the reduced time and expense in preparing slides.^{3,5} PowerPoint slides are easy to create for everyone and less efforts and time is devoted for them in comparison with the alternative methods.^{3,5,8-11}

The other advantage of PowerPoint is the ability to use high quality digital images, diagrams and graphs^{3,5,16}. Particularly, in engineering courses, where visualization is vital for understanding certain concepts, high quality digital presentation can contribute to better learning and more effective teaching process. Also PowerPoint slides are easy to update and edit in comparison with traditional methods of teaching and slides can be used for future teaching of the same courses with modifications without the need to create the entire lectures again. The PowerPoint slides can be easily integrated with other forms of media such as videos and audios and allows the educator to provide real life examples during teaching which enhances the students' motivation and interest in learning the presented materials. There have also been some reported results of better retention of information from students following the effective use of PowerPoint slides.¹⁷ Online learning has also been reported to be more effective using PowerPoint slides.¹⁸

On the other hand, slide-based presentation and teaching have its own adversaries too.^{3,19-23} There are two common terms of "Death by PowerPoint"^{20,22} and "PowerPoint Hell"²⁴ that refer to drawbacks of using PowerPoint or at least using it, inefficiently. "Death by PowerPoint" was originally introduced by Angela Garber²⁰ where she mentioned a state of boredom and fatigue that can occur for the audience of slide-based presentations especially when there is excessive information presented not very professionally.

There has been some research to modify the use of PowerPoint to avoid the issues associated with "Death by PowerPoint".²⁵ Mostly researchers believe that the issues are more the result of improper use of PowerPoint and poorly made presentations rather than the PowerPoint itself.^{3,5,19} Some other proposes the combination of PowerPoint with the display of live materials such as movies or animations and claim the media switch can contribute to eliminate the "Death by PowerPoint"

Another issue of PowerPoint is oversimplification of materials. Edward Tufte²¹ suggests the inherent hierarchical process of presenting information using PowerPoint can result in loss of significance in the eye of the audience. PowerPoint slides promote linear thinking and the listeners might deem some concepts as unimportant simply because they are presented in the last bullets. In use of PowerPoint people also tend to use abbreviations and acronyms to better fit the material in slides. This in turn is suggested to have some drawbacks on learning process. He

also associates some catastrophic accidents as the consequences of using PowerPoint for conveying important subjects ²⁶. There are also other issues associated with PowerPoint reported such as the possibility of technical issues and the peril of its pushing other methods of teaching to extinction. ^{3,5} A summary of advantage and disadvantages of PowerPoint has been provided in table 2.

Table 2- Pros and Cons of PowerPoint

Advantages of using Power Point	Disadvantages of using PowerPoint
Ease in Preparing Lecture and presentations and having a user-friendly interface	Oversimplification of significant information to be able to fit into slides
Ability to integrate high quality digital images, figures, graphs, tables, etc.	Excessive use of Abbreviations and Acronym
Ability to update and edit previously made presentations for repeated or relevant use	Dominance over the teaching community and pushing other methods to extinction
Integration of other forms of media such as live videos or audios	Boredom and Tedium associated with being overloaded with information without sufficient time to digest the information
Enhanced learning and information retention	Hierarchical nature resulting in loss of significance in bulleted items
Lectures could be provided to students as references and handouts can be readily printed from the software itself	Students losing significant amount of information due to merely studying the provided slides or the handouts.
The presenter can always look at the audience for feedbacks and comments and maintains eye contact	

Chalk and white boards have their supporters and critics. Particularly in engineering education and math related concepts, students can better understand the concepts and solution to the problems as they observe the entire process rather than being provided the information in whole on a slide or two ²⁷⁻²⁹. Summary of advantages and disadvantages of using boards are outlined in table 3.

Table 3- Pros and Cons of Chalk and Whiteboards

Advantages of Chalk and White Boards	Disadvantages of Chalk and white Boards
Ability to follow the progression of materials as they are being presented to learn	Figures and Graphs have to be hand-written and may not be as efficient as digital counterparts
Engaging students in the process of note taking and avoiding distractions and boredom suggested in PowerPoint slides	Time being wasted over presentation and much fewer concepts being covered in a session
No size and fitting issue. Information doesn't have to be condensed or oversimplified	May be difficult for students to understand the material while taking notes of the entire material on the board
	The teacher loses eye contact during writing on the board making it difficult to acquire feedbacks and comments from the audience

Most of researchers however tend to promote PowerPoint in comparison with traditional methods, as they believe the advantage outweigh the disadvantages and most of the drawbacks can be avoided by effective use of slides and proper presentation techniques.⁹⁻¹²

As the computers evolve new options are open for educators to use. Laptops and Tablets are the next generations of computers that are becoming increasingly popular as they offer much more mobility due to their light weight and ease of use. A variety of studies have been conducted by researchers to answer questions if tablet PCs' advanced features are useful for educators and whether it justifies the higher price comparing to other teaching tools (e.g. white board, PowerPoint, etc.).^{27,30-32}

One of the most recent advances in laptop technology is a convertible tablet PC with a digitizer pen. The device is a traditional notebook with full functionality of a computer that uses a pen in addition to a mouse as an input device for enhanced user interactions. The device works with computer operating systems such as windows as opposed to tablet and phone app-based operating system and therefore all popular software packages can be utilized. The convertible tablet can turn into a fully functional PC by a simple rotation in matter of seconds. This will be more significant in cases where the instructor needs to use an engineering software package during teaching. Several tablets don't offer this functionality due to lack of hardware resources or the limitation in the operating system.

In this study, we intend to investigate the effectiveness of convertible tablet PCs in teaching an engineering course as a tool that offers both advantages of chalk and whiteboard and PowerPoint slides. Microsoft Journal and Microsoft one note are the two popular programs that are used to write notes during teaching in class. The former is available free in all recent Microsoft Windows operating systems and the latter is one of the subprograms of Microsoft Office package, the same package that has Microsoft PowerPoint. Two available methods on using these softwares are described. Advantages and disadvantages of tablets as a teaching tool have been elaborated and have been compared with those of black and white boards and PowerPoint Slides. To investigate the educators' and students' experience in using this technology, particular questionnaires have been prepared for each group. The study was done in both undergraduate and graduate classes of mechanical engineering courses of two academic institutions. Statistical analyses have been performed and results have been reported. Finally we propose an optimized method of interaction between the instructors and students based on the available information in the literature and the results of our survey.

Different methods of teaching using tablet

a. Prepared Notes (Handwritten and/or PowerPoint)

One common approach that instructors tend to adopt when using tablet as a medium for interaction with students is editing a PowerPoint presentation or a handwritten note during the lecture time. In this approach, the instructor prepares a PowerPoint presentation or imports the previously written notes into a Microsoft Journal file before the class time. Instructor presents these slides using a projector and puts the last annotations on notes by writing comments, highlighting important concepts or pointing and circling for stressing some subjects. This technique offers its own advantages and disadvantages to the teaching and learning environment.

Saving the time required to copy notes on the board and the ability to cover more material in class are the first benefits of this method. In the cases that the prepared note is distributed between students before the class, it can provide students with pre-lecture study material and also students can bring a copy of the notes to the lecture session and add instructor's supplementary comments to the note. Doing this, students will have enough time to listen to the instructor explaining the material and don't worry about note taking. Also by completing notes during the

class time students can make sure they have a complete note for their later study of the material. Figure 1 shows a sample of notes before the lecture and figure 2 shows a sample of completed note after the lecture. However, as discussed later at student survey section in this paper, not all the students are fully pleased with this approach.

Most of students prefer to have time to copy material from the board. Rewriting equations and materials from the board and the time they spend during this process, allow them to have time to think more and digest the material. Also when they see the process of solving a problem by an instructor, it helps them understand the problem solving procedure more accurately. The other difficulty of this method is that, the instructor is required to prepare these materials ahead of time and make them available for students before the class time. Beside the time constraints, it also limits the last minute modifications of the lecture that the instructor would like to have due to an unexpected question or a missed piece of information as the students are already given the notes.

This method was used in the second institution and students and instructors' feedbacks and comments practicing this approach are listed and discussed in the following sections of this paper.

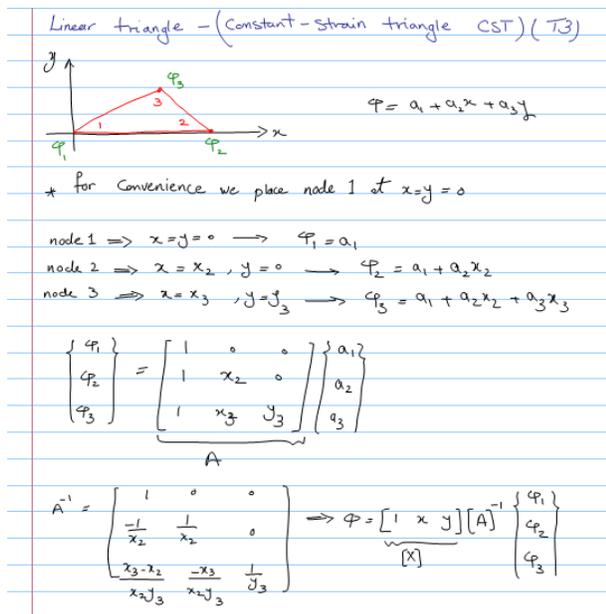


Figure 1: Sample of prepared lecture notes

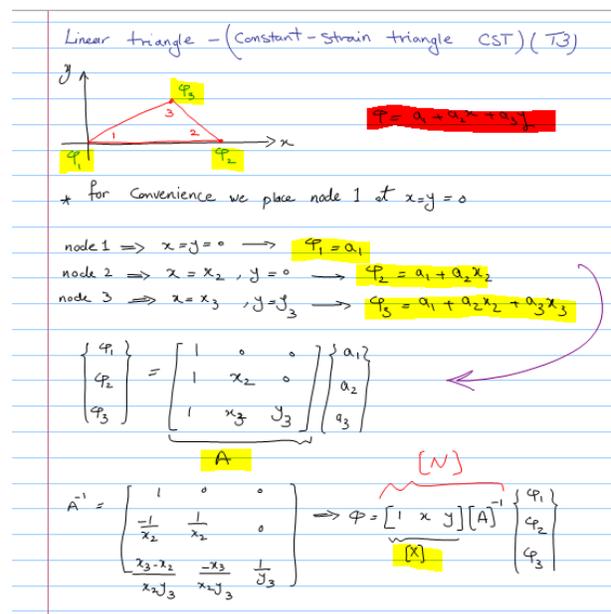


Figure 2: Samples of completed notes in class

b. Live Notes from scratch (in class) and a handful of prepared media

The second approach is very similar to use white/chalk board and write the lecture notes live during the class. What makes this approach different from the traditional white/chalk board method is the further abilities offered because of use of technology. The first advantage is using Microsoft Journal to write notes. Microsoft Journal provides the appropriate environment for handwriting. In other words Microsoft Journal plays the role of board in our application. Figure 3 shows the environment of Microsoft Journal. As shown in this figure user can select the page style, pen color or thickness or many other customizing features. User can import graphics and there is no need to draw complicated graphs which are recurrent in engineering courses. Using this technology removes the physical barriers of the screen between the instructor and students and it can improve students' note taking experience. In this approach instructor can prepare a set of class notes prior the class, similar to the traditional instructor's note. However using tablet can ease the process with providing the editing ability without the need of rewriting the notes. This approach comparing the first method slows the lecture pace. One can consider this a disadvantage however students' feedback showed that it can provide students with the time they need to understand the material. This approach was practiced in the 1st institution and students and faculty members' comments are listed in the next section of the paper.

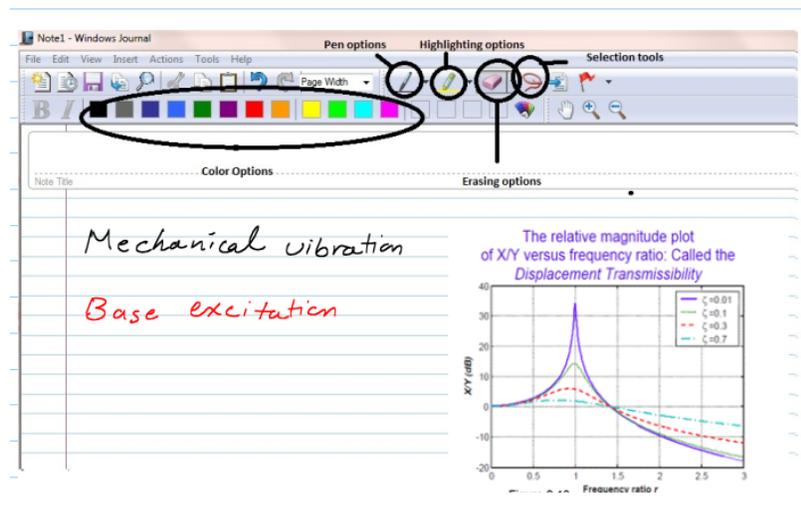


Figure 1: Sample note in Microsoft Journal

Survey: Instructors' and Students' Experience toward use of tablets

a. Instructors' experience

In order to investigate the opinion of both instructors and students, separate questionnaire has been created. The instructors' questionnaires are collected from ten instructors in two higher education institutions who regularly used tablet PC in their classrooms during four semesters of Fall 2011, spring 2012, fall 2012 and spring 2013. The years of experience in the instructors varied from 2 years to 34 years to include both new and veteran professors. All instructors tend to be satisfied with the options and facilities offered by tablet PC and are willing to use it in their future classes. The advantages unanimously mentioned by all instructors are as follows:

- Ease in adopting the technology and user-friendly interface (It must be noted that a short tutorial was considered as a necessity but the learning curve was believed to be quite short)
- Improved quality in lecture notes due to customizing options of the softwares
- Ease in editing and updating notes for future classes
- Enabling technology for remote and online courses

However, there were some areas that instructors had different opinions or believed that the tablet PC could have detrimental effects:

- The response on preparation time was rather heterogeneous. Half of the instructors believed that preparation time is increased due to the use of tablets. Others believe it has no effect on this criterion. It must be noted that these instructors use the prepared notes option discussed above which is inherently a more time-consuming procedure. However they mentioned that if the instructor repeats teaching the same course the time spent on note preparation will definitely pay back.
- As far as posting notes online is concerned, the professors in the second academic institution believed that since attendance is not mandatory, the students are discouraged to attend the class sessions and will settle for online notes for studying and therefore didn't post the notes online. However, one of the professors at the same institution who

posted notes online after each lecture reported no change in students' attendance. We will further study this matter in our future work.

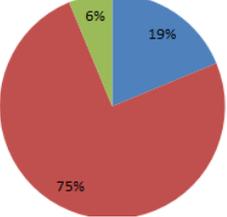
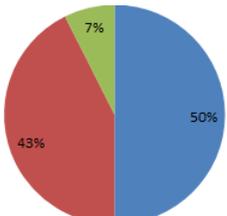
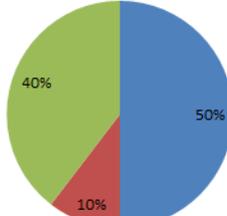
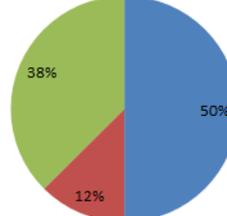
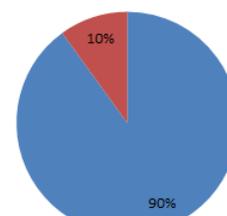
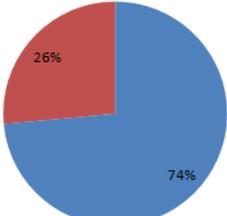
- Need for a user manual on how to use tablet was another topic discussed with instructors. A majority of professors believed that a very short introductory handout or video clip will be helpful. Therefore, one of our future works is to develop such an introductory manual for instructors who are new to use of tablet.
- Some of instructors' comments: "I can go back on the notes if students have a question", "I can easily and constantly modify lecture notes without re-writing them again", "Time is not wasted finding a working marker!"

b. Students' Experience

The students' questionnaires were collected from 90 students of undergraduate and graduate level classes of both institutions. Some of the questions and statistical information on answers have been outlined in table 5.

- The majority of students in the first institution (75%) preferred tablet PC as their major form of media of interaction. Interestingly, whiteboards are the second choice (19%) while PowerPoint has the least popularity (6%). In the second institution, the popularity between tablet PC and white boards are swapped but the PowerPoint still has the lowest percentage. This suggests that in engineering courses, the ability to be able to follow the material as it is being taught is more significant that outweighs the several benefits of slide-based presentations. Also, we see the popularity of the tablet PC diminishes as the prepared notes method (method 'a' described above) is being used and the notes are not provided to the students following each session.
- The majority of students (50% +10% in the 1st institution and 50% + 12% in the 2nd institution) took their own notes. In the 1st institution which the complete lecture notes were posted online after the class more than half of students preferred to take their own notes. These students in their comments mentioned that taking note help them to understand material better.

Table 4: Students' Experience of Tablet PC use in classrooms

Question	Students' comments	
Which one do you prefer? Chalkboard/whiteboard Or Tablet Or PowerPoint	1 st Institution	 <p> ■ Chalkboard/Whiteboard ■ Tablet ■ Powerpoint </p>
	2 nd Institution	 <p> ■ Chalkboard/Whiteboard ■ Tablet ■ Powerpoint </p>
Did you take your own notes?	1 st Institution	 <p> ■ yes ■ no ■ sometimes </p>
	2 nd Institution	 <p> ■ yes ■ no ■ sometimes </p>
Do you recommend tablet to be used in other classes?	1 st Institution	 <p> ■ yes ■ no </p>
	2 nd Institution	 <p> ■ yes ■ no </p>

- A majority of students prefer use of tablet in their other courses (90% in first institution and 74% in 2nd institution).
- Some comments of the students are provided below as the complementary to the statistics: “I was able to listen and not scramble to write everything down”, “we have time to think when lectures are written”, “no endless PowerPoint”.

Conclusion

The present work tries to investigate the proper medium of interaction between instructors and students in engineering classrooms. Although a definite statement is hard to be made over this issue due to the lack of an exhaustive nationwide research, a study of the experience of 10 instructors and 90 students over the course of four semesters suggest that slide-based presentation is popular neither among instructors nor among students.

Tablet PC as a technology that can integrate the advantages of PowerPoint presentation with the benefits of chalk and white boards have been introduced and two methods of its applicability have been discussed. It appears that live hand written notes are more desirable from students’ point of view. This approach has the advantages of white or chalk boards which can engage students in the process of note taking and avoiding distractions while they can have enough time to understand and digest new material. However this method will slow down the class pace which is not desirable especially from instructors point of view. Therefore, we suggest a hybrid method which is a combination of both methods a and b. In this approach instructor can prepare presentation slides using any available presentation software (e.g. PowerPoint, Windows Journal, ...). These prepared slides are not complete like slides from method a. Instructor can exclude formula derivations, solution of problems and any other material which requires instructor to slow down the class pace and give students more time to think while taking note or completing half complete notes provided by instructor prior the class. Instructor can present prepared materials (definitions, descriptions, graph or image, discussions, ...) and put the last touches on notes by writing comments, highlighting important concepts or pointing and circling for stressing some subjects. Problem solutions or formula derivations can be written out completely during the class.

Study on methods a and b showed that tablets can improve several aspects of teaching while eliminating inherent disadvantages of PowerPoint or white and chalkboard. It is also an enabling technology for online and distant learning classes.

Students also tend to find tablets an effective tool for their learning process and prefer methods in which they can follow the progression of materials as they are being taught rather than slide-based presentations such as PowerPoint.

In future we will study students' and instructors' comments on the offered hybrid method while including a more diverse collection of engineering courses to the study. We will also study the effect of students' age (freshman to graduate students) and gender in their preference of interaction medium in classroom. Furthermore, we will study the effect of making lecture notes available to students after class (e.g. posting notes online) on students' class attendance. We will also start collaborating with tablet manufacturers to include engineering education community's comments, who are using this technology in their classrooms, and improve the technology toward our specific requirements in classroom.

The resources (e.g. brief manual on how to use tablet effectively in classroom, questioner to collect students' feedback, etc.) are available for instructors interested in practicing this approach in their classroom and contribute to this research.

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