Experience and Student Feedback from Teaching with Guided Slides on a Tablet PC

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Abstract

Blackboard/overhead projector and PowerPoint presentations are two conventional lecturing techniques used in most of the undergraduate classes. In this study a new technique, namely guided slides with tablet PC, was implemented in a typical engineering course. Guided slides are a set of incomplete slides used in class. However, guided slides do not include every detail of the contents; they are designed to be completed by the lecturer's handwriting during the lecture via a tablet PC. The main objective of the present study is to gather students' responses to the proposed technique compared with the conventional lecturing techniques. The results are then analyzed via the ARCS motivation model. Questionnaires were issued to students in the class to assess the advantages and limitations of all three techniques. A focus group was also held at the end of the semester to obtain qualitative data and an explanation of the results from the questionnaire. The results confirmed the speculated limitations of the blackboard and PowerPoint techniques. The application of GS/T was a success in terms of students' utilization and satisfaction. With GS/T, the class moved from a passive note-taking to an active learning class. Students strongly favored the feeling of a "live" lecture offered by real-time handwriting. Many positive attributes of GS/T technique were unveiled, especially in regard to aspects of attention and relevance. Despite its popularity, PowerPoint scored poorly in the confidence and satisfaction aspects. Instead, GS/T was found to achieve face-to-face communication and instill mandatory class participation.

Keywords: Active learning, guided slides, note-taking, tablet PC

Introduction

Lecturing techniques in the Faculty of Engineering, Chulalongkorn University, have evolved continuously over the years. Before the era of computers, lectures were based on chalk and blackboard. Students depended on pen and notebook to follow the lecture. The use of an overhead projector followed, but students' practices remained the same. In the last ten years or so, the prevalence of computers and projectors has led to the implementation of PowerPoint presentations.

Nowadays, lecturers typically choose between two techniques. The first technique, blackboard/ overhead projector (BB/OHP), uses either chalk and blackboard or whiteboard pen and whiteboard. An overhead projector is usually incorporated into the lecture to display graphical materials. The second technique employs presentation software popularized by the Microsoft PowerPoint program (PPT). These two conventional techniques, however, are perceived to have limitations in dealing with mathematics and engineering courses, whose content typically involves long derivations of topics or equations.

The chalk and blackboard technique requires the lecturer to write most of the material on the board. This is potentially a time-consuming process which could easily make the class uninteresting. Graphical or complicated materials may be presented on an overhead projector. In this case, students' note-taking is essential since there are usually no handouts available before class. Students are required to listen, analyze course materials, and then take notes. This does not include class participation in the form of asking and answering questions, giving comments, or sharing opinions. Therefore, it may be difficult for students to keep up with the lecture. Once their attention is distracted or disrupted, the remainder of the class is often ineffective. Numerous studies attempted to enhance the traditional chalk and blackboard lecture in a variety of ways. Carroll (2007) used a computer and an overhead projector to produce high quality graphic on the board to enhance the quality of free hand drawing in traditional lectures. Ichimura (2007) developed a system that can automatically transform the chalk and blackboard lecture to e-learning materials, which can be published on the Internet. Timmins (2004) proposed a tablet PC and a projector as an alternative of chalk and blackboard in a traditional lecture. Gautier (2003) and Sticklen (2009) also proposed alternative lecturing methods to replace traditional chalk and blackboard lecture. Although a traditional lecture using chalk and blackboard is one of the most adopted teaching strategies, some drawbacks of the technique are well documented.

Compared with the chalk and blackboard technique, a PowerPoint presentation requires less effort from both lecturers and students. A slide presentation is prepared by the instructor, while the same set of slides is available for students in the form of a hard copy with additional handouts. With this technique, students may not need to take notes, and can just listen and follow the presentation. By not taking notes, students are more likely to sit passively through the class. As a result, students can easily lose their concentration. There are studies pointing to the deficiency of the PPT technique. Mines (2001) reported that student's performance in their class was not improved by using PPT technique compared with the traditional technique. In the study by Savoy (2009), students remembered 15 % less information presented verbally in the class using PPT technique compared with those of traditional lectures. Felder

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(2005) offers suggestions in form of dos and don'ts for PPT presentation.

Thus, there is a need for a new technique that incorporates the advantages of both conventional techniques. In this study, guided slides and a tablet personal computer were adopted for the "mechanics of materials" class in the Chulalongkorn University's Faculty of Engineering. Students' feedback and satisfaction regarding the proposed technique are presented. Guided slides with a tablet PC (GS/T) is a distinct technique that blends the positive attributes of the blackboard/overhead projector (BB/OHP) and PowerPoint (PPT) techniques. Guided slides are a set of incomplete slides which are to be completed during the class. Guided slides might include a header without a set of related equations, include a picture of a rigid body without a complete set of forces, or include a problem statement without derivations and answer. Students bring their own copies of guided slides to the class, and actively engage in learning by continually filling in the gaps in their own understanding. With the recent advent of the tablet PC, a lecturer can advance the use of guided slides a step further by being able to hand-write on top of any teaching materials. On the projected screen, the guided slide can then be filled in slowly by the lecturer during the class. A lecturer also can respond to a student's question promptly. A copy of the guided slides completed by the lecturer is then uploaded to the web depository for students to download for after-class review, accompanied by the previous incomplete version.

Related Works

Many studies have suggested the advantages of the guided slide (GS) technique (Austin, Lee, & Carr, 2004; Barbetta & Skaruppa, 1995; Heward, 2011). Heward (2011) indicated that students show a higher tendency to participate and ask questions if GS technique is employed. Students also advocate GS as materials for class preparation and for review after class, while recognizing that only contents included in the GS constitute the core material. In addition, students show a positive attitude toward faculty members who have adopted GS in class. McCann (2008) also found a positive attitude among students regarding GS. The results, however, show that if the GS were available on the class webpage, almost half of the students would never print and carry them to class.

The advantages of using a tablet PC in class have been reported in the literature. Simon, Anderson, Hoyer, & Su (2004) developed a system of tablet PCs used in a classroom that supports active learning. The lecture is mainly conducted on a tablet PC by the instructor. Students also respond in class using their tablet PCs. The authors' experience with the system was positive in terms of active and collaborative learning. A tablet PC-based-learning classroom was reported by Millinder (2007) to have a positive impact on students' grades, as well as on higher-order thinking skills, academic skills, discipline-specific skills, and work and career preparation skills. Tablet PCs were employed in a large-enrollment course, i.e. calculus for engineers, by Reba & Weaver (2007). It was reported that web-based software and tablet PCs improved communication between instructor and students. As a result, students in tablet PC sections scored 2% to 3% higher than students in traditional sections. Tablet PCs were also employed in several other studies (Ando & Ueno, 2010; Stanton, 2008; Stickel, 2009) and had a positive effect on the students' learning performance.

In an attempt to improve the teaching/learning experience at the Chulalongkorn University Department of Mechanical Engineering, informal meetings among faculty members cited "motivation" as having the strongest influence on student learning in class. It is the hypothesis of this study that the use of guided slides with a tablet PC (GS/T) in class strongly enhances students' motivation. Although the use of GS technique has been the subject of previous reports, GS/T technique is unique. In order to best apply GS/T technique, it is worth exploring strategies that can help enhance students' motivation.

Theoretical Framework

ARCS Model

To describe a learner's motivation in instructional design and development, Keller (1987) developed a model called the ARCS model. The four letters stand for attention (A), relevance (R), confidence (C) and satisfaction (S). According to the model, strategies in a class must be in place to arouse and sustain the students' curiosity and interest. Once students pay "Attention," teaching practices must connect to students' needs and motives to affect a positive attitude. When the topic at hand seems "Relevant" to students, they must be allowed to develop positive expectations for success. Many practices, both easy and challenging, help students to build "Confidence." For students to remain motivated, they must be offered reinforcement for their efforts and feel "Satisfied" with the learning experience. If these strategies are in place to activate the chain of A-R-C-S, students will be motivated and ready for the upcoming challenge. This generic application of the ARCS model in a course design is reviewed from the standpoint of GS/T technique.

Teaching with Guided Slides on a Tablet PC

Before this study, the first author's lectures were based on BB/OHP technique, where most of the time the lecturer writes on the board and students take notes while listening to the lecture. For a certain type of information, such as pictures or a long problem statement, the lecturer relies on OHP slides. This pattern of lecturing usually takes a long time just to write down the lecture contents. For complicated figures, the lecturer usually takes a much longer time

while still ending up with an untidy or confusing illustration. Students also require a lot of time to take notes before they can devote their full attention to the lecture. In short, BB/OHP technique has limitations, especially considering the typical course contents in engineering college. At the present time, the lead author does not attempt to use PPT technique since it is deemed unfit for topics with equations and long derivations.

Guided slides are prepared using Microsoft PowerPoint software. This software is chosen because figures and text can be placed, added and edited with ease. Other software can be used depending on the instructor's preference. The PowerPoint file is then converted to a PDF file which can be opened by several types of software. An example of the guided slides used in the mechanics of materials class is illustrated in Figure 1. The before-class slides are shown in Figure 1(a, b), while the after-class versions of those two slides are illustrated in Figure 1(c, d). Figure 1(a) describes the moment-curvature relationship of beams under flexural loads. Only the free body diagram of a beam and the removed element of the beam are placed sparingly on the slide. Symbols, derivation and result of the derivation are added later during the lecture. The guided slide completed by the lecturer is shown in Figure 1(c). It is the authors' intention to have figures and minor information ready before class, and then to write the mathematical derivation including important parameters on the figure during class. Another example of the before-class slide is shown in Figure 1(b), which demonstrates the problem statement with a lot of vacant space for the in-class solution. The completed slide is shown in Figure 1(d). It should be noted that with this GS/T technique the lectures are more flexible compared to PPT technique, i.e. information can be inserted or ignored according to the students' response in class. Guided slides are available on the class webpage, where students can download and print out the hard copy before class. In class, the lecturer begins speaking while noting down the main idea, definition and derivation onto the tablet PC screen where guided slides are shown. With tablet PC technology, students see the writing popping up on the projected image of the slide. They are engaged in learning and jotting down what they see as important. Should they miss certain issues or minor details, completed guided slides are available for download after class.

Research Methodology

As a part of this study, the first author applied GS/T technique in the mechanics of materials course, which is a sophomore course in the Faculty of Engineering at Chulalongkorn University. The class was held during the second semester of the 2010 academic year. The class was one of eight sections, with 46 students registered for the section. Methods of identifying strategies to enhance students' motivation included pre- and post-questionnaires and a focus group discussion. The pre-questionnaire was introduced early in the semester when students had not yet experienced GS/T technique. This was to inquire about the advantages and limitations of the conventional blackboard and overhead projector (BB/OHP) and PowerPoint (PPT) presentations. The post-questionnaire was administered at the end of the semester to investigate GS usage and learning patterns of students, including their satisfaction toward GS/T technique during the course of study. After the semester ended, a group of 6 students was chosen randomly for the focus group discussion, which uncovered the explanations behind many interesting findings from the questionnaires.

Data Collection

The pre-questionnaire asked students about a set of predetermined advantages and disadvantages of BB/OHP and PPT techniques. Since this questionnaire was issued early in the semester before students were exposed to GS/T, it was assumed that students would answer without any preconceptions or biases against the two traditional methods. At the end of the semester, students answered the post-questionnaire. The first part of the post-questionnaire inquired about learning behavior using GS/T technique. The second part asked about different aspects of how students liked or disliked GS/T technique. The focus group interview involved a group of 6 students selected to represent the entire class. The lead researcher directed the interview to uncover reasons, from the viewpoint of the students, behind many findings derived from the questionnaires. The interview was tape-recorded for further analysis. Examples of the questions asked in the focus group regarding the BB/OHP or PPT techniques are:

a) What do you like about the BB/OHP and PPT techniques?
b) Have you ever had a bad experience in the course using BB/OHP and PPT techniques?
c) In your opinion, what is the advantage of the BB/OHP and PPT techniques?
d) Do you have trouble in reading class materials written on the blackboard?

For the GS/T technique attempted in the present class, the following questions were issued.

a) Did you bring the guided slide to the class? Why? or Why not?
b) Knowing that the complete slides were available after class, did you take note during the class? Why?
c) Do you have any difficulties in reading my hand writing?
d) How well can you keep attention to the lecture in this class? How does it compare with other classes? Why?
e) Have you ever downloaded and used the complete slides after class?
f) What do you like and do not like in this class?

g) Do you want to take a class taught using GS/T next semester? Why?

Most of the questions in the surveys employed a five-point Likert scale: 5 = strongly agree, 4 = agree, 3 = uncertain, 2 = disagree, and 1 = strongly disagree. Students who answered 4 and 5 were classified as agreeing with the predetermined hypothesis, while answers of 1, 2 and 3 were categorized as disagreeing with the suggestion. Under a hypothesis, should a student gives an answer of 3 (uncertain), it is interpreted as that student is having an ambiguity towards the hypothesis. As a result, an answer of 3 is categorized as "disagree". Followed from these classifications, it is ascertained that the answers classified as agreeing with the suggestions come from students who have not doubt at all with the suggestions.

Results and Findings

Pre-Questionnaire

The pre-questionnaire is designed to confirm the advantages and disadvantages of BB/OHP and PPT techniques. For BB/OHP technique, the main hypotheses include a) it takes the lecturer a lot of time to write on the board, b) students have to take note, listen to the lecture, and try to digest the class materials at the same time, so it is easy to lose attention. For PPT technique, it is hypothesized that the technique offers a convenient teaching but rather passive learning method. With complete slides and handouts, students only listen to the lecture with minimal note taking. In addition, some types of information such as mathematic derivations are not suitable for this technique. The students' assessments in the pre-questionnaire about BB/OHP technique are shown in Table 1. BB/OHP technique, according to the results, offers a slow pace that allows students to follow steps in derivations of difficult subjects with ease. The technique, however, consumes a large amount of time, for both writing on the board and note-taking. This idle time on both sides (students and lecturer) can lead to a lack of attention. The visibility problem in this case is also evident, even for a moderate-sized class of 30 to 50 students. The students, however, rejected the notion that the slow pace of BB/OHP leads to a feeling of boredom. They seemed to prefer the lecturer to go slowly.

Table 2 presents the students' responses about PPT technique. The advantage of PPT technique is clear in terms of time-saving for both writing on the board and note-taking. The visibility problem is nonexistent. Although video and animation in PPT are theoretical advantages, the use of the animation feature in PPT, from the students' viewpoint, is often ineffective in dealing with difficult subjects and mathematical material. The delivery of content via PPT is rather rigid and cannot promptly be adapted to the students' responses in class. When asked about their past experience, more than 70% of the students reported having a bad impression of classes that used PPT technique.

Post-Questionnaire

There were two parts of the post-questionnaire. The first part was to determine student behavior concerning guided slides, class attendance, note-taking, and academic performance. Forty-three students returned the questionnaires. The first three questions involved the availability and utilization of the slides. All of the students realized that guided slides were available for download before class. Only eight of them preferred not to bring them to class. About two-thirds of the students downloaded and reviewed the after-class slides, at least occasionally. Before the semester, a major concern about posting the after-class slides was that students might not attend the class anymore, since all slides would be available after class. This concern turned out to be unfounded, however, since 33 students indicated that the availability of after-class slides had no effect on their attendance. Another 5 students suggested that they were more likely to come to class knowing that slides would be available after class. On the other hand, another 5 students indicated a tendency not to attend the lecture. Overall, it can be seen that a satisfactory portion of students took advantage of both before- and after-class slides. Therefore, it is essential to have well-designed before-class slides; after-class slides can then be posted with no effect on attendance.

One of the intended advantages of GS/T technique is to reduce students' note-taking efforts, allowing them to devote more attention to listening, analyzing and participating during class. Based on the answers to question #4, 60% of the students indicated that they still took as many notes as in a class taught by conventional technique. The other 40% said that their note-taking in this class was decreased compared to other classes. For question #5, about 55% of the students reported that they paid more attention (i.e. listening) in this class than in other classes. Another 40% of the students said that they paid the same degree of attention in this class as in other classes. These results are positive in terms of attention, since students reported: 1) a lesser degree of note-taking, allowing them more time to listen; 2) a higher degree of attention toward lectures due to class participation by filling in gaps in the guided slides; and 3) less frustration from feeling left out or uninformed about the topic, since the completed slides were readily available after class. GS/T technique, however, by its very nature requires a student's individual participation to fill in gaps in the slides. This was in accordance with the pattern of students still taking time to take notes in GS/T technique. These results can be interpreted as students being as busy as ever with note-taking; but instead of just noting down passively, they were more engaged in learning and filling in gaps in the guided slides.

Another question about student learning behavior is in regard to the availability of completed slides before the lecture. When asked whether completed slides should be posted before class, about 67% of the students indicated that completed slides should not be on hand before the lecture. Students provided some interesting comments about the benefits of not having completed slides, including: 1) without completed slides, students have to take notes, so their concentration is always maintained; and 2) writing down helps them analyze and memorize.

The final question inquired about the students' academic performance in a class taught using GS/T technique. In an ideal scenario, the academic performance of students in a class using GS/T technique should be directly measurable compared to classes using conventional techniques. However, there are many variables that need to be controlled before a direct measurement can be achieved. As a result, in this study only the students' perception about their performance was assessed. Out of 43 students, 23 believed that their academic performance in this class improved because of GS/T technique. Another 17 students indicated that the teaching technique had no consequence on their academic performance. Three students indicated that their performance was worse with the proposed teaching technique. Thus, it is reasonable to conclude that a majority of students had a positive impression about GS/T technique.

The second part of the post-questionnaire related to the students' responses toward GS/T technique (Table 3). The most positive responses were about how GS could clearly be seen by students, compared to BB/OHP and PPT techniques. This is interesting since the screen on which the guided slides are projected is the same as the one used for PPT. On the other hand, the relative expanse of the blackboard used in the BB/OHP technique does not give added advantages over GS/T technique. Students were also in favor of posting completed slides after class. Moreover, they indicated that some contents are better presented by handwriting, which conforms to their answers about the disadvantages of PPT technique (Table 2).

Students also confirmed in questions #3 and #9 that their attention is constantly aroused because they need to fill in the handout, and because the lecturer does not spend too much time on writing. In question #4, about 70% of the students indicated that they had more time to listen to the lecture. These two issues, which are the strength of the proposed technique, were thus emphatically confirmed. Students' opinions in questions #13 and #14 reflected the view that GS/T technique is an alternative technique with promising potential. The technique combines the strengths of two conventional lecturing techniques, and adopts modern technology to improve student learning in engineering courses.

Focus Group

Student interviews revealed that a perceived advantage of BB/OHP technique is its ability to show long sequences of derivation on the blackboard. However, lecturers have a tendency to use the same figures over and over for many different purposes during the class, which can lead to students' confusion. In addition, the time required to draw a complicated picture/diagram may put off many of the students. More importantly, the fact that the lecturer must literally turn his back toward the students makes them feel uninterested, and consequently they may lose attention. The focus group also suggested the reason why the relatively greater expanse of a blackboard does not provide a meaningful advantage over GS/T technique: this is because students have the handout of the guided slides readily available. By being engaged in the discussion, they can flip through the handout easily to see related derivations while maintaining their attention toward the lecture.

The students also contradicted a popularly held belief: that with PPT technique students usually listen to a lecture passively, without being engaged in thinking through topics. In contrast, students indicated an attempt to engage; but the use of PPT tended to allow the lecturer to rush through topics, leaving students behind. With GS/T technique, the gaps intentionally placed throughout the lecture period in the guided slides make it compulsory for the lecturer to slow down and allow for student participation.

Students also added that guided slides were not new to their learning experience. Students recalled the use of guided slides, without a tablet PC, in cram schools (which are very popular in Thailand) prior to their college life. In college, students also reported few PowerPoint presentations that resembled guided slides. Specifically, a PowerPoint presentation can be created with some missing content which is filled in during the presentation. The missing text is filled in by either the PowerPoint animation function (missing parts appear after a click on the mouse or keyboard), or writing by the lecturer using the mouse. The ability of the lecturer to write on the guided slides via the tablet PC, however, offers a unique advantage for the GS/T experience. More importantly, students strongly favor the feeling of a "live" lecture offered by real-time handwriting with GS/T compared to the feeling of a "pre-recorded" lecture when a lecturer recites a prepared PowerPoint slide presentation. Students recalled many incidents when, during a PowerPoint presentation, the lecturer got confused or forgot the contents. This "live" feeling leads to increased confidence in the lecturer and a very positive attitude toward the course. Although not directly related to the final achievement, this positive attitude is linked to class attentiveness and the higher priority of a course for practicing and reviewing in comparison to other courses.

ARCS Model Mapping

From the results discussed earlier, the ARCS motivation model is applied in Table 4 to systematically describe strategies in which GS/T technique helps to enhance students' motivation in class. For the first component, Attention, one of the strategies to arouse curiosity is to show a visual representation of concepts/ideas. With GS/T, it is easier and, more importantly, quicker to incorporate pictures or graphs than using a blackboard; while it is more convenient to add fresh strokes of handwriting which students prefer over a precooked PowerPoint animation. For students with guided slides in hand, it also is faster to take notes and keep up with the class, hence sustaining their interest. Flexibility of handwriting also allows the lecturer to sustain students' interest by inviting their participation, as well as by varying the degrees of difficulty on the go to suit students' responses. Although intangible at first, GS/T allows the lecturer to maintain face-to-face communication, which draws a strong positive response from students.

In terms of Relevance, one of the foremost needs of any student in a classroom is to be able to clearly see what the lecturer writes/draws. Irrespective of the difficulty of the topic, if students have a problem with the visibility of the lecture, they are more likely to be de-motivated quickly. For this issue, students overwhelmingly support GS/T technique.

GS/T technique also helps in the Confidence issue. In GS/T technique there is ample time to practice (longer than in the case of a PowerPoint presentation), allowing sufficient time for students to keep up, and hence be more confident in their learning. In addition, with completed slides available after class, students have the peace of mind that should they miss the topic/ideas in some parts, they can catch up after class by downloading the completed slides. While confirming the limitations of PPT technique in dealing with difficult subjects, students nevertheless strongly attested to the effectiveness of GS/T.

Lastly, Satisfaction is another element that adds to students' motivation. With GS/T technique, collaboration between students and the lecturer is possible and more likely, since they are literally face-to-face communications. Additionally, the flexibility of the lecture format gives the teacher a chance to provide explanations according to a student's questions or responses. This capability not only is effective in explaining difficult subjects to students, but also conveys good feeling towards students. This, in turn, creates a positive attitude among students, and high satisfaction toward the subject.

Conclusions and Recommendations

The limitations of the two traditional methods of lecturing, BB/OHP and PPT presentations, are well recognized. GS/T is a distinct technique that blends the positive attributes of the two techniques. This study reports on the use of GS/T for second-year engineering students in a mathematically involved course typical in an engineering college. Based on the supposition that motivation has the strongest influence on student learning in class, this study explores strategies in which GS/T technique helps enhance students' motivation via the ARCS model of Keller (1987).

The results of a questionnaire introduced prior to the use of GS/T confirmed the perceived advantages of the traditional methods. The slow pace of BB/OHP technique is a plus in dealing with difficult subjects, while the legibility of handwriting is a major minus. The large, clear projected images of a PowerPoint presentation are an advantage, while the rigidity of its contents and the tendency to rush through the animated slide show are major deficiencies.

The use of GS/T was a success in terms of students' usage of the class materials. The high usage of GS in this study is in contrast to the study by McCann (2008), which reported a low usage. This difference might be due to cultural issues. Although intended to reduce students' note-taking efforts, with GS/T students are still busy taking notes. The pattern, however, moves from passive note-taking to active and engaged participation by filling in gaps in the guided slides. GS/T also excels in terms of the visibility of the lecture compared to the other two methods.

In addition to tangible limitations of the traditional methods, the results from the focus group reveal many fine details that may not be readily apparent from the lecturer's point of view. Rather than sitting passively through a presentation in a class using PowerPoint technique, students indicated (mostly failed) attempts to engage in learning. However, with gaps installed in the guided slides of GS/T technique, the pace of the lecture slows down enough for students to become engaged and fully participate in learning. Although a lecturer turning his back toward students while writing on the board is a common sight, students indicated a clear dislike of these moments of classroom time. Although the use of guided slides is not new to students, the study participants strongly favored the feeling of a "live" lecture offered by real-time handwriting with GS/T.

The positive responses and increased motivation for classroom learning with GS/T were analyzed via the ARCS motivation model of Keller (1987). GS/T was able to overcome many of the negative attributes of the two traditional methods, which hinder the arousal of students' interest and create obstacles to maintaining their attention. The positive attributes of GS/T include easy incorporation of pictures or graphs, flexibility and legibility of handwriting, face-to-face communication, and lastly a "live" feeling. Large, clear projected images, together with the availability of a printed copy of the guided slides, remove the problem of visual limitations – an objection strongly voiced by students in regard to the two conventional techniques.

The extra flexibility of GS/T technique also allows a lecturer to connect to students' needs and motives extemporaneously, and adds to the relevance factor of the ARCS model.

Students also exhibited a strong feeling of confidence and mentioned positive feelings toward the lecturer and the course as reasons to keep them motivated even after class. GS/T technique also was found to fit a majority of attributes students wished for in an ideal teaching technique. Overall, students were highly satisfied with the learning experience provided by GS/T technique.

In conclusion, the use of a "guided slides with tablet PC" technique was attempted in a mathematically involved course typical of an engineering college, and was successful in terms of students' usage and satisfaction. The ARCS motivation model unveiled the positive attributes that GS/T brings, especially in regard to the attention and relevance aspects. While PPT is a popular means of lecturing, it is judged poorly in terms of confidence and satisfaction since students usually lack a sense of engagement and active learning. Instead, GS/T reintroduces face-to-face communication and instills mandatory class participation among the students. As a result, students reported strong confidence and high satisfaction in a class employing GS/T technique.

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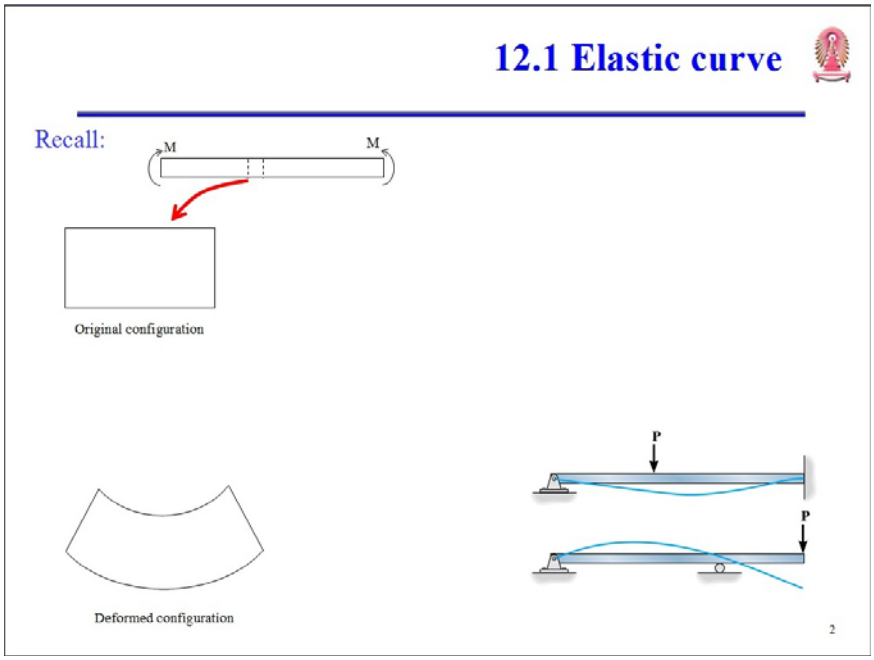
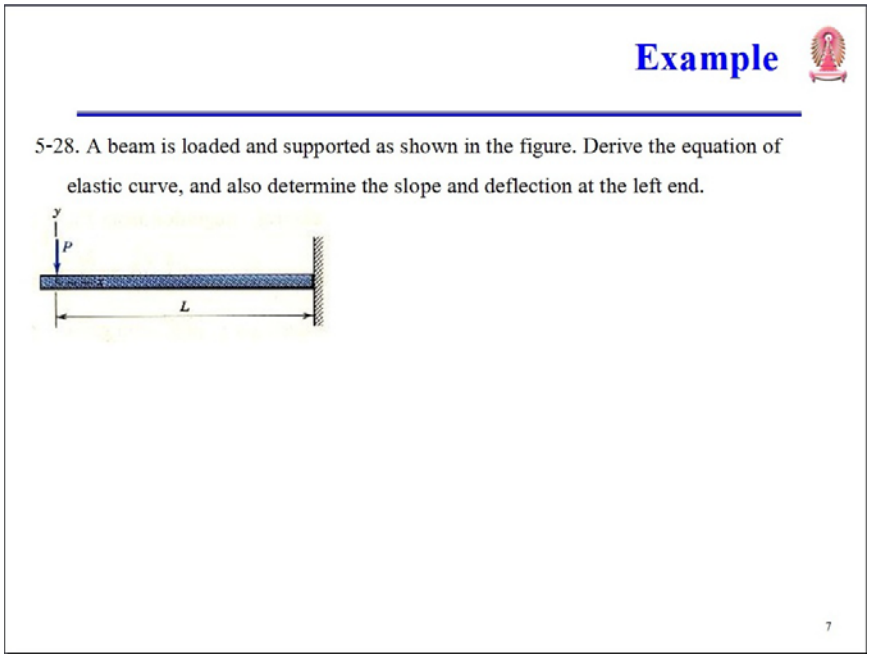
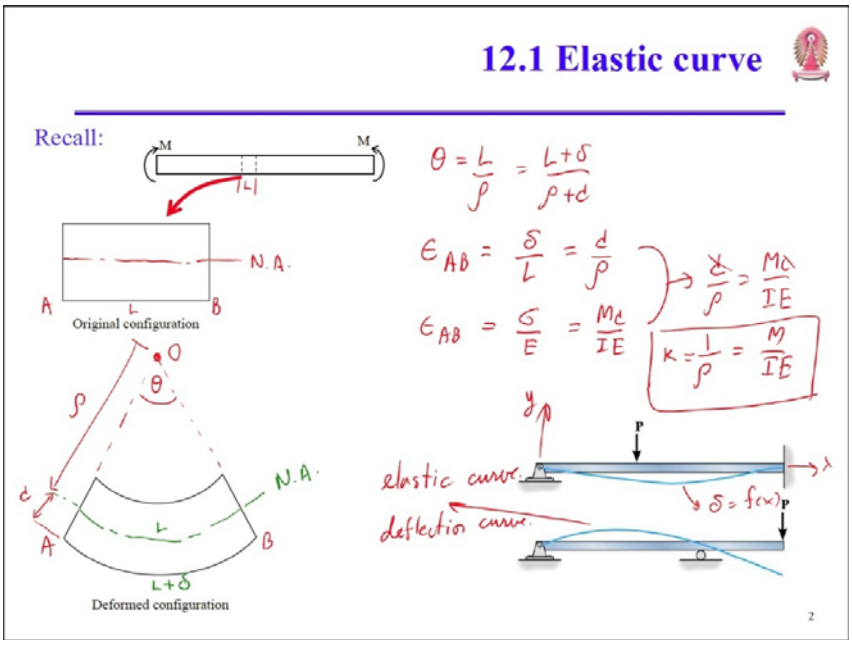
Appendices



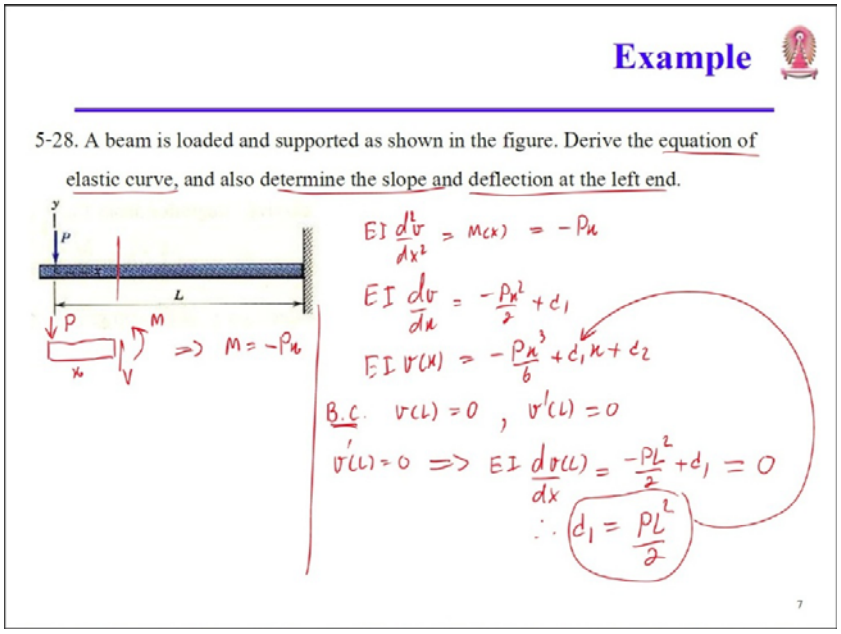
(a)



(b)



(c)



(d)

Figure 1: Examples of the guided slides used in this study

Table 1: Students' Perceptions about BB/OHP Technique

	Issue	Agree	Disagree
Pros	1. The lecture proceeds slowly, so there is enough time for students to keep up.	30	16
	2. Materials with mathematical content are sequentially and properly presented.	36	10
Cons	1. Students easily lose attention, because it takes the lecturer a lot of time to write on the board.	18	28
	2. Students' may lose attention while listening because they have to write everything down.	34	11
	3. Students who do not take notes can easily lose attention since the lecturer takes a lot of time to write on the board.	25	21
	4. Students seated at the back of the room have difficulty in seeing the content on the board.	37	9

Table 2: Students' Perceptions about PPT Technique

	Issue	Agree	Disagree
Pros	1. The lecture proceeds swiftly, since lecturers do not need to write on the board and students have handout on hand.	39	7
	2. Slides projected on the board are easily seen by students seated at the back of the room.	39	7
	3. Videos and motion pictures can conveniently be presented.	43	3
Cons	1. Students easily lose attention because students only listen to the lecture, with minimal note-taking.	26	20
	2. Although PowerPoint can utilize animation, some types of information (such as equations) are better when presented by handwriting.	27	19
	3. The lecture is not flexible; additional material cannot be added to the slides during the lecture.	24	22
	4. There are some types of information which are not suitable for a PowerPoint presentation.	29	17
Students' experiences	1. I used to misunderstand class material because of ill-prepared PowerPoint presentations.	33	13
	2. I used to feel that the lecturer read PowerPoint slides to me, instead of lecturing.	35	11

Table 3: Students' Perceptions about GS/T Technique

Issue	Agree	Disagree
1. The lecture does not proceed too fast, so I can easily catch up.	27	16
2. I can see the progression of the contents as well as when using BB/OHP technique.	18	24
3. The lecturer doesn't spend too much time on writing, so I do not lose attention.	32	11
4. I have more time to listen to the lecture than in the case of BB/OHP technique, where guided slides are not available.	30	13
5. Students in the back of the room can see the writing on the slides via a tablet PC better than when written directly on the board.	40	3
6. A lecture using GS/T technique does not progress more slowly than one using PPT technique.	32	11
7. Although the lecturer's handwriting is not as good as the printed characters in PowerPoint slides, it is clearly legible on the projector.	39	4
8. Video, animation and computer simulation can be presented with ease.	37	6
9. Writing down on the guided slides helps me to keep my attention on the lecture.	30	13
10. Some contents in this course are better presented by handwriting.	34	9
11. I remember that the lecturer occasionally talked about content which was not in the guided slides.	32	11
12. I can catch up on the lecture after class from the posted completed slides.	35	8
13. I think GS/T is a good technique that should be adopted by the Faculty of Engineering.	37	6
14. I wish the classes I take next semester would adopt GS/T technique.	37	6

Table 4: Mapping of Results to ARCS Model

ARCS components	Disadvantages of BB/OHP and PPT	Strategies of GS/T
ATTENTION	BB/OHP: Instructor writes too slowly. Students take too much time for note-taking. Instructor turns his/her back to students when writing on the board, so it is difficult for students to maintain focus. PPT: Lack of participation from students.	Interactive and flexible. Both students and teachers need to write less than with BB/OHP.
RELEVANCE	BB/OHP: Visual limitations. PPT: Students prefer instructors' handwriting over PPT animation. Contents in PPT are not flexible.	Visual limitation does not exist. Instructor's handwriting gives a "live" feeling.
CONFIDENCE	PPT: Some materials involving equations and math are not suitable to be presented by PowerPoint.	A live derivation of mathematical information is possible. Students can download lecture notes after class. From Table 3, about 80% of the students acknowledged these advantages.
SATISFACTION	PPT: Students indicated that instructors from other classes "recite" PowerPoint presentations to students.	More that 85% of the students are satisfied and would like to take a class using GS/T again.