Integrating Project Based Learning and Multimedia into the Classroom

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Abstract

Western Kentucky University is in the process of creating new undergraduate focused engineering programs. These new programs were created using a project/practice based learning model. The mission of the new programs is to prepare students for a career as a practicing engineer with an ability to become immediately productive upon graduation. One of the main challenges once this mission was established was the effective incorporation of project based activities into the classroom while maintaining effective delivery of the course content with no increase in student contact time. This paper will discuss the “trials and tribulations” of bringing multi-media into the classroom in order to overcome this challenge.

Introduction and Overview

Western Kentucky University is in the process of creating new engineering programs in civil, mechanical, and electrical engineering focused on undergraduate education. The main mission of the new programs is to prepare graduates for careers as practicing engineers with an ability to become immediately productive upon graduation. A needs assessment of the regional employers of engineering graduates was a major component in the decision to create these programs, which in many ways evolved from the now phased out engineering technology programs. The introduction of project based experiences into the engineering technology program began over six years ago, and responses from regional employers has been enthusiastic. Students are recognized for their ability to work in teams to find optimal solutions to engineering design problems. They are familiar with successful product development methodologies. They understand project management and scheduling, and are comfortable with critical path analysis and structured problem solving. The problem was their somewhat limited long-term abilities due to the fact that they could not become licensed engineers [Dettman, 1] and in some cases did not have the appropriate education for their chosen field of practice. Employers were eager to support the creation of engineering programs with a similar teaching approach with an engineering curriculum [Dettman, 2].

In addition, broader research was performed to determine the effectiveness of what has become the traditional approach to engineering education, which many believe was born with the 1955 Grinter Report [Grinter Report, 4]. This report suggested an educational model with a much stronger foundation in mathematics, basic sciences, and engineering sciences with university effort and interest directed towards graduate programs and students. A variety of studies and reports demonstrated that, although graduates of these types of programs had strong technical skills, they were not as well prepared in the other skills needed for professional success [NSF, Todd, 5, 6]. This led to the formation of the project, practice based engineering curriculum at WKU. The first graduating class will be in the Spring of 2004 followed by the initial ABET accreditation visit in the Fall of 2004.

One of the main challenges of the implementation of the new curriculum was to ultimately “deliver the goods”, or do what we said we were going to do. This meant at the front lines, in the classroom, the professors had to implement project based learning. One of the main goals of the hiring process of new faculty was to bring in people with significant industrial experience and knowledge of professional practice apart from academia. In addition, we

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had to make sure they “bought in” to the teaching style so that they would go the extra distance to prepare the graduates, through real world, hands on experiences in the classroom, for immediate productivity as engineers.

Another challenge was that the paradigm of traditional teaching could not simply be abandoned. The math, science, and engineering skills still had to be taught in addition to the project based activities. For faculty members with many years of experience, the tendency was to simply continue on with chalk and chalkboard, weekly homework assignments, 3 tests, and a final exam. This is not project based learning. The initial challenge was to deliver the course content more efficiently to offer more opportunities for student engagement in higher level discussions and project activities.

**Getting Started in the Classroom**

The decision was made to select CE 410 Soil Mechanics, which is a senior level class, to begin the process of utilizing a more efficient method of traditional content delivery. The purpose here was not simply to “cram” more material into a semester, but to deliver the content more efficiently so that the traditional lectures could be augmented with project based activities and, hopefully, higher level discussions of topics. The obvious method of choice was to utilize multi-media presentations with pre-printed notes for the students. The use of power point, or similar, presentations in the classroom is by no means new, however it is still used far less than chalk and chalkboard.

**The Technology**

The first challenge here was the technology. Was it available? Was it reliable? Could it be learned in a timely fashion? Those were the most pressing questions. Prior to this point, there was hesitation in using the technology because the necessary equipment, i.e. a personal laptop and a projector, was not readily available and could not be guaranteed to be available. The concern was why spend the time developing the slides and presentations for equipment that “might” be available. Based on this concern, some informal research was done to determine how many, if any, professors on the campus of WKU were effectively using multi-media presentations on a consistent or even full time basis in the classroom. What was discovered was that very few faculty were utilizing this technology due to the same reasons previously mentioned; availability and the reliability. The faculty that were effectively utilizing the technology for the most part had their own personal laptop and projector or they had a dedicated space that was maintained and staffed. Subsequently, a request was submitted to purchase the appropriate equipment for the personal use of the author so that it would be available when and where it was needed. Upon completion of initial studies to determine its effectiveness, a report would be submitted to the engineering with the hopes of generating support for a dedicated, staffed, maintained facility for the entire department. The request was supported and development of the classroom materials began.

To truly be able to utilize this method of delivery, some assurances must exist that working equipment will be in place when needed, otherwise it could become a very frustrating endeavor. Some faculty have written into grants the purchase of laptops and projectors, while others rely on one or two classrooms with not so reliable equipment, while the rest rely totally on chalk and chalkboard. As would be expected, the faculty who have their own equipment are far more likely to develop very impressive and well constructed power point lectures in most if not all of their classes than those who do not possess the equipment. The scheduling of the classrooms and the overuse and breakdown of the equipment often leads the rest back to the chalkboard. Without going into any more detail on this issue, for those interested in developing the capability for the delivery of these types of presentations on a regular basis, it is clear that the challenge of availability of equipment, scheduling of dedicated rooms, and reliability are all highly significant issues.

**The Slides**

The next task in the process was the creation of the slides, which ultimately required more creativity than initially expected. The initial reaction would be to simply convert notes to slides. However, the reality is that when using a chalkboard, the students cannot see what is coming next, which allows for impromptu questions and discussions
about what does come next. With the slides pre-printed and handed out to the student, the continuous process of writing on the board and asking questions about what might be next is a method of teaching that is more difficult to maintain. Therefore, the slides had to be constructed in such a way that forced the students to pay attention, fill in blanks when needed, and to still ask questions. This process will certainly be an ongoing one in order to find the best balance of content and strategically placed “blanks”.

One of the biggest advantages of multi-media presentation is that pictures and video can be incorporated easily into the lecture. With the speed, storage, and overall power of the most recent laptops, pictures and video are not much more than pasting the file into a slide. The main challenge in this case was the conversion of some helpful VHS video clips into electronic format for placement in the slide show. This challenge was overcome with a VCR and a readily available and inexpensive ($50) device that plugs directly from the VCR into a USB port on a laptop. With the software that accompanied the device, the computer screen became the TV screen and video clips were easily converted to whatever digital format you chose. It was discovered that the most convenient and least troublesome format for video was the use of short mpg clips as a highlight to lectures as appropriate.

The last significant issue with regard to slide creation was the performance of example problems. It was decided not to do any examples on the slides. Instead, examples were worked out by hand on the board. The reason for this was two-fold. First, the input of mathematical equations into the power point slides is a very time consuming task and difficult to do accurately. Secondly, it was also decided to not completely abandon the idea that writing something down does help the student learn. In order to benefit both the professor in reducing slide preparation time and to give the students the best mix of learning by interacting and learning by writing, the decision was made to do examples on the board.

Effective Use of the “Extra Time”

As indicated earlier, the goal of utilizing multi-media was not to introduce more material in the classroom, but to teach (not simply cover) the traditional topics more efficiently and create more time in the classroom for project based activities and higher level discussions that lead to a better learning environment for the student. Research has shown that engaging the students in team activities, allowing them to ask questions and seek answers in an active learning environment create better students and better problem solvers [Felder, 3]. By teaching the necessary engineering science and tools more efficiently, the student has more time to apply those skills. If the faculty take the extra time to engage the students in the application of principles, discussions of applied projects and assignments, or uses it to share case studies with the students and allowing them to engage in conversations about those case studies, the students get the appropriate material and can begin to apply it.

The Basics

In each class session, one of the “technical” challenges was that it took time to set up the laptop, turn on the projector, and get the slides booted up. This seemed to work against the entire point of the process, however this problem was overcome. Each class session started with an informal discussion of the previous lecture material [Felder, 3], which sometimes was an oral pop quiz turned in for a grade. These discussions took place during the set up time. In comparing pop quiz grades from other senior level engineering courses taught with chalk and chalkboard methods, the quiz scores in this course were on average 9 percentage points higher (86% for multi-media class vs 77% for chalkboard classes). It is the experience of the author with this course as an engineering technology course, it generally was one of the more difficult courses and pop quiz scores traditionally were much lower relative to other senior level engineering technology courses.

In addition to quizzes or discussions at the start of class, group problem solving sessions were introduced at the end of some classes at the conclusion of major conceptual topics. For example, there may be 4 lectures on settlement. At the end of the 4th lecture, a problem would be assigned to be solved in groups during the last half of the class period. The group problem solving method allowed students to share their own insights and to teach each other. Other research has shown a similar result in group problem solving [Felder, 3].
In addition to the quizzes and in class problem sessions, the extra time allowed for the inclusion of project based activities in the classroom. The overall goal of the projects was to allow the students to take on a real world type of project, and try to solve the problem and present the solution much like a practicing Geotechnical Engineer would. In pedagogical terms, the goal is to move the student beyond the 3rd level of Blooms Taxonomy of application to the higher levels, which consists of analysis, synthesis, and evaluation. In the traditional homework assignments, it is difficult to make this jump, however with project based activities that truly approach, and sometimes consist of, real problems on actual engineering projects, the 5th level is achievable. This is one of the key areas that require practical experience to understand how the consulting engineer works and thinks. In the traditional method of engineering education, the student is typically asked to solve a math-based problem and provide the numerical result. For example, a traditional type of homework assignment might be to calculate the active stress distribution on a retaining wall. If the problem is more complex with surface surcharge loads and varying soil layers and water tables, the end result could be a very odd shaped stress distribution curve. From an engineering science standpoint, the numerical analysis could be outstanding, and the complex stress distribution plot could be completely correct. However, to the practicing engineer, it would never be presented in such a way because it is not useable in design.

In this course, the students were assigned a retaining wall problem in the form of a letter from an architect concerned about a problem with a wall currently under construction. The assignment was to perform the necessary analysis, and then present the results in report form to be read by the architect and used by a structural engineer for his/her review of the situation. The students had 3 weeks to collect the necessary field data, perform the necessary laboratory testing (there is a lab co-requisite to this course), prepare the analysis and conclusions, and present the report. This type of problem not only requires the student to perform the traditional engineering analysis, but it forces them to consider the practical side of design and the real world type of issues that exist in the practice of engineering.

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In addition to the retaining wall problem, a smaller scale project was assigned pertaining to soil compaction. In this project, the students were asked to respond to a letter from an attorney with regard to a potential dispute. The main task of the assignment was to complete both a standard and modified proctor laboratory test. The use of the project based approach takes the effort of the student one step farther since the students must complete the experiments but they must also apply the results in a real world situation, much like a practicing engineer.

The method in which these assignments made their way into the lecture time was that discussions were held on how practicing engineers handle and present their results. Copies of actual engineering reports showing the students how an engineer would write-up the results of a settlement study, or a foundation investigation, would be presented and discussed in class. The students felt reasonably comfortable with the calculations, but they really got in tune with the assignments when they became “real”. One of the real challenges for them was to continue past the traditional finishing point. Back to the retaining wall example, the finishing point is the plot of the stress distribution. For this assignment, that was only the beginning. The students had to present the results in a professional report in terms that would be useful to the architect who requested the data and the structural engineer applying the results to his/her analysis.

Since specific discussions of the projects were allowed only within individual groups and not across group lines, some classes were devoted to allowing the teams access to their “consultant” (the author). During this time, they could meet in individual groups in the “consulting office” (the authors office) where they could privately discuss issues and ideas apart from the rest of the groups. The goal here was to minimize or eliminate the class effect of out-of-class assignments where all the work tends to look the same. With an open ended problem such as this, the results are expected to vary greatly and the intent was to give each group the chance to show their acquired skills in small groups as opposed to what the entire class was capable of doing as a large group. One of the more common discussions or areas of tutoring required during the “consulting meetings” was to provide the student the proper focus. They tend to get caught up in the minuita of the project and lose sight of the larger picture. For example, in the case of the retaining wall, all of the groups discovered that pallets of masonry units were stacked at the top of the wall. They all knew that it should be considered in the design, but got very caught up in trying to determine the exact weight and location of each pallet. Once they were tutored to realize that the pallet locations could change as often as daily, and certainly will not always be in the same configuration as they day the team visited the site, they
started to grasp the concept of “worst case scenario” and designing without exact information. These are the lessons most important and most valuable in the project based learning environment. It is the authors intent to maintain, and possibly expand, these types of interactions with the students.

After the assignments were officially turned in, each group presented their results. What was really impressive was the interaction of the students during these informal presentations. It was almost as if the class was a group of practicing engineers talking about their projects and the challenges they were facing.

Final Grades

The overall results of the class were outstanding. The reports prepared for the projects were typically outstanding and reflected the beginning of understanding what it is like to be an engineer. In addition to the excellent work on the projects as well as the improved scores on unannounced quizzes, the grades in the class also improved from previous offerings. The average final grade for this class was 85% vs 78% in previous offerings not utilizing multi-media. It should noted that no attempt was made to ascertain whether or not this class on average was simply a higher performing group than had taken the course before. There was a noticeable increase in the time this class spent preparing homework assignments and studying for exams than in past classes. Again, this could be simply a characteristic of this group. However, it appears that the discussions and project based activities may have increased the motivation to learn as well as the ability. With only one data point it is difficult to make this connection, but the initial evidence appears that this is very possible.

Data Collection

Upon completion of the course, the students were asked to respond to 4 basic questions regarding the delivery of material utilizing multi-media.

Question 1

How was your comprehension / understanding of the material impacted?:

<table>
<thead>
<tr>
<th></th>
<th>Slower</th>
<th>The Same</th>
<th>Better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Responses</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

Student comments on this question included the following:

More time listening and less time writing (9 comments)

I prefer to write the notes myself. I learn better that way (2 comments)

Question 2

How did the pictures in power point impact comprehension / understanding?

<table>
<thead>
<tr>
<th></th>
<th>Add confusion</th>
<th>eye candy only</th>
<th>made discussions clearer</th>
</tr>
</thead>
</table>

Student comments on this question included the following:

Pictures clear up the concepts (9 comments)

Helped me with certain topics (foundations, compaction) since I have no experience in the field

Easier to understand since I don’t have to draw a picture. I can just listen

Connected discussion to topic in situations like foundations

Pictures are a must for things like compaction, foundations, settlement problems in buildings, and other topics like those.

Seeing the process of compaction helped a great deal. Also with foundations

Charts and graphs helped a lot. Even if just taken from the book. Explaining in class was helpful. The slides made it come alive

Real world pictures make a huge difference

**Question 3**

How did the videos impact comprehension / understanding?

<table>
<thead>
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<th></th>
<th>Add confusion</th>
<th>eye candy only</th>
<th>made discussions clearer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Responses</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
</tbody>
</table>

Student comments on this question included the following:

Videos were a great help in construction related topics like compaction and foundations.

Can’t imagine the class without videos. Helped a lot.

Good. Most people are visual learners

Helped connect topic with real world (8 comments)

**Question 4**

Due to the use of power point slides speeding up class, how do you feel the class discussions went?

<table>
<thead>
<tr>
<th></th>
<th>Lead to distracting or tangential discussions</th>
<th>No change</th>
<th>Allowed time for helpful discussions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Responses</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
</tbody>
</table>
Student comments on this question included the following:

More time to discuss and ask questions which led to more time to learn instead of writing.

Led to more problem solving and more material covered

Could listen more and led to more independent thought.

In addition to the questions, the students were given space to add more comments as to the overall effectiveness of power point as a delivery method. There was only 1 comment which was significantly different from the comments above, and it stated that the slides should be made available on the internet, which I will consider for next year.

**ABET**

An added advantage of this type of approach is that the projects are an excellent source of ABET outcomes assessment. One of these projects alone addresses multiple a-k outcomes required in Criterion 3c of the EAC of ABET Accreditation Criteria. For example, the retaining wall report is an effective demonstration of student proficiency in design (c), communication (g), math and science (a), use of modern engineering tools (k), teamwork (d), experimentation (b), and engineering problem solving (e). By effectively utilizing fewer pieces of student work to fulfill the requirements of outcomes assessment, the burden placed on the faculty is reduced and more time can be spent developing effective student activities that will in the long run make them better engineers.

**Conclusions**

Based upon the results of this course offering, multi-media presentations proved to be a very effective method of creating the extra time necessary to effectively integrate project based activities in the classroom. The results show that the students feel like they are learning better and their outcomes reflect that as well. Initial evidence shows that retention is also enhanced utilizing multi-media delivery, however further data needs to be collected. Their does exist certain negatives with regard to the technology and its availability and reliability. Each individual faculty member must determine if the appropriate resources are available to make full use of this method. The advantages of this method of delivery are clear, provided that the presentations are developed so that student note taking and the ability for them to think ahead to the next issue, the next logical step, or to anticipate the next topic are not completely eliminated. In addition, the extra time created by the more efficient method of content delivery is best used to reinforce topics, engage in higher level discussions that allow the student to explore the topic in a group setting, and to introduce real world types of problems and case history discussions. While the allure of simply covering more material is great, the professor must focus more on student learning rather than covering more information. It is expected that the study of this technology will continue and future publications will demonstrate the refinement of utilizing effective power point presentations in a project based learning environment.

**References**


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Matthew A. Dettman is the James D. Scott Professor of Civil Engineering. He is currently the civil engineering program coordinator at Western Kentucky University and his primary areas of interest are in Geotechnical Engineering and Construction Quality Control. He was named Civil Engineering Educator of the Year in the state of Kentucky in 2002, and currently serves on the Governors Council for Earthquake Risk Reduction.