AC 2011-2210: DEVELOPMENT OF EDGD WEBSITE AUTOMATED LEARNING AND ASSESSMENT RESOURCES

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Development of EDGD Website Automated Learning and Assessment Resources

I. Introduction

At the 2009 ASEE Summer Conference a paper[1] was presented describing the development and use of an online working drawing review and assessment tool. This tool was created to address a problem that was consistently occurring in freshmen design courses. The problem was that, although student teams often did a good job with the analysis and fabrication of their project physical prototypes, their final project reports were usually of much poorer quality. This was especially true with regard to working drawings. In order to address this problem, all members of the freshmen design teams are now required to watch a review module and pass an online assessment before turning in their final design reports.

Project reports from both before and after the review module implementation were evaluated using a working drawing assessment rubric. The results indicated a significant improvement in most of the areas considered.

Due to the success of this module, the members of the team who worked on this project would like to consider the potential usefulness of collaborating with additional faculty members and utilizing the graphics and visualization expertise in EDGD to provide quality review modules on the EDGD Website. These modules could potentially be used as additional prerequisites and/or learning resources for many common engineering courses such as statics, dynamics, strength of materials, and fluid mechanics, as well as for engineering design graphics courses. The following is an example of how these types of review modules could be used in conjunction with existing prerequisites.

Prior to the start of the semester, a student completes a review module covering material from the prerequisite course. For instance, Statics is a prerequisite for a number of other engineering courses such as Strength of Materials, Dynamics, and Fluid Mechanics. It is very common to hear professors who teach these later courses noting ruefully that their students have difficulty drawing accurate free body diagrams. Sometimes it has been a year, or at least a winter break since the student took the Statics course, or they possibly never understood it very well in the first place. There are typically ten chapters covered in a statics course, so ten review modules with assessments could be created similar to the one described above for working drawings. Requiring successful completion of the review modules will ensure that students refresh the material in their minds. This should not only create a better understanding of the material but improved retention as well.

At the 2009 midyear meeting in Erie there were many examples of how EDGD members utilized their graphics and visualization expertise to enhance student understanding. Some examples are the media presentation by Dennis Lieu's students, "Effective Use of Animation for Technical Communication", Ed Howard's presentation on "Simulations of Carnival Rides and Rube Goldberg Machines for the Visualization of Concepts of Statics and Dynamics," and Moustafa Moustafa's presentation on using SolidWorks Simulation to help students in his machine design course review concepts in strength of materials. There are many other courses where quality

graphics and visualization materials could aid in student understanding. No doubt this would be a big undertaking, and it would require consistent oversight to ensure high quality.

II. Review of Existing Online Resources for Engineering Available for Free

Online resources are quickly becoming a popular educational tool as technology advances and becomes more readily available to the general population. These resources can be a review of material or practice tests and cover various subjects and applications. However these resources are rarely free and open to the public.

Recently there has been a push to provide free online resources. Universities such as the University of California at Berkeley and Carnegie Mellon have started to put their lectures and/or lecture notes online for free viewing. Anyone can access them to expand their knowledge. A useful feature of online delivery is that viewers can pause and replay the lectures at will so they can comprehend and review the material at their own pace.

Some sites such as MIT's free online courses have gone above and beyond just putting lecture notes up, including assignments, projects, exams, and even multimedia videos for the content covered in around 200 courses a semester. Although very helpful, this project is very costly and time consuming. It requires 12 full-time people who work directly with the faculty to compile the material and ensure proper licensing and formatting for the site[2].

These free sites are very helpful but they are much like a normal classroom atmosphere in that there is a long lecture where a student can be overwhelmed by the abundance of information being presented to them. Studies have shown that students learning the conventional way will indeed learn the curriculum, but not necessarily retain that information and be able to carry basic concepts and understanding onto the next stages of their learning. According to Louis Pugliese[3], a lecturer in Educational Psychology, students have an attention span of approximately 8-14 minutes. This means that a large portion of the conventional lecture is not retained and understood. To help them digest a standard curriculum, small videos that give a general overview of the criteria can be used alongside lectures.

One example of using short videos to better comprehend basic concepts is the Khan Academy. It was developed when Salman Khan was asked to help a cousin who was having trouble in her math class. He developed short videos with voiceovers that explained the concepts while also showing the example problem done on the screen. Khan posted these lessons on YouTube so that they could be easily accessed by her. Not only did her math grades improve dramatically (she has since been accepted into an MD program), but students all over the world also started viewing the lessons. Students began writing letters and comments about how much the videos had improved their understanding of math. The response was so great that he soon broadened his range of subjects from not only sixth grade math but to calculus and science as well. To date, there have been over 35 million viewings of the Khan Academy videos. His knowledge and videos are now helping students all over the world develop better academic skills[4].
In Figure 1, the progress of 30 eighth graders using Khan Academy over a course of six weeks can be observed. The horizontal axis shows the days that the students had been working on the

site and the vertical axis shows the modules that the students had completed. The black line traces the average progress of the students, and the green line represents the standard deviation (one above average and one below average). The purple line represents a special case of a student who originally progressed at a much slower rate than the rest of the group but over time progressed so much that the individual ended up as the top student in the class. This proves that students who might in the past have been deemed slow in class may just learn at a different rate then other students on this program but they will indeed improve, much like she did.

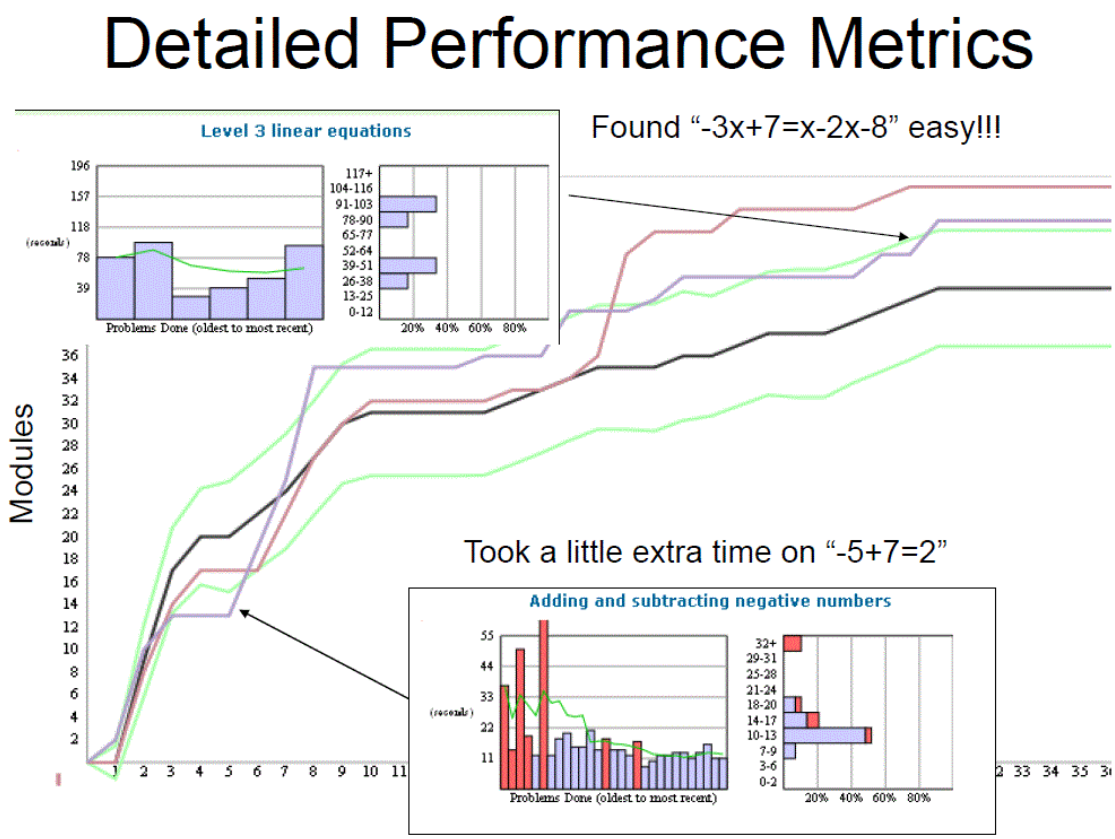

Figure 1: Progress of Students Using the Khan University

With a project such as this, funding is a big concern because the entire concept of the project is to open the content to the general population and provide it free to users. Sites such as the Khan Academy and MIT have kept most of the cost down through generous donations, although MIT's project is much more costly and the university provides a large portion of their funding. The Khan Academy sparked such excitement in the general population that it caught the interests of major companies and ended up getting a $2 million dollar grant from Google; enough that the founder was able to quit his job and dedicate all of his time to creating videos.

Although the pilot review module testing for this paper is being done to determine the feasibility of this mode of delivery specifically for engineering subjects, the goal is very similar to Khan's. Nothing will ever replace a teacher and the feedback they can provide, but the combination of a

teacher and short review modules have been shown to dramatically improve not only the comprehension of the students in the subject matter but their grades as well.

III. Importance of Using Assessments

While both of the online resources mentioned above are effective they lack any form of assessment to reinforce the material being presented. In 2004 Branoff and Totten[5] required students in their upper-level CAD course to read material, watch voiced-over slides on the Internet, and then take midterm and final exams based on the assigned information. When that same course was offered the following year online quizzes were implemented for each reading assignment. Student performance between these two semesters showed a significant increase in both the midterm and final scores. The mean score for the midterm exam increased from 84 to 91 and the mean score for the final was increased from 69 to 97. These results imply that using online assessments to reinforce an online activity enhances student performance.

Branoff[6] examined the value of using online assessments in an introductory engineering graphics course. Students were required to take online assessments based on that week's reading assignment prior to discussing the material in class. Once the assessments were completed, scores from the assessment were compared to the student's homework average and midterm score. Students were then asked to complete a survey. While there was no relationship between assessment scores and student grades on other assignments, the student surveys strongly supported the use of the assessments. The majority of students said they would have only read the course textbook when studying for exams. Eighteen out of the twenty students involved said they felt the assessments helped them prepare for the midterm exam and all said the assessments should be continued.

IV. Using the Moodle Platform

With the success at Daniel Webster College (DWC), the next phase of the project was to put the module on an online platform so that it could be easily used by faculty at other colleges or universities. Moodle was selected because it is a form of free open source software that could be made available to multiple institutions and the module could be easily transferred from the DWC's existing platform.

The existing online working drawing module was used as the pilot module and uploaded to the Moodle site. To use the module in their courses, faculty members can request access, and once their faculty status is verified they will receive a link that connects them to their own copy of the course. At this point the faculty member can input an enrollment key they give to their students. The enrollment key allows students to the access the module, automatically adds the student to the grade book, and allows them to start taking the assessments. The platform provides the faculty member with a history of student activity and grades. The faculty member can also view any individual test or question to see where a particular student is having difficulty.

Another benefit of Moodle's software is that the quiz feature allows for specific feedback based on the answer selected. An example of this specified feedback can be seen in Figures 2 and 3.

While the two comments both provide the correct answer, they provide specific information as to why the selected answer is not applicable. This is valuable because it can be used to address the specific needs of student without bombarding them with information about topics they already understand.

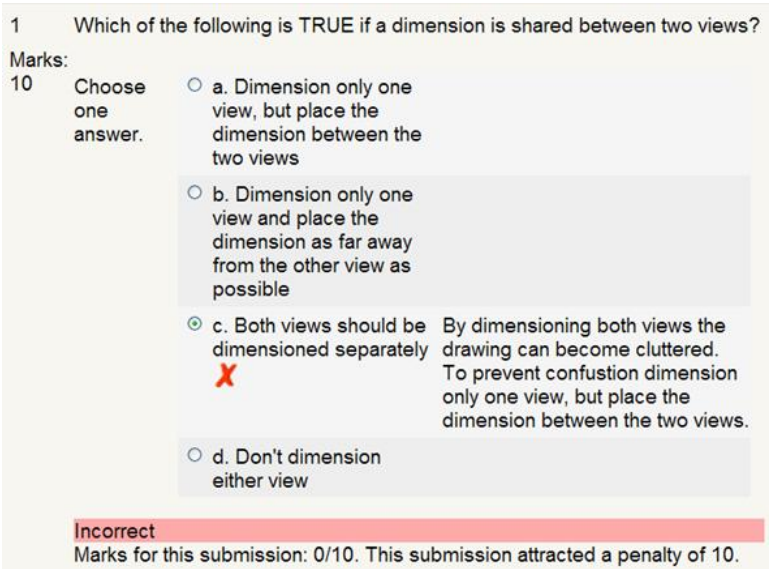

Figure 2: Sample Question with Feedback for Choice C

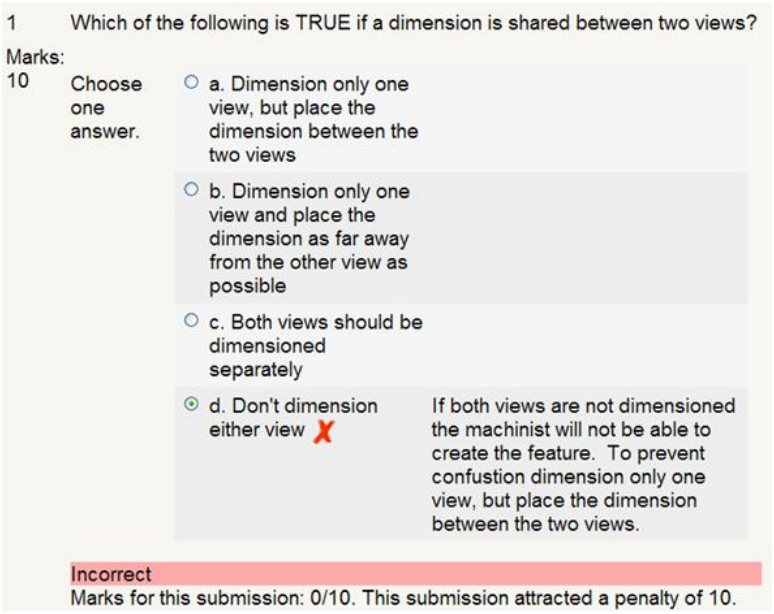

Figure 3: Sample Question with Feedback for Choice D

The Moodle platform is currently functioning. At the Houghton EDGD midyear meeting the proof of concept was demonstrated during the Media Showcase Session. Volunteers posed as faculty members and their students. The course was requested by the faculty member. Their request was accepted and created, which allowed a volunteer student to enrolled and complete an assessment. The student's results could then be reviewed by the faculty member.

V. Results of Pilot Test Using the EDGD Working Drawing Review Module

In order to further determine the feasibility of this project, several faculty members at various universities agreed to try the module with some student volunteers. A survey instrument was developed to determine the ease-of-use and usefulness, both from instructor and student points of view.

Upon completion of the modules, students were asked to fill out a six question survey. Table 1 depicts the results of this survey.

Table 1: Student Data Summary Table

	Yes	No	Undecided		
Have you used Moodle before in a course?	11	41			
Have you used streaming media before in a course?	34	18			
Do you think these units are useful as a supplement to your engineering graphics related course at you university?	42	10	1		
Do you think review modules of this type could be a useful learning resource for other topics in engineering graphics and other engineering courses in general?	51	1			
	Very Good	Good	Fair	Poor	Very Poor
Rate the quality of the streaming media presentation.	12	30	8	2	0
	Very Long	Long	Just Right	Short	Very Short
Rate the length of the units.	1	9	40	2	0

Based on the data collected, the majority of students had not used Moodle before in their classes but had used some form of streaming media. Many but not all students believed the existing online working drawing module was a useful supplement to the engineering graphics course at their institutions. A visual representation of this result is found in Figure 4. However, as shown in Figure 5, virtually all felt similar modules would be useful for other engineering courses.

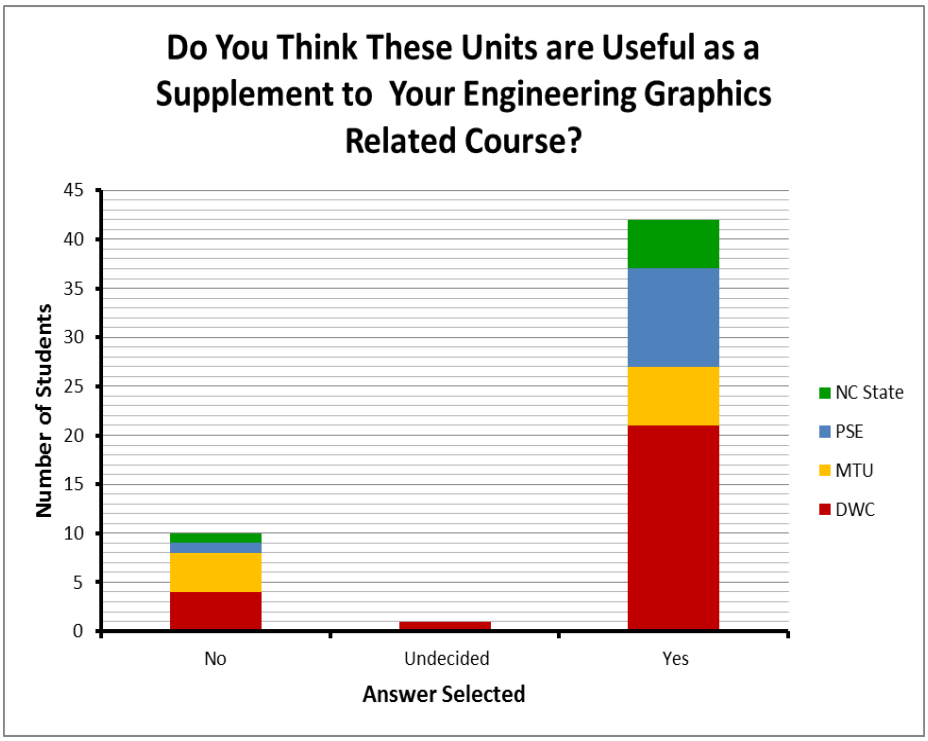

Figure 4: Is the Module a Useful Supplement to Your Engineering Graphics Related Course

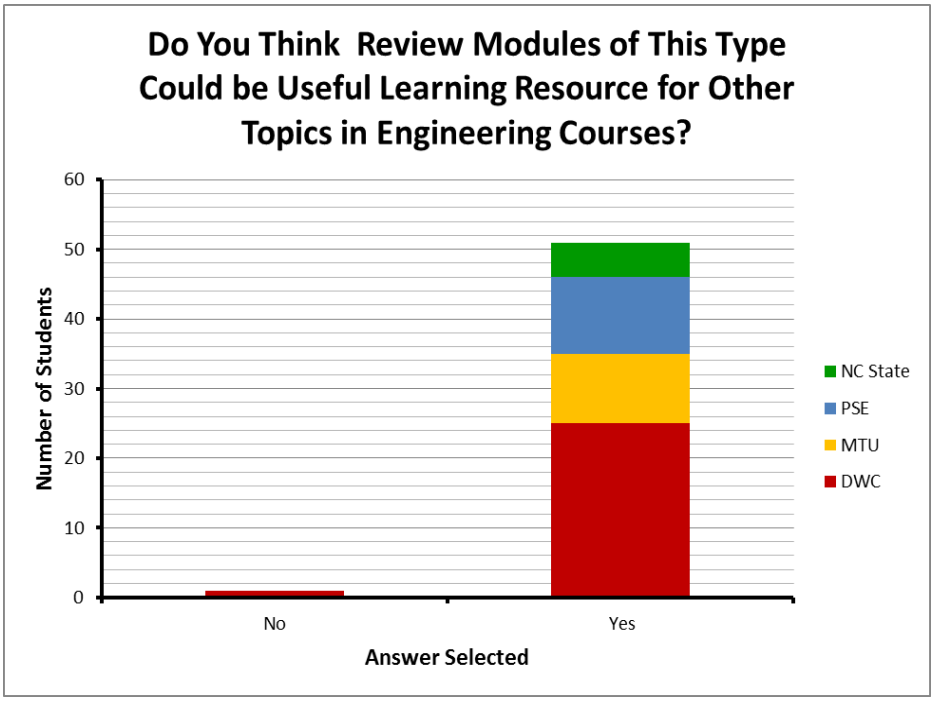

Figure 5: Could This Type of Module be a Useful Learning Resource for Other Engineering Topics?

Figure 6 displays how the students rated the quality of the module. The students rated the overall quality of the streaming media presentation as good or very good. When examining each

institution individually, at least half of the students surveyed rated media presentation as good or better.

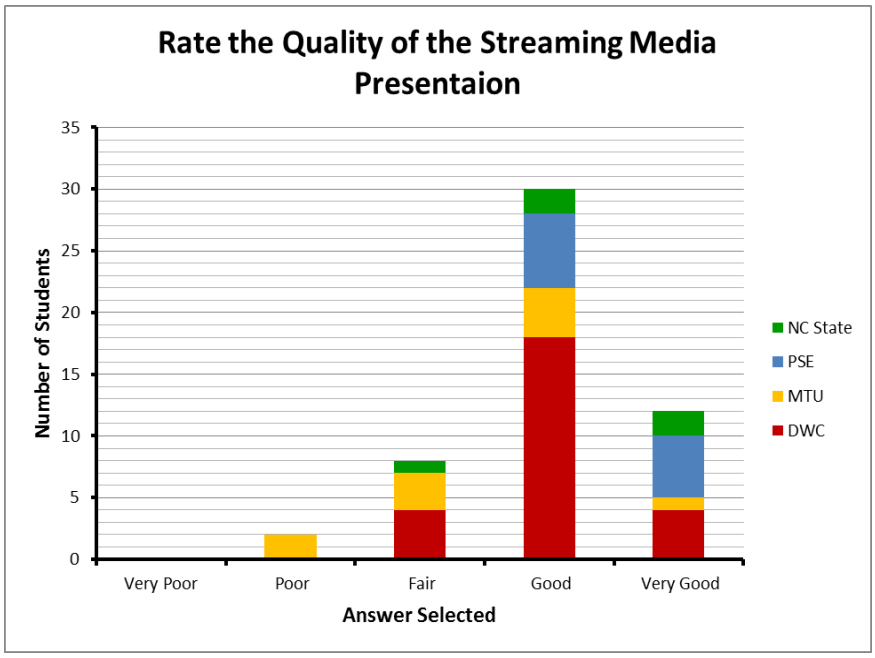

Figure 6: Rate the Quality of the Streaming Media Presentation

In regards to the length of the units, Figure 7 provides a visual representation of student responses. It is clear that the majority felt the length to be just right. This result is also reflected when each institution is looked at individually.

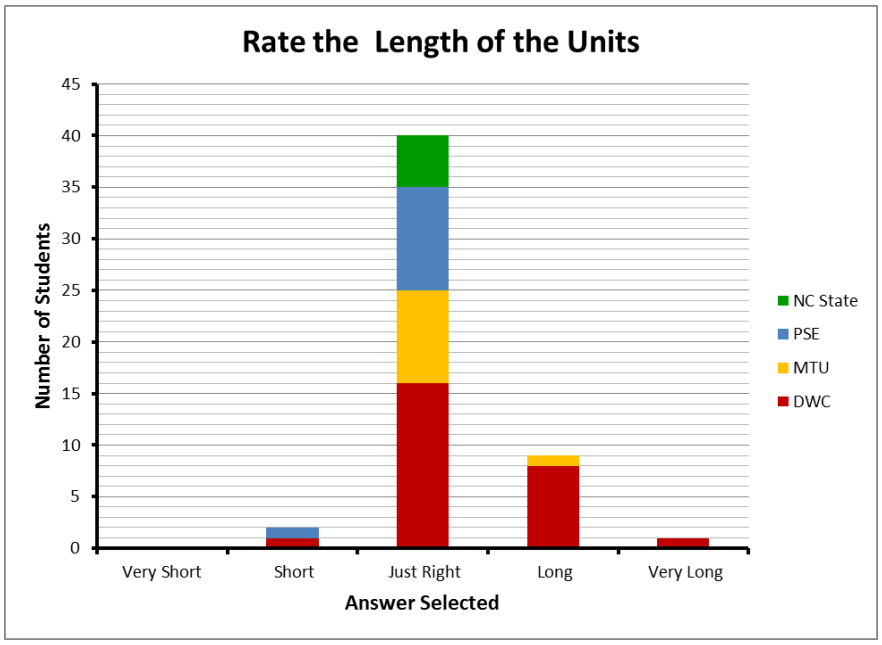

Figure 7: Rate the Length of the Units

Faculty members were also asked to complete a survey about their experience using the module. Table 2 depicts the results for each of the seven questions asked in the survey.

Table 2: Faculty Survey Results					
	Yes	No			
Have you used Moodle before in a course?	1	3			
Do you think these units are useful as a supplement to your engineering graphics related course at your university?	4	0			
Do you think review modules of this type could be a useful learning resource for other topics in engineering graphics and other engineering courses in general?	4	0			
	Very Good	Good	Fair	Poor	Very Poor
Ease of requesting the section	3	1	0	0	0
Ease of uploading students to the section	4	0	0	0	0
Ease of examining student data	4	0	0	0	0
Value of student data	3	1	0	0	0

The results indicate that while most of the instructors had never used Moodle before they felt the module was a useful supplement to their engineering graphic courses and that similar modules would be beneficial for other engineering courses. Instructors found the module easy to use, not only for themselves but also for their students.

V. Conclusions

Based on the analysis of both the student and instructor surveys as well as the positive reception of other free online resources such as the Khan Academy and MIT's open courseware project there is considerable evidence supporting the further development of this type of resource.

Research also indicates that the immediate assessment of online learning modules greatly enhances the effectiveness of this type of resource in improving student learning outcomes. The automated online assessment allows the modules to be included in the evaluation of the student work in a course in which they're currently enrolled, or to be used as an additional prerequisite for a future course.

With regard to prerequisite use, students often complain there is not enough review of the prerequisite material at the beginning of a new course, while other students feel they already know the material and believe they are being held back while the professor gets the other students up to speed. Scheduling review sessions outside of class can be difficult because students often have conflicting schedules. Through the use of online review and assessment tools, students can work at their own paces, on their own time, before the next course begins. Successful completion of review modules can help assure that all students are up to speed on day one and can open up more time in class for discussing new material.

One of the next steps in moving this project forward is to completely automate the request and setup process on the Moodle site, greatly simplifying site administration and freeing up time to expand the number of modules available. Another step will be to recruit faculty and students from other colleges who have the expertise to contribute in various areas. Their help will be necessary for the continued development and expansion of the learning resources and for effective quality control.

One of the reviewers of this paper raised an important point related to the reality that individual instructors present things in individual ways and even textbooks may vary on the same subject. Actually this was an issue to some degree with the pilot module on working drawings that was tested for this paper. Some of the formatting and dimensioning techniques that are required for students at DWC are not standard at other colleges. As the current modules are revised and new modules are developed special attention will be given to ensure that the modules as much as possible are not college-specific. One strategy might be to give users two options when they request a module. The first option would be to receive the course in a completely open and editable format so that an instructor can make any modifications they choose specific to their course. The second option would be to receive a module linked to a master that would not be editable but would automatically receive updates and enhancements as they become available. The instructor could choose the option that best meets their needs.

There is also a larger question to consider with regard to the potential of free online learning resources for education in general. The authors enthusiastically agree with Kahn's philosophy that these resources would be of great use to the developing world, but will it be possible at some point in the future to get various degrees online for free?

With regard to engineering, it seems that some portions of technical education could be done as effectively or more so online than in the classroom. This seems to be especially true of things requiring training on a software package, review of derivations, and areas that are primarily informational and don't require interactive discussion of the subtleties inherent in various complex conceptual topics. We don't believe that online resources will eliminate the need for face-to-face interaction, though it may reduce the amount of face time needed for an engineering education. Rather, the value added by faculty members could focus more on the types of things that really need the presence of an instructor, such as interactive discussions that serve to develop good engineering judgment in design decisions. If portions of standard lectures that are presented over and over throughout the country and the world could be replaced by high quality online resources, a great deal of human intellectual capital could be redirected to improve the overall outcomes of engineering education. These free online resources could also reduce the cost of bringing quality technical education to the developing world.

The cost of information on the Internet is decreasing rapidly. The question is probably not if free educational resources and even degrees in some areas will become more available but how quickly it will happen. As educators it is important to try to understand how the delivery of education will change in the future and how we can most effectively add value to the education of our students.

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