

# **The Best of Both Worlds: Hybrid Learning**

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## **Abstract**

Hybrid courses are a combination of online and traditional instruction that have the potential to improve student learning while reducing faculty teaching time and university resource usage. The University of Arkansas – Fort Smith Mechanical Engineering department recently implemented two approaches to hybrid courses. One course reduced in class time by 67% through implementing online video instruction. Another course reduced in class time by 33% through an interactive online homework system. In both cases learning actually improved even though class time was reduced. In three assessments for each course the average increase in performance was 17% when compared to an earlier traditional lecture course. The increase in performance is likely due to the interactivity and convenience that online learning often features. Student feedback was largely positive in both courses, with most students indicating a preference for the hybrid course when compared to a traditional course. Both online methods were low cost and were fairly easy to implement.

## **Introduction**

Online education has emerged as both a supplement to traditional lecture courses and as a central means to deliver content. Online engineering education is growing rapidly but lags behind most disciplines in breath and scope of adoption<sup>1</sup>. While putting additional resources and information on a course website is common within engineering education, pure online courses are not as prevalent, particularly at the undergraduate level. Online education is often thought of as courses delivered in their entirety via the Internet, but hybrid courses offer an excellent compromise between pure web delivered courses and traditional lecture courses. A hybrid course is defined in this paper as a course that regularly meets like a traditional lecture course but has some portion of class time replaced with online content. Hybrid courses have also been referred to as blended learning<sup>1</sup>. The authors of this paper believe that hybrid courses offer the “best of both worlds” by retaining regular face-to-face connection yet taking advantage of the tools available through online learning. There have been numerous studies documenting the success of online education. Within engineering several studies have shown that students do just as well or better in achieving course outcomes when they learn online as compared to an in class lecture course<sup>2,3</sup>. These studies also showed that students tended to prefer online courses. Dutton, Dutton and Perry<sup>3</sup> also found that online students had a slightly smaller likelihood of completing the course. Hybrid courses offer the personal connection that may help keep more students from dropping out.

The purpose of this paper is to outline two different examples of hybrid learning and demonstrate the success of the hybrid approach through assessment data. Both of these examples were from mechanical engineering courses at the University of Arkansas – Fort Smith. One approach involves moving all of the lecture content to web delivered video while the other approached focused more on using the web as an interactive homework tool. In both courses hybrid students outperformed students who took a previous traditional in class lecture course. In-class time was reduced 33 - 67%, resulting in a more efficient usage of faculty and space resources. But much more importantly, both examples show that online students outperformed traditional lecture students when comparing assessment results. Since online education allows students to repeat lectures and learn interactively, the authors of this paper believe that students will do better with less in class lecture time and more online tools. Such a “win-win” is beneficial to students, faculty and universities.

### **Numerical Methods: A video lecture approach**

Numerical Methods is a sophomore level required course for mechanical engineering students and a frequently chosen elective for electrical engineering students. The course has been taught using traditional lectures for many years. Student feedback has consistently indicated that students are bored with the content of the course. Several of the UA Fort Smith faculty have labored to make the course more exciting by introducing relevant examples into the lecture and doing more interactive activities. While these efforts have helped, the majority of the students have a difficult time becoming engaged in the content during lecture. The faculty decided to try a new approach: offload much of the lecture content to short online videos. The rationale behind such an approach is that students will watch the online lectures once they are faced with a homework set requiring them to complete related problems. To reduce temptation of copying off other students, each student receives a unique homework assignment. The videos are short (a maximum of 25 minutes, an average of 15 minutes) so that students will actually watch them and keep their attention. The videos are also broken down by topic, so that if a student needs to learn how to do a particular type of problem the correct video is easy to find. Videos were recorded using a graphic tablet, a headset microphone and video capture software. The total cost for the equipment and software was under \$200 and allowed for easy portability. The videos were placed on the course website and also available via USB transfer from the instructor. The course met in class once for 50 minutes per week. The purpose of the in class time was to answer questions, review any confusing material and have a time for exams. Generally the class time started with a 25 minute lecture dealing with harder material and the balance of class time for questions.

Feedback from students indicated that the hybrid course was well received. Nineteen students filled out an evaluation related to the unique nature of the course. Seventeen students (89%) indicated that they preferred the hybrid format to a traditional lecture class. Seventeen students (89%) also responded that they would rather have a hybrid class that meets once per week than a full online class. When asked how many videos they watched, sixteen students

(84%) claimed they viewed them all. All but one student indicated that they had watched at least one video multiple times. Fourteen students (74%) claimed they watched at least 3-5 videos multiple times. Comments were generally positive, with students stating that they liked how they could review specific material very quickly by advancing the video to a certain part of the lecture.

Problem	Traditional Lecture	Hybrid Course
Differential Equations	8.5	8.8
Multivariable Optimization	7.2	8.5
Solving for equation root	7.9	8.3

Table 1: Assessment from final exam problems in a Numerical Methods course with traditional and hybrid lectures (0 to 10 scale with 10 being best).

In order to assess the impact of the hybrid courses, three exam problems were given to both the hybrid class and traditional classes in previous years. The problems all came from final exams, which were never given back to students. The problems assessed three important topics in Numerical Methods: solving differential equations, multivariable optimization and root solving. A 0-10 scale was used to assess the exam results. A score of 8 or 9 indicated a minor error (with a 9 being a minor calculator error), a 6 or 7 was for one significant error, a 4 or 5 indicated multiple errors and a 1-3 resulted from only having perhaps one correct equation or assumption. The hybrid course had 20 students while the traditional lecture courses averaged 13 students with at least 10 students in each measure. Table 1 shows the assessment scores for both the traditional students and the hybrid students. In each case, the hybrid students performed better than the traditional lecture students. The authors of this paper believe that the better performance resulted from students being able to relearn material whenever they needed to learn. It is also theorized that the shorter videos enabled more students to stay focused when compared to a traditional lecture. While the reasoning is debatable, the results do show that students can do just as well or while having only one fifty minute lecture per week, a 67% reduction in lecture time.

### **Thermodynamics: An Online Homework Approach**

Thermodynamics is a sophomore level required mechanical engineering course at UA Fort Smith. The course has been taught as a traditional lecture course for many years. The difficult nature of the subject prompted the faculty to consider alternate methods to help students learn. McGraw-Hill's Assessment, Review, and Instruction System (ARIS) was chosen to supplement the traditional lecture. To encourage the students to fully use the system, the in class time was reduced from 150 minutes to 100 minutes per week. The system contains a number of tutorials along with an online homework system. The online homework system encourages students to spend more time actually doing homework by offering assistance such as worked examples and extra tutorials. Because students get a unique homework assignment there is less motivation to copy each other's work. Student feedback was nearly universal with praise for ARIS. Students spent a lot more time working on their own through problems than they have

done in previous courses which was confirmed through online data and student responses. Students realized the usefulness of having instructional resources available to them at any time, particularly when they are working on completing assignments. Only one student felt that the online hints were a crutch that prevented her from self discovery.

Problem	Traditional Lecture	Hybrid Course
Closed System	5.8	7.6
Control Volume	5.7	8.1
Heat Pump COP	7.4	7.4

Table 2: Assessment from exam problems in a Thermodynamics course with traditional and hybrid lectures (0 to 10 scale with 10 being best).

In order to assess the impact of the hybrid Thermodynamics course, three identical exam problems were used in the hybrid class as well as an earlier traditional lecture course. The three exam problems were related to closed system analysis, control volume analysis and the coefficient of performance of a heat pump. Students in both classes had similar backgrounds and abilities. There were 14 students in the traditional lecture and 15 students in the hybrid section. Table 2 shows the results of the assessments in the Thermodynamics courses. In two out of the three problems, students in the hybrid section did significantly better than the traditional lecture course. The students showed a 23% improvement with the closed system problem and a 29% improvement with the control volume problem. The increased learning occurred even though the students received 33% less lecture time in the hybrid section resulting in improved learning with less time in lecture and more effort spent with online homework rather than traditional paper homework. The online homework system provided an interactive environment that provided instantaneous help and feedback to encourage students to persevere instead of giving up when unsure how to proceed. The additional time-on-task was critical for students as they learned the material.

## Conclusions

The University of Arkansas – Fort Smith engineering faculty successfully adapted their instruction methods to match the perceived decline in attention span by experimenting with several hybrid courses in the spring 2009 semester by combining traditional lecture with online content. While other methods to address the attention deficit such as team-based approaches or active learning techniques were tried, none could give a quantifiable increase assessment scores across all measures. The traditional lecture is still critical in providing an opportunity for clarification and motivation to keep on track but the additional online tools offered a unique opportunity for learning at any time with increased online interaction. Hybrid courses can offer the best of both worlds through an efficient combination of traditional lecture and online instruction resulting in both classes showing an increase in learning even though lecture time was reduced significantly. Incorporating hybrid learning offers the prospect of increasing learning with an efficient allocation of faculty time and university resources.

## References

- [1] Bourne, J., Harris, D., and Mayadas, F., "Online Engineering Education: Learning Anywhere, Anytime," *Journal of Engineering Education*, Vol. 94, No.1, p. 131-146.
- [2] Haag, S., and Palais, J., "Engineering Online: Assessing Innovative Education," *Journal of Engineering Education*, Vol. 91, No. 3, p. 285-289.
- [3] Dutton, J., Dutton, M., and Perry, J., "Do Online Students Perform as Well as Lecture Students?," *Journal of Engineering Education*, Vol. 90, No. 1, p. 131-136.

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