Experiences of Implementing Blended Teaching and Learning Technique in Mechanics and Design Courses

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Abstract

In this paper, effectiveness of implementation of hybrid (blended) teaching/learning in mechanics and design courses is presented and discussed. Blended teaching and learning has much been discussed and practiced in the past with many positive experiences reported. What inhibits, if any, in continuing to practice and to implement this technique? Implementation of blended teaching and learning method has been tried for two courses taught at two different four-year engineering degree local colleges. The first course is Mechatronics taught at Baker College in Flint, MI and the second course is Finite Element Analysis taught at Kettering University, Flint, MI. Both are four-year ABET accredited engineering colleges. The effectiveness of the blended teaching and learning are gaged by the overall student performance in the class and through tools that are based on student survey conducted via e-mail. These issues, together with the authors' limited experiences in this field are presented in this paper.

Introduction

A lot of research has been done that deals with blended teaching and learning. However, there is no general consensus as to what is blended learning and what does it constitute. Figure 1 [Wikipedia[1]] shows one method of blended learning that comprise the formal classroom learning and online learning using a stationary computer or a mobile device such as a tablet or. With the advent of more technology, the cell phone can also be used. This form of learning already exists for example in a social atmosphere such as finding a favorite restaurant in a new city and navigating to reach its destination using the GPS.

Figure 1: Blended Learning Methodology[1]

Many terms such as web-based learning, e-learning, hybrid learning, mixed-mode learning, etc are used to indicate a certain percentage of face-to-face teaching and online learning. The work done by Dziuban et al[2] concludes that face-to-face contact blended

with online teaching provides an ideal teaching-learning atmosphere for both the teacher and the learner. This type of learning combines the "best of both worlds", allowing for the social interaction specific to the traditional classroom, as well as the effectiveness of a student-centered approach to learning.While blended learning is practiced in some form in industry set up, it is an evolving phenomenon in higher educational environment [Kadle[3]]. Many companies successfully practice blended teaching because their audience is mature and motivated to learn for personal growth and for the growth of the company in which they work. Figure 2 [Kadle[3]] shows the differentiation between formal to informal learning. While the former method is based solely on instructor-led training, in the blended classroom the instructor-led training has been reduced to only a few weeks mostly at the beginning of the semester.The blended classroom leverages a variety of technology resources such as streaming, chats, wikis, and blogs distributed across the entire spectrum from Formal to Collaborative to Informal Learning. Each of these resources is appropriate at a certain point in time; for example wikis are a useful tool especially in the first half of the semester, while mobile learning is utilized in the middle. User-generated content and individual blogs should feature prominently in a student-centered learning environment.

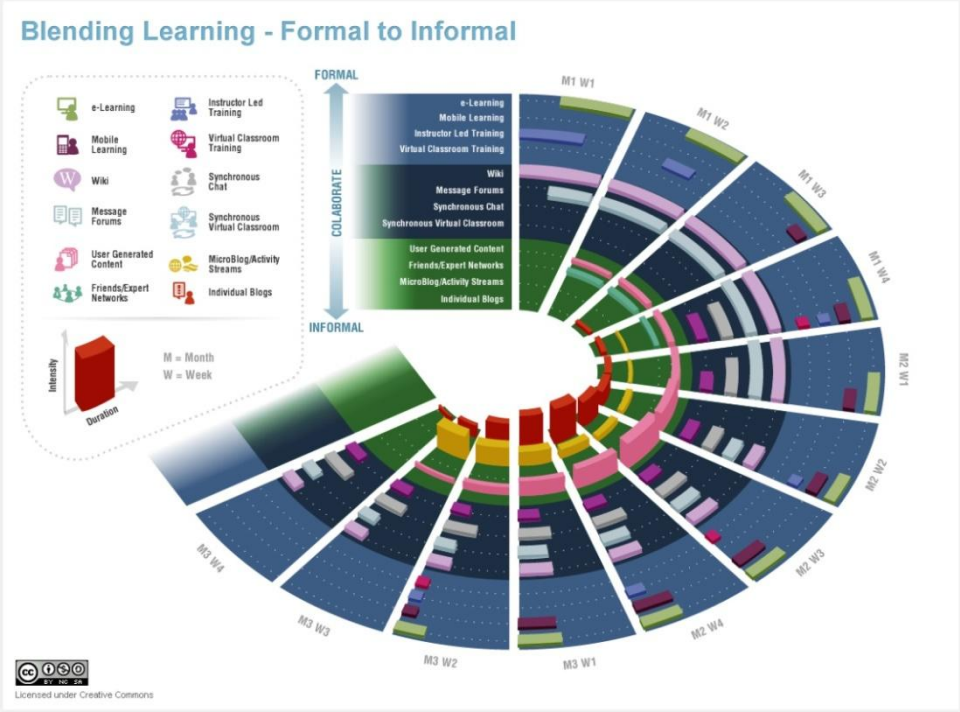

Figure 2: Instructor-led program to a modern blended classroom[2]

Driscoll[4], a consultant to IBM Global Services, trains IBM's mid-span customers using one of several blending learning styles that she identified. These include assessment online, pre-work by the IBM employees before they undertake travels for face-to-face meetings, providing online office hours, etc. Again, factors such as maturity and motivation of audience play an important role in this compression of time to learn.

Milne[5] discusses how the physical space in which learning takes place influences how the virtual space is accessed (Figure 3). As schools continue to pursue blended learning there will be a need for iterative design and prototyping of these spaces to fulfill the needs of the learning process while maintaining flexibility and reducing cost (Figure 4). Collaboration between institutions and sharing of best practiceswill be very helpful in this regard.

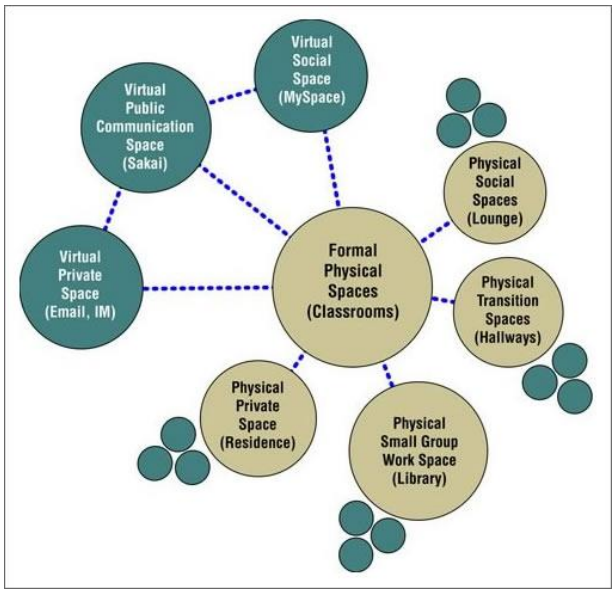

Figure 3: The varied nature of blended learning environments[5]

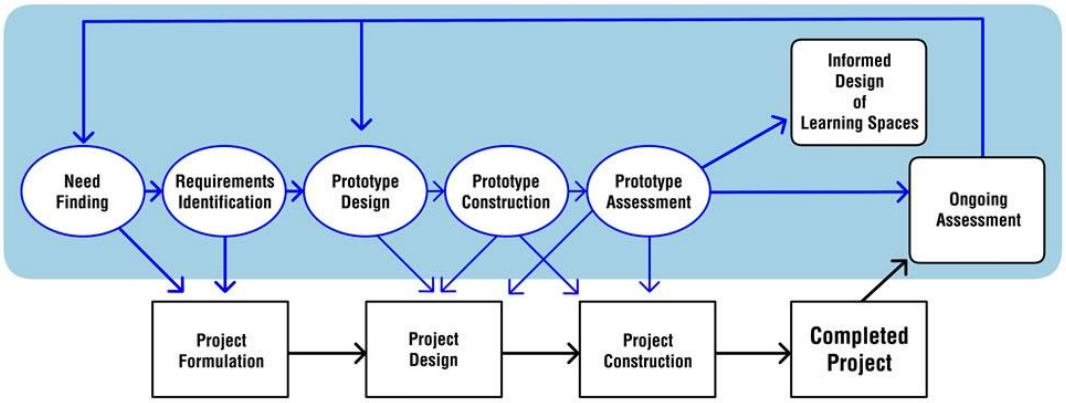

Figure 4: A revised design process[5]

Figure 5 shows the path to full blended-learning from a simple e-learning strategy as suggested by Dean[6] from his several years of experience in practicing this methodology in developing several high school level courses. Allen et al[7] conducted several studies on face-to-face, online and blended learning and concluded that:"Most online students, like

the overall student body, are overwhelmingly undergraduates; Online enrollments continue to grow, reaching 3.18 million for fall 2005; An increasing number of academic leaders say that offering online courses is critical to their institution's long-term strategy", and finally, "A majority of academic leaders believe that the learning outcomes for online education are now equal to or superior to those for face-to-face instruction"[7]. They assumed that in order for a course to be classified as blended, 30% to 79% of that course delivery should be in the online from. Garrison and Vaughn[8] explain how the traditional values of face-to-face teaching and the best practices of online learning can be integrated to achieve a blended learning environment. Means et al[9] conducted studies under a grant from the U. S. Department of Education on how online learning immensely helps in better learning and understanding by the diverse student population that they studied compared to the traditional face-to-face teaching. Zhao et al[10] support these findings with an understanding that online learning also depends on the type of learners some of whom may not succeed in courses taught solely online. There are quite a few other studies performed on blended learning that a reader can easily find using modern Internet resources.

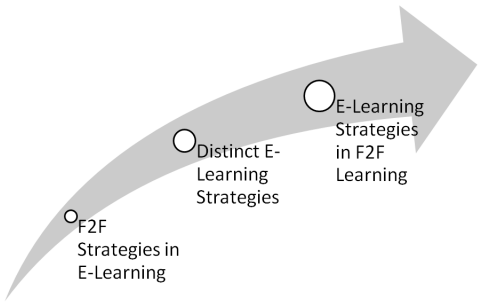

Figure 5: The three phases about e-Learning[6]

Mechatronics hybrid course at Baker College

A new Mechatronics course was introduced in spring quarter 2012 as a technical elective for Mechanical Engineering students at Baker College. The College operates on a quarter schedule, with 10-week fall, winter, and spring quarters. The new course is a 4-credit hour course, with "Circuit Analysis" and "Dynamic Systems and Control" as pre-requisites, which effectively limits access to the class to senior students only. Mechanical Engineering core courses are taught in the evening starting after 5pm to allow full-time working students to attend classes at a convenient time. Evening classes meet one time per week, with the four instructional hours associated with a 4-credit class being taught in a continuous block.

The Mechatronics course, which includes lecture and experimental laboratories, was taught in a hybrid format. Students and instructor met in-class for 60% of the course and online for the remaining 40%, which allowed for more flexibility in students' schedules. The senior students taking the course had mature study habits and abilities, and they welcomed the opportunity to complete some of the work for the course in a remote location at a time of their choice. The class met face-to-face for six weeks and online for

four weeks out of the 10-week quarter as shown in Table 1. The first in-class meeting took place during the first week of school to discuss in detail the format and all the requirements of the course. The final two weeks the class also met in-class so that students were able to completethe laboratories and the final design project. In between these weeks the class met every two weeks face-to-face,and every two weeks online.

Table 1. Schedule of Hybrid Mechatronics Course

Week	**Class Format**	**Topics**
1	In-class	Introduction to Mechatronic Systems
2	Online	Analog and Digital Circuits and Components
3	In-class	Microcontrollers, Data Acquisition
4	Online	Control Software
5	In-class	Sensors
6	Online	Actuators
7	In-class	Feedback Control
8	Online	Project
9	In-class	Project
10	In-class	Final Exam, Project

As with any course with an online component, students were required to study and attempt to understand the course material by themselves as much as possible. Students relied on traditional resources such as the textbook and the Lab Manual, supplemented by instructor's course notes and summaries of the material posted in the course management platform Blackboard.Audio lectures were not developed for this first offering of the course, but are in consideration for subsequent offerings.

The focus of the class was to introduce students to Mechatronics systems and applications using a hands-on approach, and as such it did not involve very difficult concepts or mathematical derivations which require extensive face-to-face explanation from the instructor. Students were required to participate in weekly online discussions moderated by the instructor using the Discussion Board feature of Blackboard. The main goal of participating in these discussions was to help students understand and learn the material, but this also fulfilled the attendance requirement for the weeks when there were no on-ground meetings. When the face-to-facemeetings took place the instructor took time to answer questions from students, however the bulk of the time was dedicated to the experimental laboratories and the completion of the class project.

The course used traditional assessment tools including homework assignments, lab reports, in-class quizzes and final exam, final project and oral project presentation.The hybrid format of the course was well received by the students. As this was the first offering of the Mechatronics course at the College, it is not possible to compare student performance in the traditional 100% face-to-faceformat vs. the hybrid format. However this course lends itself very well to the hybrid format due to the mature student population enrolled, senior students only, who were able to draw on previous knowledge and experience to support them while learning the new material. The focus of the class on applications was also appropriate for the hybrid format, allowing the instructor to devote the face-to-faceclass time to experimental work rather than lecture. For future offerings

the instructor plans to provide students with additional materials posted to Blackboard, and administer the quizzes and final exam through Blackboard rather than utilizing time during the face-to-facesessions. The only challenge for wider adoption of the blended format in the Mechanical Engineering program at Baker College is related to the time it takes to set-up such courses. This includes instructor research and training to understand detailed aspects of the technology and developing additional materials such as annotated power points, video lectures, and non-traditional assessment methods. Even with these challenges there is interest and motivation from both faculty and students to expand the number of courses offered in this format.

Finite Element Analysis (FEA) hybrid course at Kettering University

The second hybrid course considered in this paper was taught at Kettering University, which also follows the quarter system calendar. The course was Applied Finite Element Analysis. This is a technical elective course and is taught simultaneously to two groups of students. One is on campus (face-to-face) and the other group is completely online via distance learning (DISTLC) facility that the university provides to off campus students. Although in a way this is not purely hybrid learning set up, the on campus students are sometimes asked to learn some material on their own using the streaming video files of the course posted on Blackboard system provided by the university. Conversely, some off campus students who live nearby preferred to drive to campus on weekends and on certain weekdays to complete the homework on campus using face-to-face meetings if they needed any help and to use the on campus computational facilities. Interestingly, since the off campus students are practicing engineers, they have the maturity in terms of practical knowledge to appreciate the online course topics and to apply those to real life problems. The duration of each class period is roughly 2 hours and the quality of the media (PC based video streaming files) as reported by the students is very high. The course topics for the FEA course are outlined in Table 2 below.

Table 2. Schedule of Applied Finite Element Analysis(FEA) Course

Week	**Class Format**	**Topics**
1	In-class/DISTLC	Introduction to FEA with applications; Basic Theory
2	Online	Review of Statics and Solid Mechanics
2	In-class/DISTLC	1-D Bar Element Using Direct Stiffness Method
3	In-class/DISTLC	Modeling Planar Trusses using 1-D Elements
3	Online	Review and modeling of spatial trusses
4	In-class/DISTLC	Modeling Frames and Grids using 1-D Elements
5	Online	Review of Thermal Stresses
5	In-class/DISTLC	Modeling Thermal Stresses using 1-D Elements
6	Online	Review of Fluid Mechanics and Heat Transfer
6	In-class/DISTLC	Modeling Pipe Flow, Conduction and Convection using 1-D Elements
7	Online	Basic Vibrations Theory/Final Project Assignment
7	In-class/DISTLC	Eigenvalue Problem using 1-D Elements
8	In-class/DISTLC	Energy Methods and 2-D Element Analysis
9	In-class/DISTLC	Axisymmetric Element Formulation
10	In-class/DISTLC	Final Exam, Final Project

This course also used traditional assessment methods: homework using a math tool, quizzes, mid-semester and final exams plus a term end project that uses both a math and to some extent a CAE tool such as Solid Works, UG NX, or NX I-DEAS, etc. This and many other courses at Kettering University are offered for both on campus and for distance learning students via online system and Blackboard. Compared to the on campus students whose class usually is scheduled at 8 am to 10 am on two days a week, the DISTLC students appreciated the online and in some cases the hybrid learning (by coming to campus to do some homework).This course is usually offered in a face-to-face set up twice a year with 20 to 30 students per year in the class using the 'blended or hybrid' style as mentioned in Table 2 above. However, since the actual recording of the course material is done once a year during summer terms, students registering for this course during other three terms (3 to 5) can use the online format by viewing the previously recorded material (in summer term). The on campus students have the additional advantage to attend the class face-to-face during fall term. The overall satisfaction and the performance of the students in the course in either one of these set ups (face-to-face + online, and purely online) is very satisfactory with the online students (6 to 12 students per year) showing better performance in the class. Graduate student feedback evaluations in all graduate level courses are routinely conducted by the graduate office at Kettering once or twice a year to know the students perception of the quality of in class (face-to-face) and distance learning facilities provided, course content and delivery, availability of instructor for immediate help, etc.

Conclusions

In this paper, an attempt has been made to present some literature in the face-to-face, online, hybrid and blended learning techniques. Also, some of these techniques as adopted by the authors show encouraging results that the students like a combination of face-to-face and online instruction (blending the better practices of the two). A lot of online material has been used including YouTube by the students for better understanding of the material at a self-paced style. Verbal and written feedback shows that the students prefer the hybrid learning more than face-to-face instruction. This is to be understood since the computational power in the hand held smart phones has tremendously increased making it possible to clear many doubts in the least possible time. There is no doubt that even many instructors use the available online resources in their daily classes. With the advent of cloud computing, hybrid or blended learning may even reach higher levels of teaching and learning environments.

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