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On Synchronous Distance Teaching in a Mathematics MS (Master of Science) Program

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A fully online graduate program that was developed at the UWF (University of West Florida) has been successfully implemented using synchronous instruction since fall 2009. The hybrid nature of the developed model has proven to be of benefit to both face-to-face and distance students. Aside from the robustness of students' discussions and interactions outside the regular class period via an e-learning platform, the fact that the instructor can be a part of the discussion when needed has been an added advantage. Moreover, our assessment results showed that the model is flexible and cost effective. A statistical analysis of students' performance indicated that the distance students do as well as their face-to-face counterparts when this delivery model is used. We will provide some recommendations for institutions wishing to adapt this hybrid model.

Keywords: synchronous instruction, elluminate live, online MS (Master of Science) mathematics program

Introduction

In summer 2008, a mathematics graduate course was redesigned and delivered in hybrid mode using a synchronous instruction software package. Lessons from the experience were discussed among the department faculty. Our method was then refined and used to deliver several courses similarly in fall 2008. We then conducted an assessment in spring 2009 and the statistical analysis suggested that distance students performed as well as their face-to-face counterparts when this delivery model was used. Consequently, the new MS (Master of Science) program was started in fall 2009. Since then, all graduate courses have been taught with synchronous instruction in hybrid mode. Although the original program was designed to accommodate the schedules and the needs of mathematics teachers in area high schools, our experience with the general population convinces us that this model can be adapted to suit any motivated student group.

Mathematics teachers in the United States live in locations that are spread over large geographic areas. This reality presents economic and practical challenges when they wish to complete graduate courses in a campus setting. As a result, some type of distance learning becomes not just an attractive option, but in many cases, it is a necessity. The faculty members in the Department of Mathematics and Statistics at UWF (University of West Florida) visited a large number of high schools in the Florida Panhandle and South Alabama to meet with mathematics teachers and their students beginning in fall 2003. During the 2008 to 2009 year, we contacted 890 high school principals and their respective mathematics department chairpersons in Florida and Alabama. The feedbacks which we obtained indicated that many high schools had an urgent need

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for high quality mathematics teachers, especially for upper level and dual enrollment mathematics courses. Even though the idea of training new teachers was a laudable long-term solution, it was of immediate interest to provide more training for current teachers. It was also clear that unless the program/training was offered fully online and during the evenings, most teachers would not be able to attend due to conflicts with their teaching and family schedules. However, the question of offering a fully online advanced undergraduate or graduate level course in the mathematical sciences presents unique challenges.

Research studies showed that the nature of mathematical sciences dictates that students should actually hear that the instructor explain the concepts and ideas, as they are methodically developed by the instructor (Amin & Li, 2010; Aminifar, Porter, & Caladine, 2005; Chickering & Gamson, 1987; Leventhall, 2004; Li, Uvah, Amin, & Hemasinha, 2009; Smith & Ferguson, 2005). As institutions grapple with the teaching and learning of mathematics, they are limited to choosing from the three prevalent modes of delivery in current use, namely, traditional face-to-face, face-to-face lecture with Web-based homework and asynchronous (fully) online. As Leventhall (2004) and Smith and Fergusion (2005) have articulated, perhaps the greatest challenge with asynchronous online instruction lies in the unavailability of immediate feedback to student questions, as they navigate a challenging topic. Thus, while asynchronous e-learning management systems, such as D2L (Desire 2 Learn) and blackboard, are useful platforms for instructors and students to exchange ideas and hold discussions, these systems are insufficient for mathematical sciences courses to provide distance students the same immediate feedback that traditional face-to-face students enjoy (Amin & Li, 2010). Research showed that better results are obtained when instructors provide distance students real time access to ongoing class discussions and lectures (Li et al., 2009). Furthermore, there is research evidence to show that among these three teaching modes, many students at the general education level perform best in the face-to-face lecture with Web-based homework (Cole & Todd, 2003; Foster, 2003; Hauk & Segalla, 2005; Li, Uvah, Amin, & Okafor 2010; O'Callaghan, 1998; Phipps & Merisotis, 1999).

In this paper, we discuss our approach to the online delivery of our graduate mathematics courses. Although the number of departments of mathematics that offer mathematics courses with synchronous online instruction is quite small in the United States, we, in the Mathematics and Statistics Department at the UWF have been offering mathematics courses in this mode for several years. We discuss our unique design which includes the delivery of lectures in hybrid mode coupled with an elaborate e-learning platform. We articulate the salient elements that set our program apart from others. Moreover, we summarize results of our statistical analysis that show our distance students perform as well as their face-to-face counterparts. We also offer suggestions for persons wishing to adapt this viable mode of instruction.

How It Works

For each graduate course, the lecture is delivered from a classroom with either a computer equipped with a sympodium or a tablet PC (personal computer) on which the instructor writes the lecture materials. The synchronous software package that we use is "Elluminate live", for which our institution has a site license. Students who use the software incur minimal extra cost. For each course, some students enroll in a traditional face-to-face section while others enroll as distance students who attend the scheduled class via an Internet connection from their various locations. Distance students must receive permission in order to enroll in a course. For first time users, the permission is contingent upon completing a 30-minute personalized training session with a designated instructor on the use of the synchronous software package. Particular attention is paid to the

students' ability to communicate with the instructor and the rest of the class during lectures. All distance students are required to log-on during all lectures. Each class meeting is scheduled and lectures are live instructions given to both face-to-face and distance students simultaneously. Each lecture is recorded and the recording is posted on the web. An asynchronous e-learning platform, such as D2L, is used as a supplement, for course information, instructor's summaries, homework, recorded lectures and notes (whiteboards) and multiple formats of out-of-class discussions to include small groups and the whole class. Collaborative learning strategies known to enhance student learning are utilized by means of the e-learning system. For some results of studies on collaborative learning (Hiltz, Coppola, Rotter, & Turoff, 2000; Riffell & Sibley, 2005; Stephens & Kovalina, 1999), students are subjected to at least one proctored test that is administered at instructor-approved test centers that are convenient to the student. All courses are scheduled after 4:00 pm to provide maximum access to students with full-time day jobs.

What Sets It Apart

The number of departments of mathematics that offer fully online Master's programs in the United States is quite low. The only online graduate program with synchronous instruction in mathematics that was identified with a Google search was the online program at UWF. This is an indication that synchronous instruction is quite far from being commonplace in the mathematical sciences. It is, therefore, noteworthy that our graduate program (master's level) is fully online and more, so that we use the hybrid synchronous mode of instruction. Furthermore, our model using the synchronous instruction has taken into account and addressed the known shortcomings of asynchronous online delivery.

The Web-conferencing software package, "Elluminate live", permits us to deliver lectures online at flexibly scheduled times to distance students in real-time at little or no extra cost to them, while simultaneously teaching face-to-face students in a regular classroom setting. Not only does this instructional delivery medium permit real-time instruction and communication, it has full two-way audio, an optional live display of video and a versatile combination of applications to include the recording of all proceedings in two formats: voiceless notes (whiteboards) and audio recording with the notes as they were being developed. The online-hybrid format, with both face-to-face and distance students, has several advantages over offering two separate course sections. Aside from the obvious cost-effectiveness, the format is convenient and flexible from the view point of distance students. The distance students attend class by logging on to the Internet at the scheduled time. They ask questions and interact with the instructor and the rest of the class in real time. This setting creates an experience that is similar to being physically presented in the classroom. Since all lectures are recorded, students can later review these as needed. This approach creates additional learning opportunities for both distance and face-to-face students, and opportunities that are ordinarily out of place for other modes of instruction.

The hybrid design is accompanied by a supplemental e-learning platform (D2L, in our case). The e-learning medium is used to post course information, instructor's summaries, homework, recorded lectures and notes as well as facilitate out-of-class discussions. Group projects and all assignments are easily handled via e-learning while office hours are set up on "Elluminate live" to accommodate distance students' needs. A conscious effort is made to provide uniformity and an even playing field for both groups. Thus, for example, an instructor may elect to react to course assignments in progress only on e-learning for the whole class rather than entertain private emails from the student. It has been our experience that discussions among students are more robust in our hybrid classes in comparison with those in the same course when it was taught in the traditional

face-to-face format.

Students' performances in the program are assessed annually, course by course, to determine the effectiveness of our instruction. Not only do we examine the topics covered in each course and the student learning outcomes set and achieved, we compare the success rates for face-to-face students with those of the distance students. Based on these assessments, we have concluded that there is no statistical evidence to claim a disparity between the performance of distance students and that of the face-to-face students when synchronized instruction is used in combination with an effective e-learning medium. In fact, some instructors have claimed that they are able to cover more course material when using the hybrid model mainly, because they have better control over student discussions on e-learning in comparison to the face-to-face format, whereby students are encouraged to discuss, but such discussions are neither monitored nor evaluated.

The UWF model may ultimately be implemented in many institutions on a large scale in mathematics and sciences to benefit the professional development of mathematics and sciences teachers across the United States. Workforce needs that are enhanced by further study in mathematics and science can be addressed since the model provides access via the Internet, flexibility of schedule to accommodate work schedules and effectiveness as shown by our results. Evidence of successful graduate-level learning by the distance students is likely to have the broader impact of serving as a model for effective graduate instruction in mathematics for place-bound teachers and underrepresented groups across the United States. The national need for high quality teachers in mathematics, combined with tough economic situations that preclude teachers' travel for face-to-face graduate training programs, makes the effective online MS program an attractive and feasible option. This pilot program may help other institutions to establish successful and effective online programs. In this regard, the potential impact of this report is to significantly enhance distance higher education in mathematics and sciences.

Key Benefits

The synchronous hybrid instruction has several advantages over other formats:

(1) From an administrative perspective, the class scheduling of courses remains the same as it would be for a traditional master's program that is taught face-to-face. The addition of distance students to the class roster for the face-to-face course makes this strategy cost effective since the hybrid design accommodates two sections of a course simultaneously. The logistical issue of having two sections on paper is a small price to pay for the access that is provided to persons who would otherwise be denied the access and opportunity;

(2) As far as the distance students are concerned, the hybrid format is very convenient and appropriately flexible. Their (anonymous) account of their experiences is similar to being physically presented in the classroom. Moreover, since all lectures are recorded, students are able to return to a given lecture or a small portion of it, as many times as they wish. From their standpoint, this feature is an added benefit that is absent in other modes of instruction, especially if they are used independently. Both face-to-face and distance students deeply appreciate this feature;

(3) Our hybrid approach creates additional learning opportunities for both distance and face-to-face students at minimum cost to the institution. Students have tended to engage often and in a timely manner when distance students are mixed with others that are face-to-face in both group projects and individual/practice homework.

Summary of Assessment Results

Table 1 summarizes our student enrollment and students' performances for the distance students in comparison with their face-to-face counterparts, from summer 2008 to fall 2010.

Table 1

Students' Performance: Summer 2008 to Fall 2010

Instruction	Enrolled	*W*	*A*	*B*	*C*	*D*	*F*	CDWF%	DWF%	W%	DF%
Synchronous distance	423	52	195	114	39	9	14	27	15.1	12.3	5.4
Synchronous in class	589	52	300	138	62	17	20	26	17.7	8.8	6.3

Notes. CDWF refers to all grades of C, D, W and F; DWF refers to all grades of D, W and F; DF refers to grades of D and F.

For the purpose of this study and recognizing that they are graduate-level courses, we have regarded course grades of A and B as passing grades, while C, D, F as well as W (withdrawal without completion) have be regarded as failure. As Table 1 shows, the success rate of the distance students was 73% and that of the face-to-face students was 74%. Similarly, the various classes of failure had comparable rates for both groups.

The issues of enrollment, retention and graduation rates have persisted in the higher education environment as funding authorities continue to demand for accountability of productivity. Figure 1 represents the student enrollment in our MS program from years 2005 to 2010. We note that our program grew from 13 students in fall 2005 to nearly 80 students in 2010. Our rapid growth rate during 2009 and 2010 when the fully online program implemented is of special emphasis.

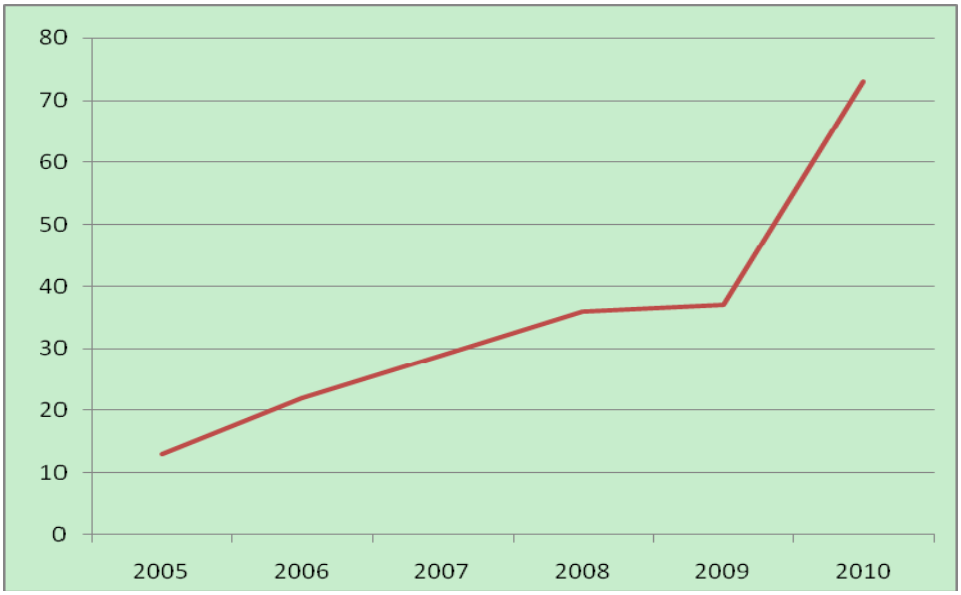

Figure 1. Student enrolment: Fall 2005 to fall 2010.

Based on our assessments and experiences:

(1) There was no statistical evidence that distance students performed differently from those that were face-to-face when synchronous instruction was used in combination with an e-learning system;

(2) The teaching and learning of subject materials were enhanced with synchronous instruction when utilized with a supplemental e-learning system. In many cases, the instructors were able to cover more material

than in the face-to-face setting alone or in the face-to-face format combined with the e-learning system;

(3) Enrollment and retention rates increased dramatically when we implemented the fully online program in hybrid mode. The reason was obvious that the program was in very high demand, as we created controlled access;

(4) The distance students overwhelmingly like the program. Face-to-face students have had no cause to complain. Periodic student surveys have continued to be very positive.

Conclusions and Recommendations

Based on our experiences with the pilot hybrid fully online MS program in mathematics:

(1) We believe that upper undergraduate and graduate level mathematics and sciences courses can be successfully taught fully online using the synchronous instruction on Web conferencing software. In order to create more access to high quality programs, this mode of instruction may be a viable means to the future;

(2) Having also experimented by teaching a few sections with "Elluminate live" but without face-to-face students, we strongly recommend the hybrid mode comprising distance students and face-to-face students within the same class. Instructors should aim at uniformity in formulating class policies and their syllabi;

(3) A supplemental e-learning system is a necessary component of our design. While lectures are given in hybrid mode via a conferencing platform, important course information, instructor's summaries, homework and active discussions among participants should take place on the e-learning system. Conferencing systems that permit the recording of lectures do provide an added avenue for learning;

(4) For program integrity and quality assurance, we recommend at least one comprehensive proctored examination. Test centers to be used for proctored examinations should be vetted by the instructor, department, or institution;

(5) We recommend periodic assessment of student learning. The assessment results should be used to adjust the curriculum and program with the aim of enhancing student learning and streamlining the operation. This should be a departmental exercise as opposed to individual instructor efforts;

(6) We also recommend periodic student surveys with a combination of tailored and open-ended questions. Mature students are usually able to make useful suggestions that may also help departments to improve the teaching and learning of mathematics;

(7) The above hybrid design is cost-effective for the institution. However, institutions wishing to adapt the design must be willing to make a necessary initial investment. We note that our success is a combination of institutional support, purposeful leadership and faculty commitment. At UWF, most classrooms have state of the art technology with integrated "smart" podiums, touch screen annotation, document cameras and video conferencing. UWF also has dedicated IT (instructional technology) classroom support services that can remote into any system to assist instructors in need at short notice;

(8) Finally, we caution that the above design may not produce similar results if employed on younger and perhaps less committed groups of students.

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