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The Converged Classroom: A Follow-up Study

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Introduction

Learning new ways to utilize technology is a common challenge[1]. Distance learning has been with us for over 100 years. With changes in technology, distance learning has steadily changed to more closely resemble traditional face to face instruction. First, paper based correspondence courses were supplemented by lectures recorded on video tape. Later, computer based training provided the first elements of interaction. With the spread of the internet, materials moved from the computer to web pages. There were discussion boards where students could interact with instructors and other students. Finally, there came the advent of real time class meetings through software such as Wimba®, Blackboard Collaborate®, and GoToTraining®. Through these developments, the experience of distance learning has moved closer to that of a traditional face to face classroom, through the use of hybrid, blended, online, and other new delivery models.

Quality is always a concern. Studies of learning outcome effectiveness found an increase in student perception of learning[8], and evidence of higher cognitive gains for hybrid or online students[9]. Doo, et al.[10] found no significant differences in learning outcomes between hybrid and online courses. The primary concern of most educators, aside from learning technology, is preserving the effectiveness in achieving learning outcomes with hybrid and online coures[11]. Choi, et al.[12] suggest that it is more efficient to encourage students to adapt to hybrid or online learning than it is to try to design systems to adapt to each student's learning style.

From 2009 through 2012, our Industrial Engineering Technology program at Southern Polytechnic State University converted all of our major courses to a Converged Course format. The Converged Course format can fit the needs of both traditional and non-traditional students. A 2013 ASEE conference paper[17] presented the format and a very simple measure of performance. In 2015, Southern Polytechnic State University merged with nearby Kennesaw State University. This merger has not affected our Converged Course offerings. It was however, a time for reflection. It was noted that another three years had passed, and it might be useful to examine the performance of Converged Courses again. We also decided to have a more nuanced look at the data.

The impetus for this type of flexible offering was driven by the needs of our students. The purpose for the transition from traditional to hybrid was to better serve our students, and to make better use of resources. Many of our students are older than traditional age. Most work full or part time, and many have family responsibilities. Providing flexibility and accommodating different learning styles have been increasingly necessary. Some research has suggested that hybrid or blended learning may be an improvement over more traditional approaches[2]. Other studies have suggested that students prefer a hybrid format over a traditional one[3]. The converged classroom is an effort to remove any remaining differences between online and traditional formats, except for physical presence.

Purpose and research question

This study is a work in progress. The purpose of this study is two-fold. First, since we now have data covering an additional three years, is to extend the timeframe of the original study. The 2013 analysis was done just as the implementation was complete using data from fall 2009 through fall 2012. Data from 2013 through 2015 represents a steady state for the curriculum. The second purpose is to more closely examine the data from both periods to determine if our initial conclusions were correct. Our research question is: Is there a difference in student performance between Hybrid Face to Face (HF2F) and Hybrid Synchronous On Line (HSOL) delivery in Converged Courses?"

Converged classroom

In order to explain what the converged classroom is, it will be necessary to provide some definitions. These are not necessarily standard definitions. They are mostly terms that are commonly used, with the definitions agreed upon by the authors.

- Traditional: Live in person classroom meeting. These courses usually meet face to face two to three times per week. In our case, our traditional courses had two 75 minute meetings a week.

- Hybrid: A hybrid course includes some split between pre-recorded and live delivery. In our case, half of the material is online, usually as pre-recorded lectures, and the other half is delivered in a live face to face class room meeting once a week. In academic literature, this is often referred to as blended learning[5, 6, 7]. Our hybrid courses meet once a week for 75 minutes. The other 75 minutes a week is made up of pre-recorded lectures and other materials that can be accessed and addressed asynchronously.

- Face to Face: Delivery where students must be physically present. This can be a traditional course, or a hybrid.

- Asynchronous Online: Many online courses offered today are asynchronous. In an asynchronous online course, all of the material is available online, and students generally work independently, either to a schedule, or at their convenience. Interaction is limited to email and discussion boards.

- Synchronous Online: In a synchronous online course, there is at least one live online session each week where students can interact with each other and with faculty.

- Converged Course: A hybrid course with two sections taught simultaneously by one instructor. The classroom experience in one section is delivered face to face. In the other section, the classroom experience is delivered in a synchronous online format. The two sections are otherwise identical

A Converged Course begins with a hybrid design. In our case 50% of the material is pre-recorded lectures and other asynchronous activities. The remaining live classroom activities are delivered in a face to face or synchronous online format. For a Converged Course, two sections of a hybrid course are created. One uses a face to face format to deliver the live classroom

activities. This will be referred to as Hybrid Face to Face (HF2F). The other section uses synchronous online format to deliver the live classroom activities (Figure 1). This will be referred to as Hybrid Synchronous On Line (HSOL).
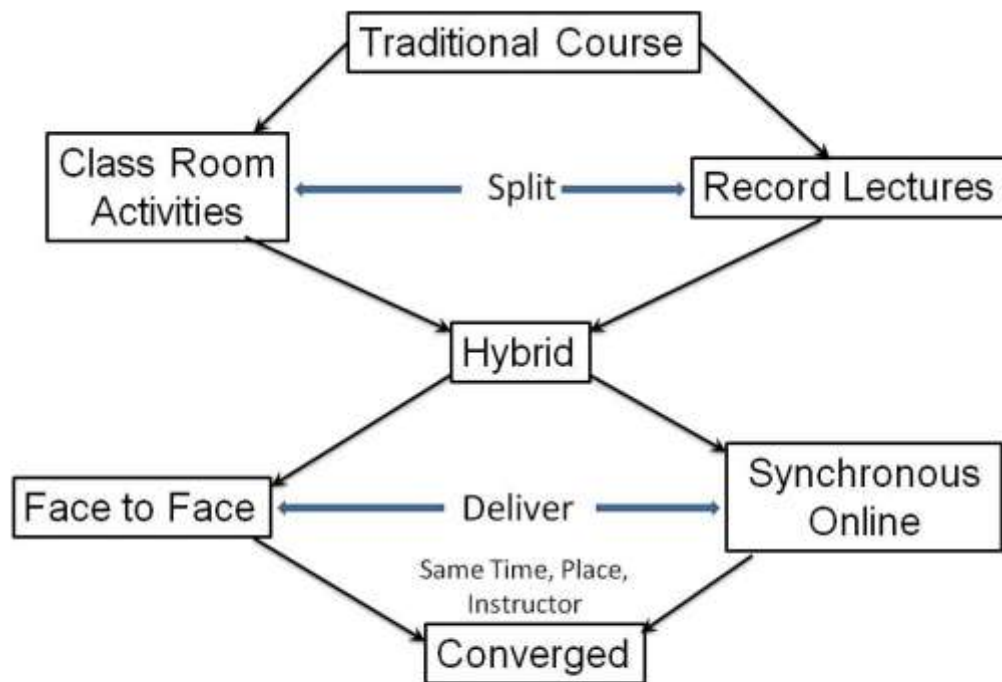

Figure 1. Creating a Converged Course

In order to accommodate our registration system and institutional policies, paired sections for each course are offered. In most cases this is a HF2F section and a HSOL section. These two course sections are cross-listed. They are taught at the same time, by the same instructor, in a technology equipped classroom as if they were a single course section. These two course sections share the same hybrid structure, the same material, assignments, activities, assessments, course schedule, meeting times, and the same instructor. The only difference is the delivery method for live material. Students in the HF2F section are physically present for the class meeting, and students in the HSOL section are digitally present for the class meeting. HSOL students interact in real time with HF2F students and with the instructor. Studies support this need for peer and instructor interaction, and suggest that it helps to overcome social and academic isolation common with purely online courses[13, 14].

There is some technology required for the converged classroom. It is necessary to have a course management system such as D2L®, Vista®, Moodle®, or one of the many other systems available. These are in common use at most universities and colleges. Software for live online interaction is also required. This may be something like Blackboard Collaborate®, Wimba® or GoToMeeting®. This allows multiple HSOL students to have a virtual meeting with the

instructor and the HF2F students. HSOL students can participate through voice or text. Some classroom technology is also required. A classroom should be equipped with ceiling microphones, speakers, overhead projection and software/hardware which permits writing on the screen. We use Sympodium®. The cost of equipping a classroom is approximately $10,000 - $15,000.

2013 study summary

The Industrial Engineering Technology department at our State University began converting traditional courses to Converged Courses in the fall of 2009. By the end of 2012, all of the major IET courses were offered in this format. The changes in enrollment (Figure 2)[17] reflect the transition in our offerings. Over the three year implementation period, nearly all of the courses were converted from traditional to hybrid, and delivered both Hybrid Face to Face (HF2F) and Hybrid Synchronous On Line (HSOL). HSOL enrollment increased gradually. It should be noted that in fall of 2009 each traditional, hybrid and online course represented a different offering. By fall of 2012, courses were listed as hybrid (F2F) or (Hybrid) online, but they were taught as one section rather than separately. The decrease in enrollment for traditional offerings is a direct result of those offerings being replaced by paired HF2F and HSOL offerings.
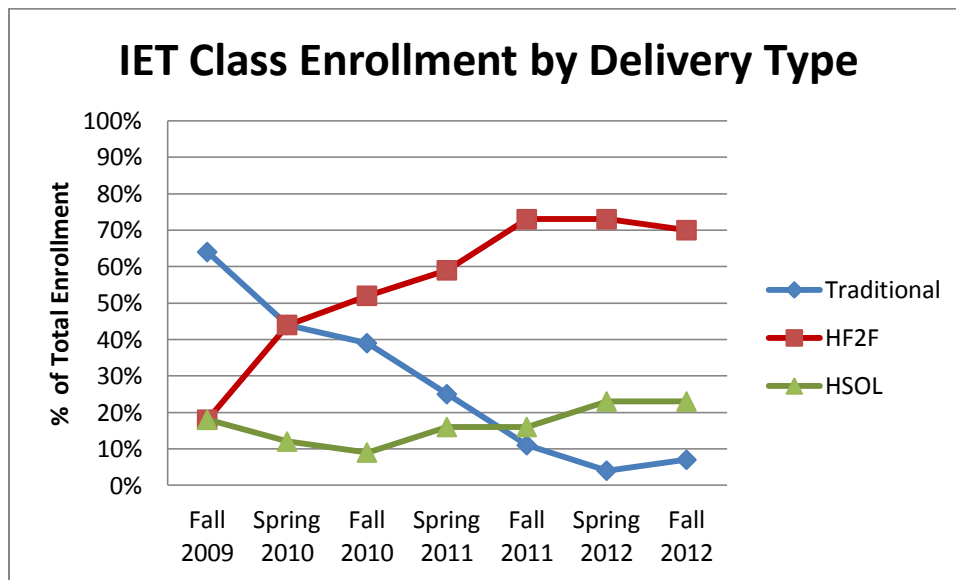

Figure 2: Comparison of IET course enrollments by delivery type.[18]

There are two courses that were not converted from traditional to hybrid. The first is a one credit hour safety and ethics course. This course only meets 50 minutes per week, so there was little benefit in creating a hybrid. The other is the senior project. In this course, teams of students meet with a faculty mentor at times arranged for each team. Although they were not converted to hybrid, these two courses have a companion online section, and are taught in a converged format.
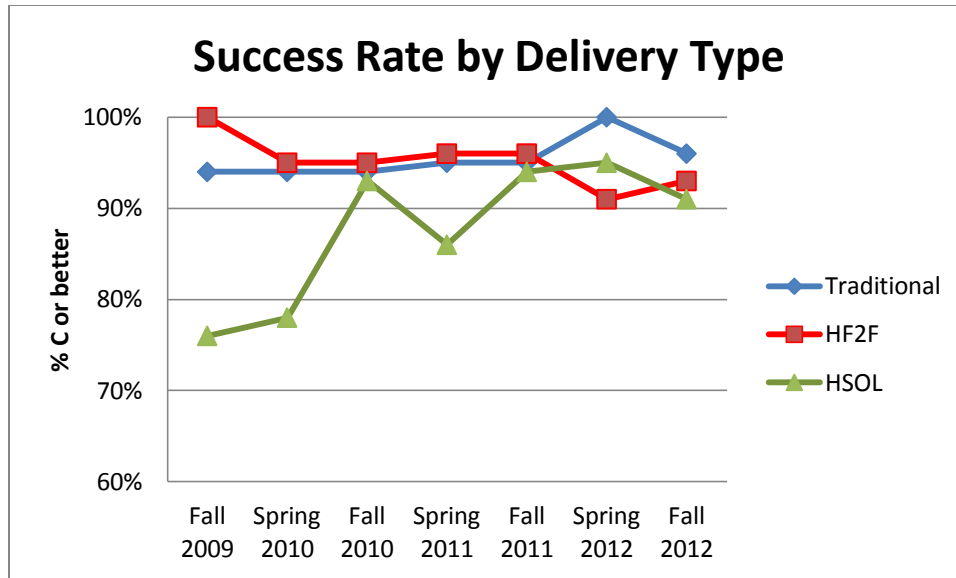
Figure 3: Comparison of Undergraduate IET Success Rates by Delivery Type.[17]

The results of the 2013 study are shown in Figure 3[17]. A grade of C or better was used as a measure of student success, since a C in all major courses is a requirement of the program. In three of the first four semesters, the success rate of HSOL students was lower than traditional or HF2F students. This difference was attributed to a learning curve, primarily for faculty, but also for students and the department. There was little difference in success between traditional and HF2F students. By the end of the implementation period, the difference in success rate between HF2F and HSOL students was less than three percentage points. At that point, only the two courses mentioned previously were offered in a traditional format.

2015 study update

In the 2013 study, student success (C or better) rate was the chosen performance measure. The difference of about three percentage points between online and hybrid students was deemed sufficiently small to continue the offerings. This follow up study analyzes data from six academic years, including those in the 2013 study. Additional measures and analysis have been added in an attempt to better understand the nature and the importance of any performance differences.

Table 1: Number of Course Sections by Delivery Type

Sections	Fall 2009-Spring 2012	Fall 2012 – Spring 2015	Totals
HF2F Sections	84	125	209
HSOL Sections	55	137	192
Traditional Sections	45	15	60
Totals	184	277	461

Table 1 demonstrates that the number of hybrid sections continued to grow and the number of traditional sections continued to shrink even after the initial implementation. There was some growth in total students (Table 2). Those taking HF2F and HSOL courses absorbed all of this increase. The number of students in traditional courses declined even more.

Table 2: Number of Students by Delivery Type

Students	Fall 2009-Spring 2012	Fall 2012 – Spring 2015	Totals
HF2F Sections	1677	2289	3966
HSOL Sections	489	989	1478
Traditional Sections	924	254	1178
Totals	3090	3532	6622

In this study, we extended the success rate measure for the additional three years of data (fall 2012 – spring 2015), and we performed statistical tests to see if the 3% difference between hybrid and online students is statistically significant. Because of the small number of traditional sections, they have not been included in the new success rate analysis. We also looked at course GPA by semester and delivery type for a more in depth analysis. The success rate by semester and delivery type was calculated for the three most recent years (Figure 4). The difference of about three percentage points has been fairly consistent over the last six semesters.
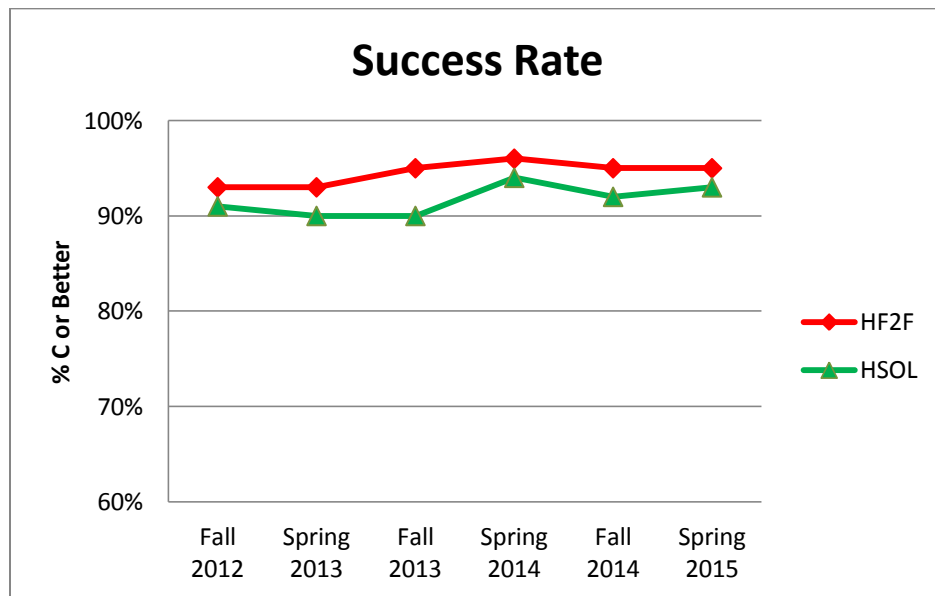
Figure 4: Student Success Rate by Semester and Delivery Type

A Chi-Square Test for Association was performed to test for statistical significance. Alpha was 0.05. The resulting P value was <0.001 indicating that the difference is statistically significant. The Percentage Profiles Chart (Figure 5), illustrates the three percentage point difference between the two delivery types. The question remains whether the magnitude of this difference is of practical significance.
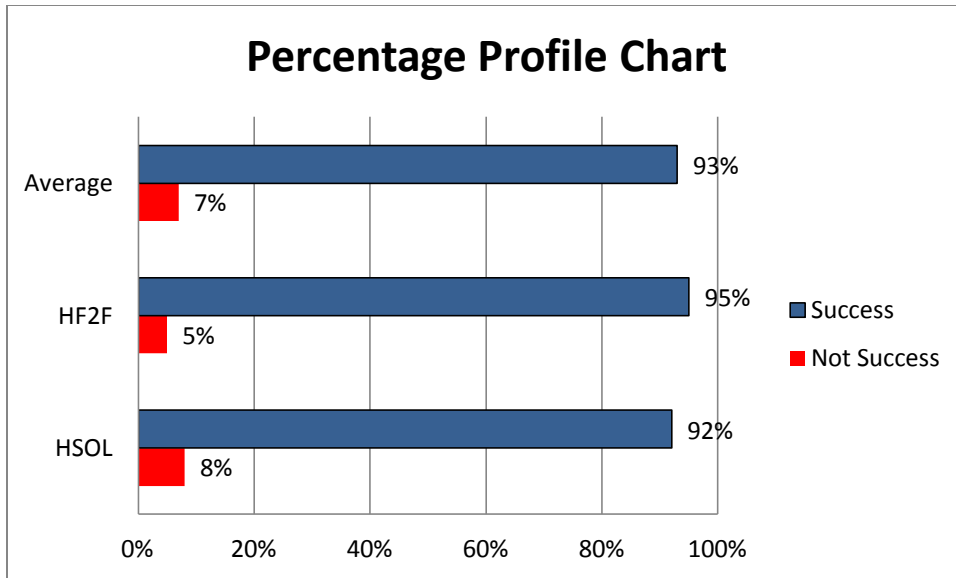
Figure 5: Percentage Profiles from Chi-Square Test for Association

Since the success rate was different, GPA was also examined. GPA was calculated for each course by delivery type. Each of these calculated averages is a data point within a given semester. The result was a sample size of 125 HF2F sections and 137 HSOL sections. Because this was not included in the earlier study, the first analysis includes all six years as shown in figure 6. There is a clear difference in GPA during most of the period covered in the initial study (fall 2009 – fall 2012), indicated by the vertical line in Figure 6. This confirms differences that were attributed to a learning curve. However, in the most recent six semesters, GPA for HF2F and HSOL courses appear to be very similar.
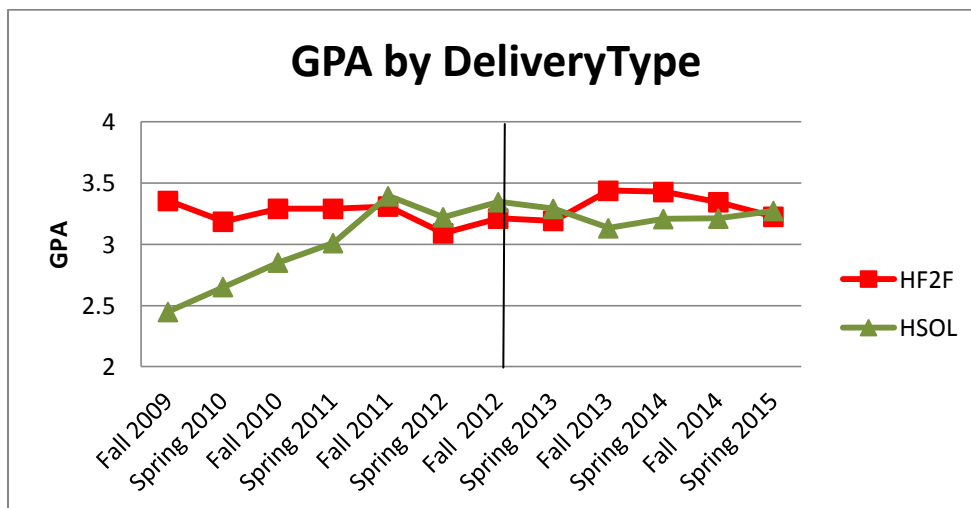

Figure 6: GPA by Semester and Delivery Type

A 2-Sample t Test for differences in mean GPA was performed for the data from the last six semesters using Alpha = 0.05. Mean GPA for the HF2F group was 3.3172, and the mean GPA for the HSOL group was 3.2306. But, the resulting P value of 0.127 indicates we were unable to

detect a statistically significant difference in mean GPA between HF2F and HSOL sections. However, histograms of the distributions for these two groups suggest some difference in the distribution of this data, as shown in Figure 7.
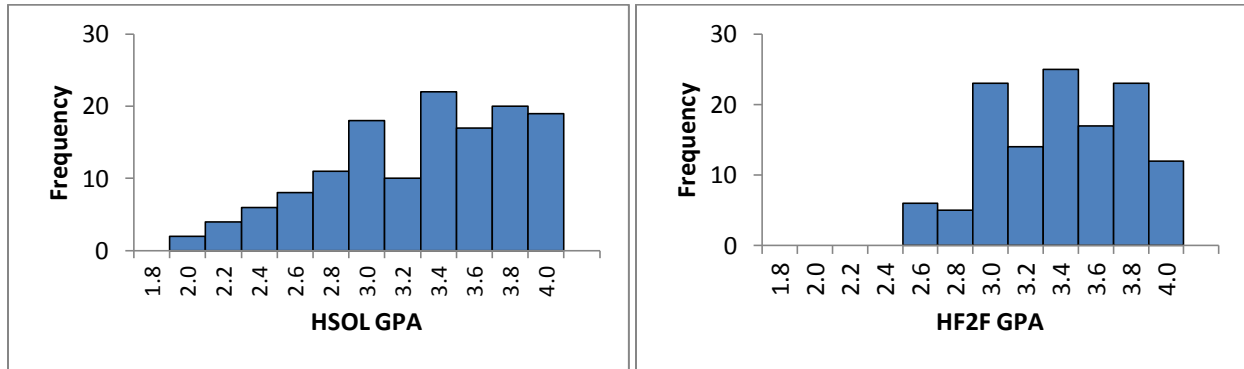

Figure 7: Distribution of Data GPA by Delivery Type

Because of this apparent difference, a 2-Sample Standard Deviation Test for GPA by Type was performed using a Bonett Test in Minitab software (Table 4). This test indicated that even though we were unable to detect a statistical difference in mean GPA between HF2F and HSOL courses, there appears to be a statistically significant difference in variation at alpha = 0.05. The test resulted in a P value of <0.001. Standard deviation of the HF2F data was 0.3767, and the standard deviation for the HSOL data was 0.5317. This suggests that although average performance is very similar, there appears to be a real difference in performance variation. This difference may have practical implications for us.

Table 4: Results of 2-Sample Standard Deviation Test for GPA by Type

	HF2F	HSOL
Sample Size	125	137
Mean	3.3172	3.2306
Standard Deviation	0.3767	0.53170
95% Confidence Intervals	(0.3427 0.4206)	(0.4810 0.5962)
P <0.001		

Given the difference in variation in course GPAs for the two methods of delivery, a more nuanced view of the grade distributions was desired. The distribution of grades was tested using a Chi-Square Test for Association (Table 5), using Alpha = 0.05. This test analyzed the distribution of each grade (A, B, C, D, and F) in both HF2F and HSOL course sections. As indicated in the previous test of variation, the percentage profiles for these grades differ by delivery type and the P value of 0.003 indicates that difference is statistically significant. On a practical level, although these differences are relatively small they are real, and further efforts to remove these remaining differences are probably warranted.

Table 5: Chi Square Test for Association Grades by Delivery Type

	HF2F		HSOL	
	Obs	Exp	Obs	Exp
A	1294	1282	542	554
B	632	612	244	264
C	240	251	119	108
D	58	64	34	28
F	65	80	50	35
Total	2289		989	

P=0.003 Expected counts should be at least 2 to ensure the validity
of the p-value for the test.

The percent difference between observed and expected counts in figure 8 demonstrates the differences more vividly. HF2F courses have more As and Bs than expected, fewer Cs, Ds, and Fs. HSOL courses show the opposite pattern; fewer As and Bs than expected, and more Cs, Ds, and Fs.
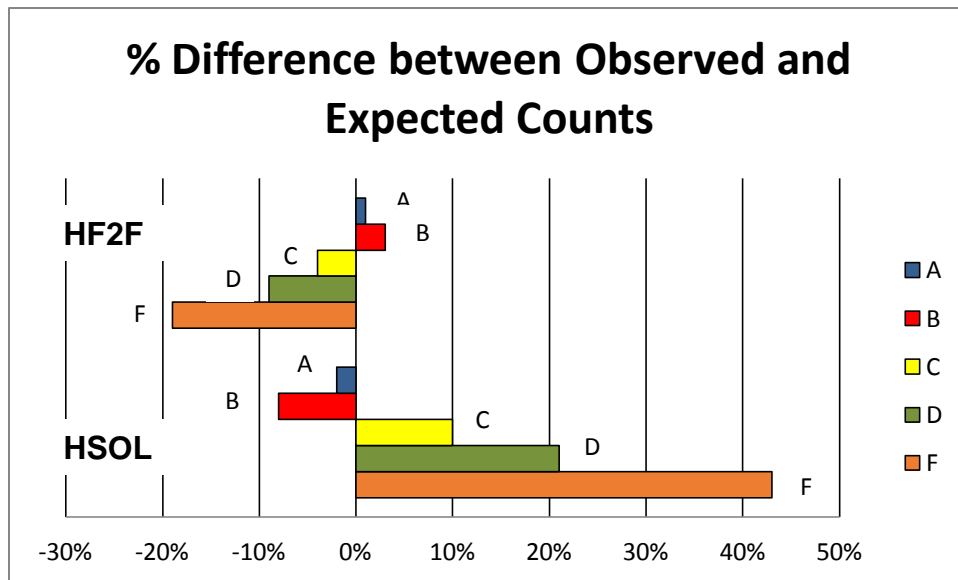

Figure 8: Chi-Square Test for Association: Grade Outcomes by Delivery Type.

We also attempted to examine graduation and retention rates before and after the implementation of Converged Courses. Unfortunately, traditional measures of graduation and retention offer little insight. These measures typically track a cohort of first time full time freshmen through their college careers. Our discipline attracts many non-traditional and part time students who would not be reflected in that data. Additionally, we have a much higher rate of transfers into the program than transfers out. As a result, our freshman cohort size is often around 20 students, while we may have 80 seniors, the majority of whom did not enter the program as first time full time students.

Conclusions

The difference in success rates between HF2F and HSOL courses is persistent and is statistically significant. Although this significance indicates that the difference is real and not random, the practical significance of the difference is another question. Clearly it is desirable to eliminate the difference. But, a slightly lower online success rate is preferable to not offering these courses online. Similarly, the difference in grade distributions is statistically significant. From a practical perspective, the net result is that some online students will have a slightly lower GPA. However for each letter grade, the difference is three percentage points or less. This is a real difference, and we need to continue to find the root causes. It is the opinion of the department that the benefits of this approach outweigh current differences. While these differences are undesirable, the Converged Course format allows many students to take courses that they would not otherwise be able to take. This finding of differences is consistent with previous research. Scherrer[7] found that students in a traditional setting did better on average than hybrid or online students, but on individual items such as homework assignments, the difference was not significant. Studies of student satisfaction scores found that students were pleased and adapted well to whatever format they chose.

Benefits and challenges

Much of this paper has focused on the relatively small difference in success rates and GPAs between HF2F and HSOL students. This is an important issue, and will continue to be a focus as we complete the study. However, there are also many benefits to both students and the institution from offering Converged Courses.

Benefits for students include:

- Increased flexibility.
- Students can self select the delivery method that best meets their needs.
- Recorded learning materials can be reviewed as needed.
- Live class meetings are archived for review or in case a student is unable to attend.
- The live sessions promote student interaction with faculty and peers for online students.

Benefits to the institution include:

- Combining HF2Fsections with HSOL sections results in larger more viable class sizes, lessening the chance of course cancellations.
- Consistency in content and delivery between HF2F and HSOL offerings.
- Better utilization of faculty workload.
- Reduced demand for classroom space.
- Aids in starting new programs or dealing with low enrollment programs.
- Reach a much larger student target market.

Interaction with peers and faculty has been shown to increase opportunities for students to actively participate, increasing motivation and providing positive reinforcement for learning [16]. HF2F and HSOL delivery are good tools for reaching all types of students, and may increase participation and attendance, help develop group identity, and provide more efficient instruction depending on the actual mix of online and face to face [17].

Challenges include an increased workload for faculty, at least initially, cultural and technical barriers, working in dual environments, and the need for student self-discipline [16].

Further Study

This is a study in progress. There are several avenues of further study planned. First, we intend to dig still deeper to find causes for the differences we have found. One way to do this is to look at results by course and delivery type to see if any courses are contributing disproportionally to the differences we see. We also plan to look at end of course student evaluations. One problem that we have encountered here is that a different instrument was used for online evaluations. We will create a cross walk and match questions in the survey where we can, to see if we can identify important differences there. We plan to continue to look at graduation and retention rates to see if we can get this data in a form that will be useful to us. For each course at the end of each semester, a faculty course assessment review (FCAR) is completed. Among other things, this document contains information about student success on specific course objectives. Differences in success on specific objectives may indicate areas for improvement. Finally, with all of these measures, we intend to perform root cause analysis to try to find the causes of the current performance difference with the objective of reducing or eliminating remaining differences.

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