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Structural Analysis of Courses as a Precursor to Moving them On-Line

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Abstract

In recent years, on-line courses have often been touted as the solution to all manner of academic problems. In many cases, the advocates are administrators with minimal teaching experience, especially when attempting to educate professionals. The sudden rise of Massive Open On-line Courses (MOOCs) a few years ago has been matched by an odd loss of interest, but the number of on-line courses is growing at regular colleges.

To move courses to distance learning mode, we need to look at all the components of each course. A course, as a unit within a discipline or program, can be considered to have nine components that need to be included when planning distance learning. Not all of these components apply to all courses, but consideration still needs to be given to all of them. Without making these components explicit, the course will be less successful.

Introduction

In the last 20 years, on-line courses have grown in number and enrollment. They have spread across education systems and institutions in a massive wave of change. In California in 2012, for example, the state's community colleges reported 11% of all enrollments, almost one million, were in on-line courses. Almost all of the enrollment increases in California's community colleges over the period 2002-2012 have occurred in on-line courses (Johnson and Mejia, 2014).

It is not surprising that on-line courses have become a go-to tool for increasing enrollments at a time when higher education enrollments are steady, rather than growing. Many education administrators see on-line courses as a solution to stagnant income from students and declining state support. Sending directives to move courses on-line is far easier than updating programs, funding better facilities, or dealing with promotion and recruitment.

The purpose of this paper is to provide some guidance for moving courses on-line. As programs in our discipline tend to prepare people for professional careers where there is a need for well-defined skills and a knowledge base, together with outcomes assessment for accreditation, there is a definite interest in the outcomes of on-line courses, combined with a need for ways to improve outcomes.

How Good are On-Line Courses?

The question that is rarely asked is: How good are the outcomes for students who take on-line courses? Johnson and Mejia (2014) reported on their analysis of outcomes, looking at both long-term and short-term outcomes, across a range of students. Their work was restricted to California community colleges, but that matches many of our students, especially in the first two years of a four-year degree program.

The first important statistic is pass rates. Students in face-to-face (F2F) courses passed 70.6% of the time, while those in on-line courses passed only 60.4% of the time, as shown in Figure 1. This rate has remained steady over a decade. The comparison was made between different sections of the same courses. The authors attempted to isolate causes, but this was not particularly helpful in trying to determine what might be driving this significant difference in student performance.

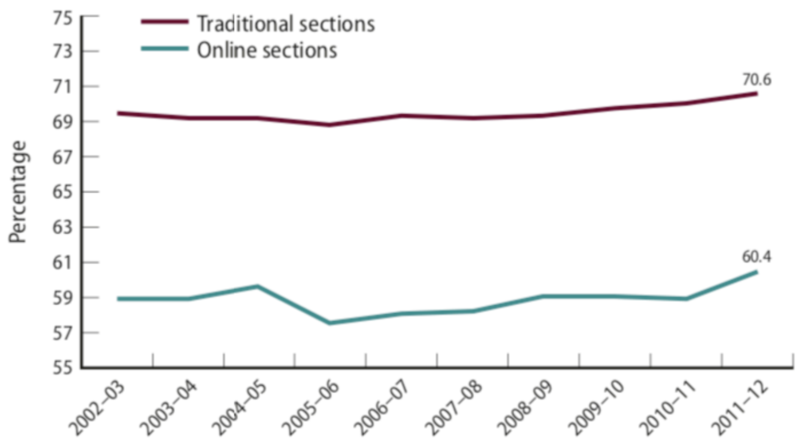

Figure 1 Student pass rates in F2F (Traditional) and On-line sections of the same course. (Johnson and Mejia, 2014, p. 7)

Different student populations performed differently. The gap in performance between F2F and on-line courses, i.e., the difference in pass rates between the two courses. According to Johnson and Mejia (2014, p. 9), "younger students, African-Americans, Latinos, males, students with lower levels of academic skill and part-time students are all likely to perform markedly worse in on-line courses than in traditional ones." So the performance gap is largest for Latino and African-American students (15.9 and 17.9 percentage points, respectively), while the performance gap for white and Asian students is 13.6 and 10.6 percentage points, respectively. There are also performance gaps present for male and younger students, as shown in Figure 2.

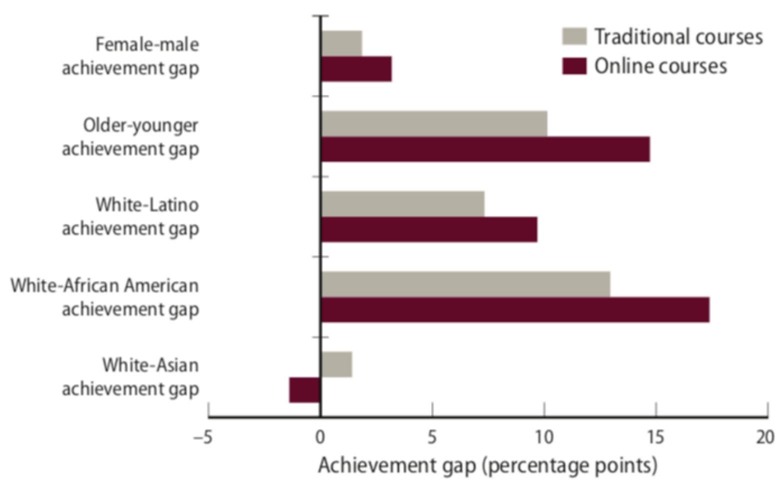

Figure 2 Achievement gaps are exacerbated in the on-line setting. Note that these data are based on the 2006 student cohort and are calculated based on regression models that control for differences in the student mix across terms, colleges and subject areas (Johnson and Mejia, 2014, p. 10).

There are major differences in the performance gap between disciplines. Some disciplines do rather better than average, such as health and the basic sciences, while engineering and industrial technologies (which is probably where surveying/geomatics would fall) had a performance gap of 19.1 percentage points, as shown in Figure 3.

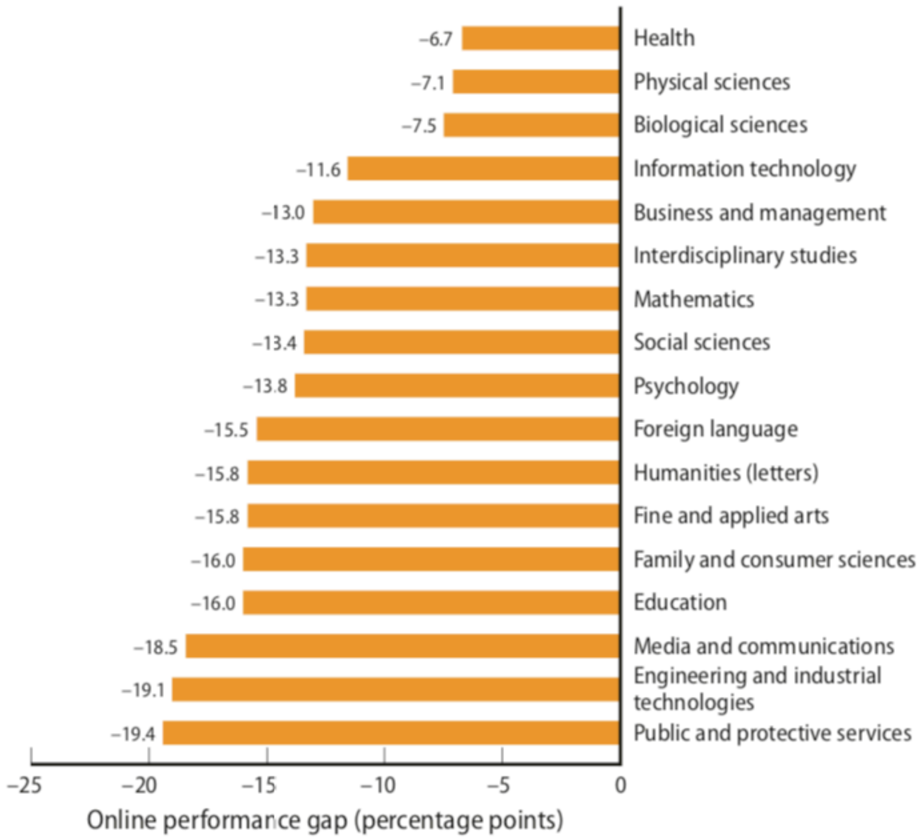

Figure 3 On-line performance gaps are wider in some subject areas. The data are from the 2006 student cohort (Johnson and Mejia, 2014, p. 10).

The short-term outcomes for students taking on-line courses appear to be significantly poorer for students across the board, but especially for minority and poorly-prepared students, and particularly in the engineering disciplines. This is an important consideration when deciding whether to move courses on-line.

The long-term outcomes, by contrast, were found to be somewhat different in Johnson and Mejia's (2016) study. They found that "students who take on-line classes tend to be more successful than those who enroll only in traditional courses." (Johnson and Mejia, 2016, p. 11) 'Long-term success' in this part of the study was defined as either transferring to a four-year college or earning an associate degree. They controlled for student demographic characteristics, student academic performance during their college career, and the fact that some community colleges have higher completion and transfer rates than others. They excluded students whose aim was just taking a few courses and used approximately 130,000 students from the 2006 cohort, one third of whom took at least one course on-line during the six years that the cohort was followed. The students were divided into those who took less than 30 credits, 30-60 credits and more than 60 credits of all courses (traditional and on-line). The probability of successful completion or transfer was plotted against the proportion of credits taken on-line, as shown in Figure 4.

Among students who took fewer than 30 credits, 13.6% took at least one on-line course; among those who took 30 to 60 credits, 35.2% took an on-line course, while among those who took more than 60 credits, 53.9% took at least one on-line course.

Naturally, the more credits that a student took, the greater the probability of long-term success. About 38% of students in the cohort completed at least 60 credits, and for these students on-line course taking is strongly associated with improved long-term success. Using semester credits, 60 is sufficient for an associate degree.

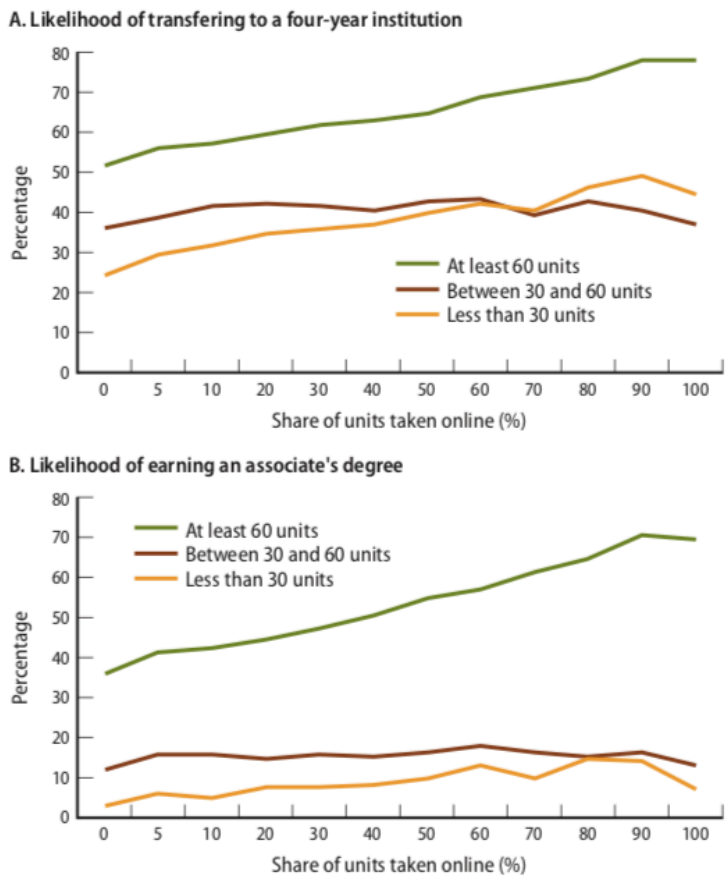

Figure 4 Long-term outcomes are better for students who take on-line courses. The effect is pronounced for those taking the most credits (>60) but is still present for those taking fewer credits (<30). Students in the middle group saw little change in outcomes compared to proportion of on-line courses taken. (Johnson and Mejia, 2014, p. 12).

While it appears that there are significant benefits from on-line courses helping students succeed, correlation does not equal causation. Johnson and Mejia (2014, p. 12, 15) note that they were unable to control for self-selection bias, such as students with greater motivation choosing on-line courses (a double-blind study is not possible in this situation). The convenience of on-line courses, allowing students to work and study in their own time, and to complete coursework on-line when it was not offered in F2F mode at a convenient time, can help expedite completion or transfer.

The interesting differences between short-term and long-term outcomes for on-line courses suggest that the current form of on-line learning may not be ideal, especially the serious performance gap for courses in engineering and related subjects. This suggests we need to re-think how we approach on-line courses.

Economics, Education and Course Development

As almost all geomatics programs in the US are in state colleges and university, they are very susceptible to fluctuations in state government funding. The last quarter-century has seen an overall reduction in funding to state institutions of high education in the US. Sometimes this is tied to changes in the economy and fluctuations in the state's overall income. Sometimes, as in the case of the 41% cut to the University of Alaska in the current state budget, it's a matter of political will desiring to reduce higher education in the state. As geomatics programs tend to be expensive to set up, operate and maintain, there is pressure to find ways to economize.

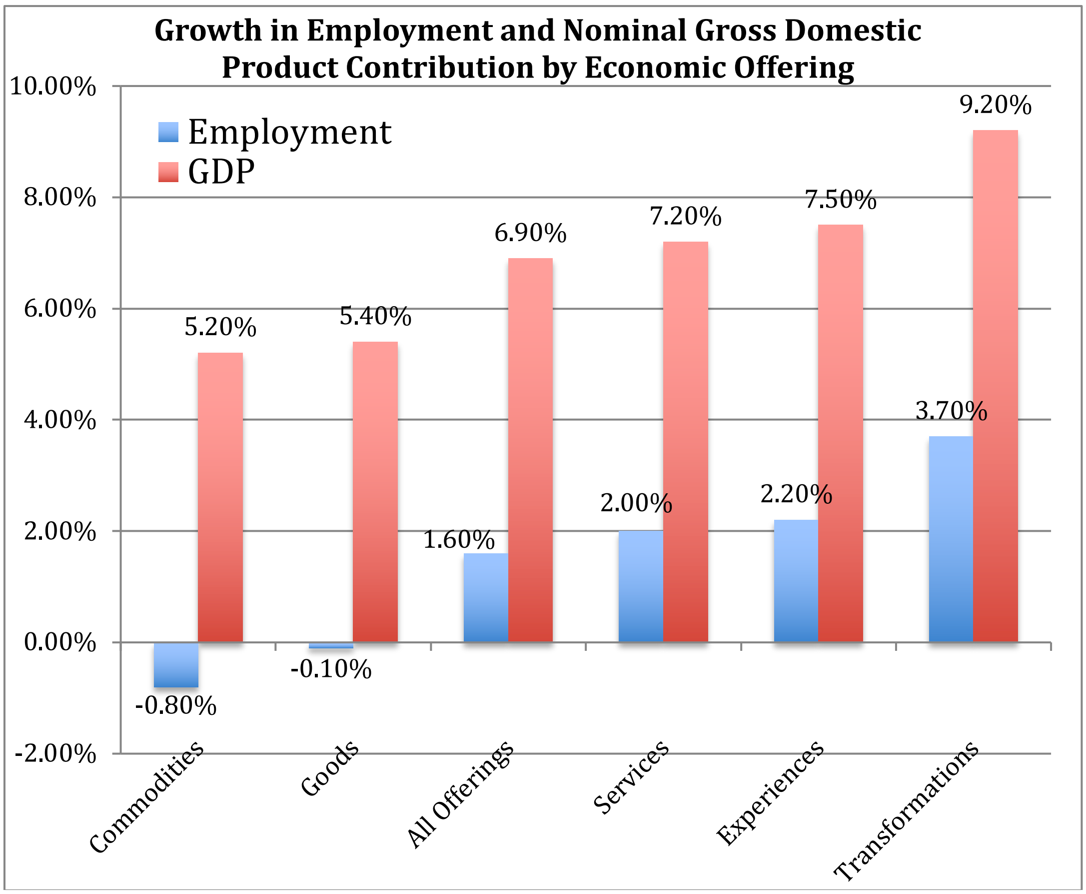

Figure 5 Changes in Employment Levels and Contributions to the Nominal Gross Domestic Product (GDP) by Economic Offering, for the 50-year period 1959 to 2009. The offerings can be approximately equated to different sectors of the economy. 'Commodities' is primary industry: farming, fishing and mining. 'Goods' is secondary industry: manufacturing. The information sector is not necessarily represented here. (Compiled using data from: US Bureau of Economic Analysis; Strategic Horizons LLP; and Lee. S Kaplan, Lee3Consultants.com analysis. Pine and Gilmore, 2011.)

However, there are major changes in the national economy that have crept up on people. Many people have assumed that the US economy is built on mining, farming or manufacturing, but this is not the case. The total share of GDP coming from agriculture, mining, fisheries, forestry, mining and other primary production, combined with all manufacturing (the secondary sector), is about 16%. By comparison, healthcare in the US is also about 16% of GDP.

At the same time, the profitability of the primary and secondary sectors of the economy are declining, as they become commodities (manufactured goods are becoming commodities). Figure 5 shows that these two sectors (Commodities and Goods) are growing more slowly than the economy as a whole, and employment is falling in these areas.

The biggest growth area in the US economy is in 'Transformations,' which is where people pay for a major change in their lives. This includes medicine and education. It seems a little unwise to try to restrict the area of the economy which is, and has been, growing the fastest. However, the changes in the economy and society have also led to a need for changes in education. Education needs to be more flexible to allow for different needs, while still fulfilling the requirement to provide the necessary education for professionals.

"We are, in fact, living more and more in an intangible economy, in which the greatest sources of wealth are not physical. We aren't yet used to an economy in which beauty, amusement, attention, learning, pleasure, even spiritual fulfillment are as real and economically valuable as steel or semiconductors … Increasingly, people aren't just buying goods and services. They're buying experiences." (Postrel, 1996, p. 118). The sources of wealth in these new sectors of the economy are not physical, but intellectual.

The growth in the profitability of education has led a number of for-profit organizations to enter the field, with outcomes that have been unfortunate for those involved on occasion. But the interest in trying different ways to exploit the intellectual sources of wealth is widespread. The question is which methods are successful and productive, but traditional educational institutions have too much invested in the existing systems to be interested in major innovation. Small-scale efforts that may end up being highly successful, but these are not able to return sufficient income to allow them to be developed within traditional institutions. This is the Innovator's Dilemma, and if allowed to play out in the more common way, tends to lead to the disappearance of the more traditional institutions as the innovators overtake them (Christensen, 1997). This means that it is difficult for real innovation in education to come from the traditional educational institutions, especially as there is a decline in interest in funding higher education in the US.

While there are many changes likely to appear, such as very different approaches to education, credentials, learning processes and structures, the traditional educational institutions are unlikely to be the major players. We will be playing catch-up to innovation elsewhere, or perhaps just providing the most specialized levels of education or the unprofitable bits. But this should not prevent us from considering where education can develop, or trying to serve our stakeholders better. In this environment of uncertainty (and perhaps also impending doom!) we can try some small changes and test them out. Within the surveying discipline, we have had limited success in private education ventures, but that may be because we have not yet found a suitable methodology, and we are still wedded to existing ideas and approaches.

On-line courses are one way to broaden the appeal, and fit well with the current explosion of on-line education tools spreading through the training and transformation markets. Webinars are everywhere, offering all manner of topics. You can always a find a YouTube video that explains how to do something you need to do.

At the same time, MIT, Stanford and other top-rank universities are giving away course content on-line, which suggests that the value of their degrees is something other than that content. What is the component that is missing in the on-line classes they release? The following discussion attempts to tease this out of courses, so that we can make it explicit. Consideration of the issue suggests that there are nine general components of a college-level course. These were outlined in Hazelton (2015), and a more detailed discussion of each component is included here to assist in course analysis for on-line course design and development.

Breaking Down a Course

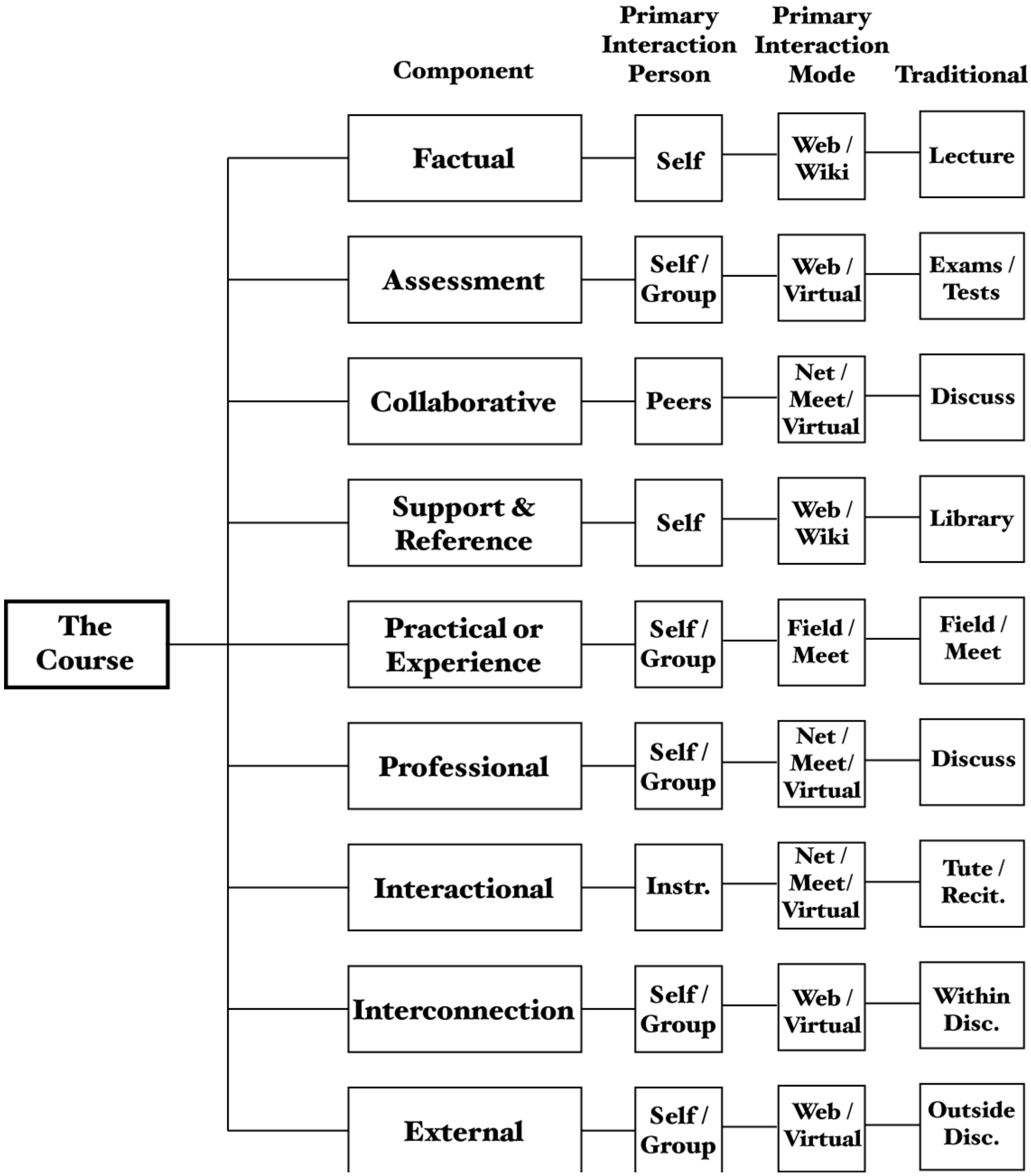

Figure 6 The Nine Components of a Course. Each of these components needs to be dealt with for each course, although not all will apply and they are not equally weighted, and they need to be interconnected within the course. For each component, the primary interaction person can be Self (the student), their Peers, a work Group, or the Instructor. The primary interaction mode for a virtual course can be via a Web-based system, through a Virtual reality connection, physical Meetings, Fieldwork, or with a Wiki or other repository. The primary interaction mode for the same components in traditionally-delivered courses is given for comparison, covering Lecture, Exams and Tests, Discussion, Library, Fieldwork, Meetings, Tutorial or Recitation sessions, or connections Within or Outside the Discipline area.

To move courses to distance learning mode, we need to look at all the components of each course. Basically, a course, as a unit within a discipline or program, has nine components that need to be considered for planning distance learning. These are shown in Figure 6. Not all of these components apply to all courses, but consideration still needs to be given to them, to ensure they aren't needed.

The External Component is how the course relates to the outside world, beyond the program. This needs to be made explicit, and will be part of the feedback loop for ABET, etc.

The Interconnection Component is how the course connects to other courses within the discipline or the program. This may be by prerequisites, but also by explicit links to previous or concurrent material.

The Support and Reference Component is the equivalent of the textbook, providing the library resources for the student. Part of this will come from on-line text, as well as wikis and similar on-line resources. Other parts remain in print, e.g., everything before about 1993.

The Assessment Component can be as fine-grained as needed and includes assessment of both the students and the course.

The Factual Component is the core material in the course, which can be conveyed by canned material: notes, videos, podcasts, etc. This is largely factual or core theory and tends to last for long periods of time. This is the component that on-line courses can do well.

The Collaborative Component is the discussion between the students, as well as that between the students and those outside the course (e.g., other students). This is where students help each other learn and teach each other, as well as share what they have learned and reinforce it. It also helps build a community of learners around the discipline.

The Interactional Component is the interaction between the student and the instructor. This can be face-to-face or via intermediary virtual tools. But this interaction is critical and goes beyond what is in the Factual Component.

The Practical / Work Experience Component is where the students get to practice what they have learned in exercises that reinforce the theory and instruction. This may be in more extended projects, or in small contained labs.

Each course needs to have each of these components made explicit and developed. If this isn't done, the course will be less than successful.

What can be seen from this model is that there is a strong interactional component required for courses. The factual component is well suited for on-line delivery, but there is a strong need for real people who can interact with students. By focusing faculty attention on this aspect of the course, while moving the factual part of the course on-line, faculty can offer more courses without adding to their workload. This allows greater diversity of course material, as well as the ability to offer electives. This will take advantage of the strengths of the faculty, while not spending time on teaching factual material.

It is also well-established that the more the faculty connect with the students, and the less that they lecture, the more the students learn. Rather than spending time lecturing, it is far more important that faculty get involved with getting students involved. The more involved students are, the more they understand. But until AI improves considerably, involvement needs a real person. This is the role of the faculty, and it is how faculty must attract students to their programs, by how they involve students in the discipline.

As Confucius pointed out a mere 2.5 millennia ago:

> "Tell me, and I'll forget.
> Show me, and I'll remember.
> Involve me, and I'll understand."

But improved involvement is only one reason for changing the models we are using. We are in the middle of changing economic systems, and with those economic changes will come major social changes, as well as changes in work and what geoscience/geospatial/geomatics/surveying people do. Universities will also change, in what they do, as well as how they do it. Unfortunately, one of the ways that they can change is by being destructive before they are creative, cutting costs before increasing income. This is a challenge for small programs.

The Cost of Course Development

When a faculty member is asked to prepare a new course, it is most commonly cost-free to the institution. Faculty are usually salaried, so any extra time spent on any activity appears to be at no real cost to the institution. Of course, there is the time that cannot be devoted to other activities, but that is a different issue. Because there are limited incentives to create new courses, faculty tend to do a 'good enough' job on development, but rarely include additional bits such as professionally-created video. Using Camtasia and PowerPoint to create a lecture on-line is a common approach. F2F courses can be created on-the-fly by someone who has taught similar material before, if necessary. The old saw of being two pages ahead of the students in the textbook is the worst-case scenario here.

But if a professional training company were to be engaged to produce computer-based materials for a regular college course, at their regular rates, what would be the cost? One of the authors explored this with just such a company some years ago, before on-line courses were a big thing, but computer-based training was becoming very common. A realistic price was about $200,000 per credit hour, if a credit hour was around 15 class contact hours. Such a course was more than just a lecture on-line, or a webinar, but was a comprehensive training regime that was carefully researched, planned and executed, and required significant interaction by the student.

How does that compare to the equivalent process within a university? About 20 years ago, The Ohio State University undertook a complete re-write of its freshman physics sequence. This created hands-on classes with plenty of activities, minimal lecturing and strong student support. The resulting courses improved student outcomes significantly, which was an important part of recreating the freshmen engineering sequence. The Physics Department's effort's main cost was the hiring of a specialist full professor of physics education and two support professionals. A simple accounting of the overall cost of this recreation process came out to about $200,000 per credit hour.

While this information is anecdotal, it does indicate that creating innovative and effective coursework is time-consuming and very expensive. Most of the on-line course development that we do, by contrast, is quick and cheap. This cannot help but lower the quality of what we produce, together with student outcomes. It is not unreasonable to assume that the courses discussed by Johnson and Mejia (2014) were of the quick and cheap variety, rather than the '$200k per credit hour' variety, which may have contributed to some of the short-term problems these courses faced. Massive Open On-line Courses (MOOCs) often have extremely low completion rates, but they tend to be much more the 'quick and cheap' variety of presentation. Many of the webinars flooding the commercial sector of the education market are similarly 'quick and cheap' presentations, where the worst aspects of a lecture are provided, with none of the advantages of interaction and collaboration present.

As a means of improving the way we develop on-line courses, the nine-component analysis is offered as a tool for course design and planning. It is simple to make into a check sheet that allows each area to be explored during design and summaries created as a guide to implementation of the course.

Conclusions

Success rates in individual on-line courses are significantly lower than for equivalent F2F courses, even when a number of potentially biasing factors are controlled for. This performance gap is even more pronounced with engineering and technology courses, reaching 19.1% (Johnson and Mejia, 2014). While on-line courses do not appear to cause a lessened rate of graduation in a program, they may not have a positive effect on student retention, especially in surveying and geomatics courses.

As education changes rapidly, with new technology allowing new educational models to be offered, our approach to on-line courses (usually pushed by administrators for economic, rather than pedagogic, reasons) may not be serving our programs and the profession very well. On-line courses are often touted as 'the answer,' but we may not have determined the right question. This can lead to awkward outcomes (for example, '42'; see Adams, 1979, p. 136).

Meanwhile, education is one area of the economy that is growing and becoming more profitable. There is growing competition in this sector and new educational models are appearing. We, as a group of education professionals in the geospatial field, face some very serious challenges. Producing on-line courses that are significantly less effective than our F2F courses, and retain a pedagogical structure unsuited to the on-line medium, is not a recipe for success. The nine-component analysis model presented here is a small step in the direction of improving materials, as well as helping us rethink how we educate future generations of geospatial professionals.

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