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Information Systems Education Journal

A Tale of Two Curricula: The Case for Pre-requisites in the IS Model Curriculum

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Abstract

The most recent Information Systems (IS) Model Curriculum recommendations is IS2010. While the goal of this revision was to update the curriculum from IS2002, the end result was a change in curriculum design philosophy whereby a pre-requisite structure that fostered increasing depth of knowledge was flattened to make the curriculum easier to traverse for the student. At the same time, the number of core courses was reduced from ten to seven by either combining subject matter or eliminating content. This paper examines the usefulness of having perquisites to increase the student's "depth of knowledge" and explores how to analyze the need for those pre-requisites. The data show that five years after the release of IS2010, ABET accredited IS Programs in business schools seem to be embracing the underlying philosophy of IS2010. On the other hand, ABET accredited IS Programs outside business schools continue to embrace the curriculum design philosophy of IS2002. The IS community is now at a critical juncture due to these two differing curriculum design philosophies, both in terms of curriculum content and assessment methods.

Keywords: Model Curriculum, Pre-requisites, IS2010, IS2002

1. INTRODUCTION

Many papers have been written on the subject of curriculum design in Information Systems, including the use of course pre-requisites. While these papers have discussed and suggested using course pre-requisites, none have really addressed the underlying rationale for having pre-requisites.

> One of the most prevalent problems in course and curriculum design is the tendency of faculty to make false assumptions about the knowledge and skills that students bring to their courses. These incorrect assumptions lead to failure for the students who are ill prepared, boredom for their classmates who are often more than adequately prepared, and frustration for the faculty (Diamond, 2008).

In the Information Systems (IS) discipline, the need for this type of discussion is clearly seen in a side-by-side comparison of the course architecture in the current IS2010 Model Curriculum shown in Figure 1, which illustrates a flattened curriculum structure (Topi, Valacich, Kaiser, Nunamaker, Jr., Sipior, de Vreede, G. & Wright, R., 2010), herein after referred to as IS2010.This is compared to its predecessor IS2002 shown in Figure 2 (Gorgone, Davis, Valacich, Topi, Feinstein, & Longenecker, Jr., 2002), herein after referred to as IS2002, which illustrates a more hierarchical curriculum structure.

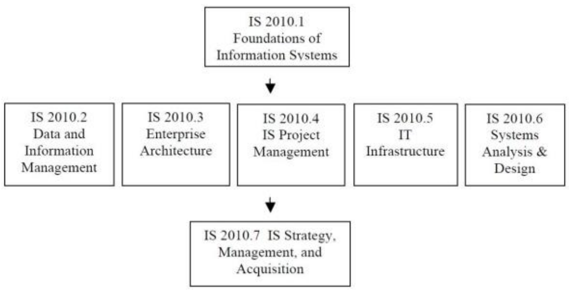

Figure 1 – IS2010 Structure

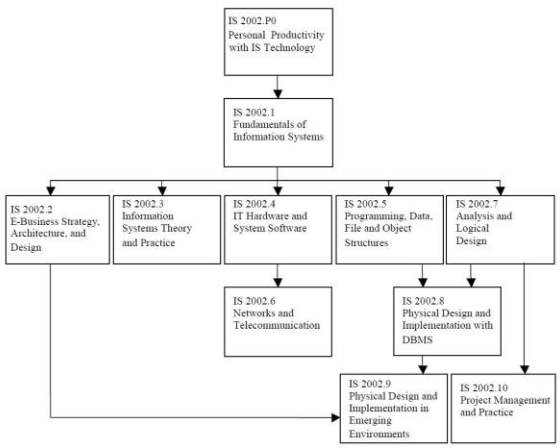

Figure 2 – IS2002 Structure

Bloom's Taxonomy and it's adaption in the IS Model Curriculum shows how pre-requisites play an important role in defining "depth of knowledge" throughout the curriculum models. This paper then compares the required courses of ABET accredited IS Programs in business schools with those ABET accredited IS Programs outside business schools for both their pre-requisite structure and overall content.

2. PRE-REQUISITES AND DEPTH OF KNOWLEDGE

One paper defined a pre-requisite as "the skills and information necessary to succeed in a given instructional unit within a curriculum." (Young, 2011). Regarding programming courses, Walker (2010) notes that "upper-level courses commonly expect students to have mastered the basics of programming at the beginning level." A typical pre-requisite, referred to by some as a direct pre-requisite, takes the form of requiring a class (or set of classes) prior to taking a course. Direct pre-requisites typically target specific skills that are needed (or believed to be needed) for the advancement into the next course. For example, the pre-requisite for a Database II course would be a Database I course.

Inherent Challenges

This section examines the problems that pre-requisites cause institutions, curriculum developers, and students. From a student's perspective, any pre-requisite could cause a delay in graduation and in some cases, a significant delay, depending on the availability of the particular course. If a course is offered only in one term and its pre-requisite is only offered in the preceding term and is full, a student's graduation could be delayed an entire year.

For curriculum developers, pre-requisites that are inserted into a model curriculum could cause institutions not to adopt the model curriculum. In other words, the ability, in terms of cost and resources for an institution to adopt a model curriculum that has a significant pre-requisite structure would be higher than to adopt a model curriculum with a flattened (minimal) pre-requisite structure. Higher costs are incurred when scheduling for faculty and rooms is more difficult since courses must be offered to allow students to complete the sequences in a timely manner. Students, too, are burdened with more complicated schedules and potentially longer times to graduate due to full/conflicting class schedules, thereby potentially resulting in lower student enrollment. Simply put, having a significant pre-requisite structure in your model curriculum causes roadblocks for students, institutions and curriculum developers, but what is the cost to the student's education and career success?

Bloom's Taxonomy in the Model Curricula

A pre-requisite is determined to be useful for a course if that pre-requisite gives the course the ability to have the student reach a higher level of ability on Bloom's taxonomy as modified and articulated in the Appendix 3 of IS2010 (see Table 1) and referred to as a Depth of Knowledge Metric (DKM). For example, a pre-requisite of a Database I course for a Database II course would be useful if and only if Database I is required to allow a student in Database II to reach a higher level in the DKM. Otherwise, the course (i.e., Database I) does not meet the definition of useful and may not be a wise use of a pre-requisite. The following section shows how different pre-requisites structures, i.e. having or not having a significant pre-requisite structure, affect a student's ability to reach higher levels knowledge.

3. STRUCTURE OF IS2002 VS IS2010

Referring to Figures 1 and 2 above, the IS2002 Model Curriculum has three significant two-course pre-requisite sequences that do not appear in IS 2010: Hardware/Software (HW/SW) to Networking, Programming to Database, and Systems Analysis and Design (SAD) to Project Management. In the case of the first sequence, not only isn't the pre-requisite required for Networking, IS2010 combines HW/SW and Networking into one course.

To validate the sequences described above in IS2002 and following the overall methodology suggested by Vuong, Nixon, and Towle (2011), a further analysis of the Programming to Database sequence shows that the course labeled IS 2002.8 – "Physical Design and Implementation with DBMS" has a pre-requisite of IS 2002.5 – "Programming, Data, File and Object Structures". The description of IS2002.8 states

> Students will demonstrate their mastery of the design process *acquired in earlier courses* by designing and constructing a physical system using database software to implement the logical design.

Based on this description there is a clear requirement of comprehension (level 2 in the DKM) because the phrase "acquired in earlier courses." In this case the course IS2002.5 (Programming, Data, File and Object Structure) is where the students would have acquired that knowledge. The description of IS2002.5 states

> Students will gain in-depth understanding of defining and measuring events that produce data, both simple and complex, and principles, concepts, and practices of successful software development.

The description of this course uses terms that are taken directly from the DKM indicating a Level 1 depth of knowledge. Given the definition above, the pre-requisite of IS2002.5 is useful for IS2002.8 because the student moves to a higher level in the DKM, and without this pre-requisite the student would not reach that higher level.

While these three two-course sequences are the primary focus of this study, a further analysis of the two model curricula in their entirety also supports the proposition that each follows a different curriculum design philosophy, particularly as it relates to pre-requisites in the core.

To reach IS2002.9 a student will have to take the following sequence first: IS2002.0, IS2002.1, IS2002.5 and IS2002.8. The benefit of this long sequence of classes is that students, after completing IS2002.9, reach Level 3 (Application) in the DKM. This high level could not have been reached without pre-requisites and hence the pre-requisites are useful.

In contrast, analysis of the IS2010 model curriculum shows a more flattened structure. Even though senior standing might be assumed, to reach IS2010.7 (the capstone course), according to the curriculum model, a student only has to take in sequence IS2010.1 and IS2010.4. Based on the same analysis of their use of terms from the DKM in their course descriptions, both of these courses, IS2010.1 and IS2010.4, give students knowledge (Level 1) and hence satisfy the definition of usefulness above. However, by that same standard students only reach level 2 (comprehension) in the DKM.

This minimal set of pre-requisites allows students some flexibility in scheduling of courses and allows students an easier time to fit in all of their classes before graduation. In addition, this minimal set may even help cut cost for the institution. However, students will reach a higher level in the DKM when useful pre-requisites are utilized. Other institutions have come to this same realization with both research and teaching experience indicating that a lack of ongoing integration between courses creates a learning barrier. If a subsequent course's concepts do not begin where preceding ones end, "students lose sight of the overall goal of the curriculum" (McGann, Frost, Matta, & Huang, 2007).

4. COMPARING ACCREDITED IS PROGRAMs

Since the publication of IS 2010, several journal articles have collected data from IS programs to evaluate those programs against the IS 2010 Model Curriculum. One article noted the need for updating programs to the current Model Curriculum (Apigian and Gambill, 2010), another demonstrated a very detailed research design to classify and evaluate programs (Mills, Velasquez,

& Fadel, 2012), and another sought to analyze the adoption rate of the new model curriculum (Bell, Mills, & Fadel, 2013). Unfortunately, none of these sought information from any IS programs that reside in academic units outside business schools.

The purpose of this study is to evaluate IS programs by matching their curriculum structure to the curriculum design philosophy of either IS2002 or IS2010. The authors chose ABET accredited IS programs with the understanding those programs ostensibly share a common baseline, while at the same time including programs outside of business schools with those in business schools, since ABET accreditation is complimentary to AACSB accreditation (Hilton and Lo, 2007).

The programs were then divided into two groups: those programs that were housed in a business school and those programs that were outside a business school. There are 15 institutions in the first group and 24 institutions in the later (see Appendix A). One institution had a combined undergrad/grad program and was excluded from the sample.

For each program, the core curriculum requirements of the IS program were evaluated to see if any of the three two-course pre-requisite sequences noted above (see Section 3) existed; hence, the following hypotheses were generated.

1) Does the first Networking course have a pre-requisite Hardware/Software (HW/SW) course?

H_1: Information Systems Programs outside business school will be different in the percentage that have a Hardware/Software (HW/SW) course as a pre-requisite to a first Networking course.

2) Does the first Database course have a pre-requisite Programming course?

H_2: Information Systems Programs outside of a business school will be different in the percentage that have a Programming course as a pre-requisite to a first Database course.

3) Does the first Project Management course have a pre-requisite Systems Analysis and Design course?

H_3: Information Systems Programs outside of a business school will be different in the percentage that have a Systems Analysis and Design course as a pre-requisite to the first Project Management course?

One might argue that it is difficult to have a course as a pre-requisite if the course is not part of the required courses in the IS program, which naturally leads to a further set of hypotheses regarding only the courses that are not in both model curricula. For the sake of brevity, they are combined into one question and subsequent separate hypotheses:

4) Are any of the individual courses in the previous hypotheses (HW/SW, Networking, and Programming) part of the required courses?

H_4: Information Systems Programs outside business school will be different in the percentage that require a HW/SW course.

H_5: Information Systems Programs outside business school will be different in the percentage that require a Networking course.

H_6: Information Systems Programs outside business school will be different in the percentage that require a Programming course.

Statistical Methodology

For each of the three hypotheses, the null hypothesis will be accepted or rejected using the significance level of .05. To compare two independent groups based on binary variables, most statistics guidelines suggest using the chi-square test of independence as long as the sample sizes are large enough. Sauro and Lewis (2008) contend, however, that the "latest research suggests that a slight adjustment to the standard chi-square test, and equivalently to the two-proportion test, generates the best results for almost all sample sizes" (p. 75).

To determine whether a sample size is adequate for the chi-square test, calculate the expected cell counts in the 2x2 table to determine if they are greater than 5. When the values in this study met this test, the chi-square test results were used. When the values of one or the other of the subgroups did not meet this test, the N-1 chi-square test was used. The formula for the N-1 chi-square test (Sauro and Lewis, 2008) is shown in the next equation using the standard terminology from the 2x2 table:

$$\chi^2 = \frac{(ad - bc)^2(N-1)}{mnrs}$$

When the values for both groups in the study failed to meet the threshold, the more conservative Fisher Exact Test was used. The formula for this test is also given by Sauro and Lewis:

$$\rho = \frac{m!\,n!\,r!\,s!}{a!\,b!\,c!\,d!\,N!}$$

Test Results

Hypotheses are supported when the null hypothesis is rejected. In this study, the null hypothesis is rejected when there is a statistically significant difference between the proportions represented by $p<.05$. Accordingly, the first hypothesis (H_1) is supported since there is a significant difference between the 7% of Business School IS Programs and the 42% of IS Programs outside a business school that require a Hardware/Software course as a pre-requisite to a first Networking course. The second hypothesis (H_2) is also supported since there is a significant difference between the 53% of Business School IS Programs and the 88% of IS Programs outside a business school that require a programming course as a pre-requisite to a first Database course. Although the programs outside of business schools had a higher percentage requiring a pre-requisite of an analysis and design course, the third hypothesis (H_3) is rejected since there is no significant difference. Chart 1.0 shows the comparison of the proportions for these three course pre-requisite sequences.

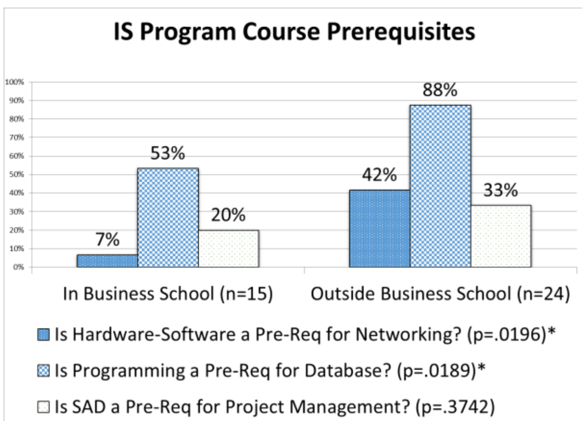

Chart 1.0 – Course Pre-requisites

The fourth hypothesis (H_4) is accepted as there is a significant difference between the 7% of IS Programs in business schools and the 58% of IS Programs outside business schools that require a HW/SW course. H_5 and H_6 are rejected. It is worth noting that significant statistical differences remain the same between the two groups for H_1, and H_2, even when the data from the individual course results are factored in as dependent variables.

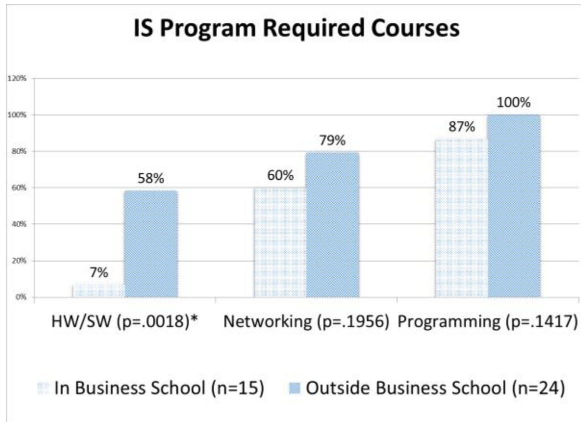

Chart 2.0 Required Courses

Of those IS programs that are in a business school and did not offer a HW/SW class, 6 have created the IT Infrastructure course proposed in IS2010 that essentially combines what IS 2002 called HW/SW and Networking into one class. Two of the IS programs outside of a business school have also created an IT Infrastructure course.

Database is listed in both model curricula as a required core course, and only one school out of all the schools in the study does not require a Database course (one school combines Database and Networking). In contrast, Project Management is listed as a core course in both model curricula, but only 53% of all the schools in the study require this class in the core. Even among those programs, there is little agreement on what should be the pre-requisite – there are as many that require database as those who require SAD and several programs require both.

Lastly, it is worth noting over 25% of the business schools in this study are AACSB accredited – one does not mention any special accreditation and three are accredited by the ACBSP.

5. CONCLUSIONS

The curriculum design philosophy of the pre-requisite structure is significantly different between the IS2002 and IS2010 model curricula. A student graduating from an institution that models their program after IS2002 will, by design, have a greater depth of knowledge in specified knowledge areas where there is a prescribed pre-requisite structure compared to a student graduating from an institution that model their program after IS2010.

The rejection of H_1 and H_2 show a propensity of business school IS programs toward adopting a flatter pre-requisite structure and the rejection of H_4 shows a trend toward fewer technical core courses, thereby implying agreement with the IS2010 philosophy. On the other hand, IS programs outside business schools have shown a desire to continue with the IS2002 philosophy, both in the pre-requisite structure and inclusion of technical core courses. While many of the business schools would argue that they do make these courses available as electives, this study was focused only on the required courses of every student that graduates from a program.

The data show that the IS community is now at a critical juncture. Previous efforts at a unification of the differences in the IS community have apparently failed, as this was the stated goal of the IS2010 authors, yet the data suggest that this unity is a myth. This paper shows the validity of the efforts of some in the IS community to develop a sister model curriculum (Waguespack, ISECON 2014), acknowledging the fact that there are two different IS program philosophies and goals.

In the end, neither philosophy is better or worse than the other, but these differences will eventually affect program identities and assessment. It would be disingenuous for one program to be classified and/or evaluated by the standards of the other, therefore these differences must eventually be acknowledged in future accreditation and assessment standards.

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Knowledge Levels, Templates for Objective Writing, and Meaning of the Depth Levels with Associated Learning Activities

IS'90,'94,'95, 2002, 2010 Depth of Knowledge	Bloom Levels of Knowledge	Template for Writing Behavioral Objectives Students completing ... will be able to	Meaning of Depth of Knowledge Level and Activities Associated with Attaining that Level
0 No Knowledge			
1 Awareness	1 Knowledge Recognition	Define ... List characteristics of ... Name components of ... Diagram ... List advantages/disadvantages of ...	Introductory Recall and Recognition Class presentations, discussion groups, reading, watching videos, structured laboratories. Involves only recognition, but with little ability to differentiate. Does not involve use.
2 Literacy Strong Knowledge	1 Differentiation in context	Compare and contrast ... Explain ... Write/execute simple ... Define functional capabilities that are ... Describe interrelations of ... to related objects	Knowledge of Framework and Contents, Differential Knowledge Continued lecture and participative discussion, reading, team work and projects, structured labs. Requires recognition knowledge as a pre-requisite. Requires practice. Does not involve use.
3 Concept/Use Skill	2 Comprehension Translation/ Extrapolation Use of Knowledge	Use ... Communicate the idea of ... Form and relate the abstraction of ... as ... Given a set of ..., interpolate/extrapolate to ... List concepts/major steps in ...	Comprehension and Ability to Use Knowledge *when Asked/Prompted* Requires continued lab and project participation, presentation involving giving explanations and demonstrations, accepting criticism; may require developing skills in directed labs.
4 Detailed Understanding, Application Ability	3 Application Knowledge	Search for correct solution to ... and apply it to ... Design and implement a ... for ... Write syntactically correct ... and/or debug ... Apply the principles of ... to ... Implement a ... and maintain it	Selection of the Right Thing and Using It *without Hints* Semi-structured team-oriented labs where students generate their own solutions, make their own decisions, commit to and complete assignments, and present and explain solutions.
5 Advanced	4 Analysis 5 Synthesis 6 Evaluation	Develop/originate/institute ... Construct/adapt ... Generate novel solutions to ... Come up with new knowledge regarding ... Evaluate/judge the relative value of ... with respect to ...	Identification, Use and Evaluation of New Knowledge An advanced level of knowledge for those very capable of applying existing knowledge in which *denovo* solutions are found and used in solving and evaluating the proposed new knowledge.

Table 1 – IS 2010 Depth of Knowledge Metric (DKM)

Appendix A - List of Universities with ABET Accredited IS Programs Grouped by Academic Unit Location (as of May 2015)

Business Schools

1. East Tennessee State University (AACSB)
2. Gannon University (AACSB)
3. Kennesaw State University (AACSB)
4. Lock Haven University of Pennsylvania (ACBSP)
5. Metropolitan State University of Denver
6. Quinnipiac University (AACSB)
7. Rowan University (AACSB)
8. Slippery Rock University (ACBSP)
9. The University of Tampa (AACSB)
10. University of Central Missouri (AACSB)
11. University of Houston - Clear Lake (AACSB)
12. University of North Alabama (ACBSP)
13. Virginia Commonwealth University (AACSB)
14. West Texas A&M University (AACSB)
15. Wright State University (AACSB)

Non-Business Schools

1. Arkansas Tech University
2. California State University, Chico
3. California University of Pennsylvania
4. City University of Seattle
5. Drexel University
6. Fitchburg State University
7. Florida Memorial University
8. Grand Valley State University
9. Illinois State University
10. Jacksonville State University
11. New Jersey Institute of Technology
12. Pace University
13. Radford University
14. Regis University
15. Robert Morris University
16. Southern Utah University
17. State University of New York at Brockport
18. University of Houston
19. University of Nebraska at Omaha
20. University of North Florida
21. University of Scranton
22. University of South Alabama
23. University of South Carolina
24. Utah Valley University