The IS Core: An Integration of the Core IS Courses

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ABSTRACT

This paper describes an innovative, integrated implementation of the core Information Systems courses. While the published IS curriculum provides standards on course *content*, it gives little direction on the *implementation* of the courses. At Brigham Young University, we have reengineered the traditional topics of analysis, database, design, development, networking, etc. into an integrated, 24-hour course block called the "IS Core". Instead of students moving from class to class, professors now rotate through integrated subjects in a common classroom environment. The IS Core has allowed the department to increase the rigor and integration between subjects so students see the entire systems process and has provided opportunities for cross-topic assignments and integrated exercises. Finally, it has resulted in unintended, additional benefits like increased student culture and student ownership of the major.

Keywords: IS curriculum, Learning, Teaching, Pedagogy, Integrated course design, Cross-course curriculum

1. INTRODUCTION

The publication of the IS model curriculum by the Association for Information Systems (Gorgone, et al. 2005) represented a major step forward for IS programs. This document has now gone through several revisions (Couger, et al. 1995; Davis, et al. 1997; Gorgone and Davis, 2000; Gorgone, et al. 2002), and it represents a best practices model for the content of information systems programs. However, the document primarily leaves the implementation of this curriculum up to each school. A common implementation today is 6-8 separate classes for analysis and design, networking, programming, etc. Each professor has full control over the specific course content and the format of each class; cross-course coordination is rare at many schools. In the same vein as the traditional waterfall model of systems development, students are sometimes "thrown over the wall" to the next course, possibly forgetting, and often not using, the material covered in the previous set of classes. Certainly, there is usually some carryover from one class to the next, but despite the natural interdependence of IS topics, curriculum organization often remains compartmentalized.

In recent years, some notable work has been done to better integrate IS curriculum topics. Table 1 summarizes some of these initiatives.

The experiments and courses listed above represent smaller changes to one or more classes. McGann et al. (2007) describe a more comprehensive integration, starting with the introductory course through the capstone experience. Their restructuring efforts resulted in a common framework—based on the systems development life cycle—used throughout all courses, with principles, skills, and tools taught in earlier classes being specifically built upon in later courses. Their paper references the benefits found with course integration in medicine and engineering fields, but it notes that no other published papers in the main IS journal outlets exist on integration in the IS curriculum.

This paper serves as a description of significant integration done in a redesign of our program. While changes were made to the introductory and capstone courses, the paper focuses on the IS Core classes most students take during their Junior year of our B.S. in IS program.

University	Change	Author	Year
Case Western Reserve	Appreciative learning approach	Avital	2005
Idaho State University	Cross-course team project	Aytes and Byers	2005
Bentley College	Curriculum change	Chand	2004
Victoria University of Technology, Australia	Problem-based learning	Bentley et al.	2001
University of Texas - Austin	Small group learning initiatives	Smith and MacGregor	2000
University of Maryland	Large class project	Smith and MacGregor	2000
Michigan State University	Active learning based	Smith and MacGregor	2000
University of Delaware	Problem-based learning	Smith and MacGregor	2000
University of Texas – El Paso	Model institutes of learning	Smith and MacGregor	2000
University of Jyvaskyla, Finland	Constructivist approach	Tynjala	1999
Drexel University	Application of learning theory in a curriculum review	Haslam	1997

Table 1. Example of IS Curriculum Revisions at Other Universities

The integration effort started because some students didn't seem to grasp the full context of IS. While students could create class diagrams and use cases and program simple applications, they had difficulty applying knowledge learned in their analysis or database course to their design and programming courses. In short, most students knew the details in the trees, but few saw the forest.

Research on expert learning supports the limitations seen by our faculty. Despite the IS model curriculum and limited integration done at some universities, some feel that universities have generally failed to turn out expert professionals (Tynjala, 1999; Schatzberg, 2002). Instead, universities have produced a host of consumers of expertise, training students to routinely respond and react to predictable questions, problems and/or tasks (Geisler, 1994; Bereiter and Scaramalia, 1993; Mandl et al., 1996). It is necessary for the current curricula to be taught in such a way that students can become experts (Schatzberg, 2002)—at least eventually.

For the purpose of this paper we refer to experts in the context of training students entering the workforce as individuals that understand fundamental concepts and how these concepts can be structured to deal with novel or unique problems (Klein and Hoffman, 1993; Svinicki, 2004). Certainly, professional experience is required for true expertise, but new, integrated approaches to curriculum can better prepare the students to become experts in IS.

There is a substantial difference in the training graduates receive and the training that employers need them to have (Snoke and Underwood, 1998). Higher education provides students with a naïve, textbook-based understanding or knowledge of a particular domain, but withholds the more informal and tacit conceptual processes that are needed to produce professional experts (Bereiter and Scaramalia, 1993; Tynjala, 1999). Institutions may have the correct content, but many courses lack the correct approach to teach this content (Tynjala, 1999).

Through the current teaching methods and styles, only a few students are able to show expert ability by integrating basic content (Tynjala, 1999). However, schools do have the ability to improve the manner by which they convey content to students and thereby increase the level of expertise among students (Bereiter and Scardamalia, 1993). The ability of an individual to become an expert depends on numerous factors, including the student, the teacher, the material, and the way that the material is taught. Schools need to address and alter their current methods of teaching IS curriculum to meet the demands for more subject-matter experts.

This paper first discusses the theoretical basis for integrative learning. It then presents the changes made at the Information System Department (at the Marriott School of Management, Brigham Young University) by the introduction of the fully-integrated IS Core. Major areas of integration, including two significant integrated group exercises, are described. The paper finishes by discussing the benefits seen and potential limitations with this approach.

2. THEORETICAL FOUNDATIONS

It can be said that a primary aim of higher education is to produce experts of knowledge. As opposed to learned information, knowledge is conceptualized, abstracted, interpreted and considered by the learner (Cairncross, 2001). Knowledge can be further categorized into three varying levels: formal knowledge, practical knowledge, and expertise (Bereiter and Scardamalia, 1993). Traditionally, these three levels of knowledge are taught within schools and organizations (Schon 1983 and 1987, Mezirow et al., 1990; Mezirow, 1991; Jarvinen, 1992; King and Kitcher, 1994). We note that this paper does not delve deeply into competence, knowledge and employability (For a more detailed discussion of these concepts please see Eraut 1994) as the focus of this paper is on our implementation of the IS Curriculum and how it improves the overall education of our students.

Formal knowledge is explicit, factual, and it constitutes the core of education (Eraut, 1994; Etelapelto and Light, 1999). This type of knowledge is frequently learned by students who cram the night before a test or learn rote information without obtaining a deep understanding of the subject (Svinicki, 2004).

Practical knowledge enhances formal knowledge through augmentation of the individual's skills or "know-how". This knowledge is personal, tacit, and has a close resemblance to intuition (Eraut, 1994; Etelapelto and Light, 1999). This knowledge is common of professionals with deep knowledge in a given area.

Expertise increases the understanding of practical or procedural knowledge through the ability to perform advanced problem solving, adaptive approaches to applying concepts, and understanding of patterns between concepts within an area (Eraut, 1994; Sternberg, 1997; Etelapelto and Light, 1999). Klein and Hoffman (1993) explained how experts are not marked by a superior knowledge of information but by an understanding of concepts and the patterns that they form. The understanding of structure allows experts to deal with novel problems in unique ways (Svinicki, 2004).

Experts have the ability to solve many business problems and thereby provide the most value to a business. Since most students do not possess the practical knowledge or expertise desired by businesses, it is a challenge to universities to develop curricula and teaching methods that give students the foundation required for expert development (Tynjala, 1999). Thus educators need to develop and adopt an approach that focuses on encouraging expertise as opposed to formal knowledge.

Recently, many educators have adopted a situated learning approach to enable students to acquire expertise as opposed to formal knowledge (Brown et al., 1989). Situated learning is a constructivist educational approach that insists that the learning of knowledge and expert skills need to be accomplished within a context that reflects how the knowledge would be used in real life (Collins, 1988). Researchers have debated various ways to implement situated learning (Tripp, 1993; McLellan, 1994).

The IS Core attempts to create a learning environment where students can achieve expert learning through its integrative approach.

3. IS CORE DESCRIPTION

To begin the description of the IS Core, it should be stated that the Core is a reengineering of the entire curriculum presentation rather than an experiment with a few selected classes or a cross-class project. The changes involved every Core class teacher, and all faculty agreed to participate and adjust their courses to the new structure. The changes were primarily pushed by faculty concerns and insights, but recent graduates and current students were consulted for ideas and structure decisions. We interviewed (and continue to interview) all Masters-level students before graduation for feedback on our program, which provided insights into course topic depth, topic selection, tool choice, and integration possibilities.

We did not involve recruiters directly in the reengineering process because we did not have formal relationships at the time. Since the introduction of the IS Core, we have formed an advisory council comprised of recruiters and other professionals. The advisory council is fully supportive of the IS Core (and now suggests improvements), but it was not in place at the time we implemented the IS Core. Several of the faculty involved had been IS professionals for many years before returning for Ph.D.s and becoming faculty, and their experience was invaluable in integrating the topics.

It is useful for the reader to have a context for understanding how the BYU IS Core works as universities and IS programs vary significantly. All IS students at BYU are full-time students and students are not allowed to have a double major. A student must complete 120 hours to graduate. This includes general education classes required by BYU and 75 hours required by the Marriott School of Management and the Information Systems Department. Those 75 hours include Introduction to MIS, Introduction to Programming, Introduction to Excel and PowerPoint, Business Writing, Economics, Accounting I, Accounting II, Calculus, Statistics, Finance, Marketing, Supply Chain, Managerial Economics, Organizational Effectiveness, Ethics, Business Law, Strategic Management, and the 24 hours of the IS Core that is explained in Section 3.1. There are no electives in the undergraduate IS program.

Most IS Core students are juniors and the rest are seniors. The students are usually two or more years older (average age is just over 24 years) than students at most universities due to many of them spending two years in voluntary missionary service. About 75% of the students speak one or more foreign languages. Depending on the year, between 75% and 85% of our students work (60 to 65% work in on-campus positions).

3.1 Course Structure

The IS Core represents a 24-hour block of courses that students typically take during their Junior year. The courses span two semesters and generally follow the IS model curriculum. The courses are laid out as shown in Table 2.

While individual teachers still maintain control over their respective classes, the Core integrates the above topics in the following ways:

Semester 1 Courses	Sample Topics
Analysis	Unified modeling language (UML), business process reengineering, analysis techniques
Database	Theoretical foundations, relational databases, structured query language (SQL)
Business Programming	Java, object-orientation, data structures and algorithms
Processes and Controls	Business cycles, standard business documents, accounting and IT controls
Semester 2 Courses	Sample Topics
Application Design	Design patterns, business objects, layers
Application Development	Programming patterns, Web programming, large systems
Networking	Open systems interconnection (OSI) and TCP/IP models, protocols, layers
Project Management	Projects class for INTEX 2, as described later in this paper

Table 2. IS Core Courses

- Students meet in the same room and time throughout the semester. The professors rotate in and out of the rooms as needed. For example, students in one section meet every day from 8:00 am to 10:45 am. On Monday, the analysis professor and database professor might teach 1.25 hours each. On Tuesday, the Programming professor might teach the entire 2.5 hours. On Wednesday, the student might attend a networking lab with his or her group. Thursday might be given as a group work-day with no official class time.
- The professors maintain a common Core schedule to coordinate lectures, exams, and classroom activities.
- Student groups (normally 4 students per group) are Core-wide, making them the same in each of the four Core classes. No attempt is made to match student work schedules; the students are in a full-time program and are expected to be in class and available for group meetings.
- Several common cases are used across the Core courses (in the same weeks) throughout the semester. Each professor approaches the cases from their course's perspective.
- At the end of each semester, classes are canceled for an intensive, cross-topic, practical case experience (INTEX 1 and INTEX 2).
- A common, Core-wide wiki/blog site and student email list is provided (to which Core professors also subscribe and participate as active contributors). Students are encouraged to discuss class topics (as well as general IS-related topics) and help each other learn topics presented in class as well as additional topics they find interesting.
- The Core is highly integrated with the activities of the IS student club—each supporting the other with topics, schedule, and environment.

With all the collaboration and cross-course activities that are described in the previous sections, individual faculty still maintain responsibility for their respective courses. While professors certainly work together; meet almost weekly throughout the semester, make content suggestions to each other, and share assignments; each professor is ultimately responsible for the exact content of his or her course, the timing and format of assessments, and the tone of the course. The Core provides the foundation and structure for collaboration and group work—which professors take advantage of at every opportunity. At the end of the semester, students receive an individual grade for each of the four courses they were enrolled in that semester.

3.2 Orientation Meeting

On the first day of classes, we hold a full day orientation in a conference-type format, with presentations, breaks, lunch, and group activities. This opening day sets the tone for the year and sets expectations for the students. Students are required to wear professional dress as they would at any proper business function. The entire day has the feel of a professional conference, including a continental breakfast and catered lunch. We start the meetings by giving fun awards for accomplishments such as: the oldest and youngest students, the student with the most children, the student who speaks the most languages, the student who has the most computers in his or her apartment, the student with the most portable storage on his or her person, etc. Our department head, Core professors, and college dean give short addresses on program introduction, classroom and recruiting professionalism, assignment expectations, effective group management, and time management. The IS student club also gives a short recruitment speech.

After the speeches, we hold a discussion on teamwork success factors, and we conduct group-building exercises. We give each group a light bulb, an envelope, a rubber band, a bit of kite string, and a small piece of scotch tape. The groups have 20 minutes to design a protection for their light bulb. We then drop their light bulbs 10 feet on to a set of bricks. The groups are evaluated on whether their light bulb still works, whether it didn't break, or whether it shattered.

The orientation day helps the students feel that they are part of something greater than just a set of classes, makes them proud to be part of our program, and sets realistic expectations for the heavy workload ahead.

3.3 Concept-Based, Deeper Learning

Once students learn how to apply fundamental subject material to solve selected real-world problems, students become more expert in the material by understanding how to use concepts and patterns to understand the environment around them. As students begin to apply principles in a real world environment, teachers should attempt to instruct students how to understand the concepts embedded in the complex real world setting (Spiro, 1988; Saloman and Perkins, 1989). Through their understanding of the concepts in the complex environment, students will be able to focus on more critical thinking skills and create their own solutions as opposed to simply repeating facts or memorized answers (Dearing Report, 1997; CSUP, 1992). Once obtained, this type of knowledge is easier to use, maintain, and apply to numerous settings as the brain encodes information through the use of patterns and concepts (Svinicki, 2004). When a student begins to meta-cognate and understand the concepts within a system, they begin to become experts in that area.

In most classes, we scaled back the number of topics taught in favor of more depth for certain topics. We determined that we would never be able to include all the topics in the broad IS field and instead focus on a smaller set of important issues. The chosen topics became environments for learning skills and expanded competencies like logical thinking, different approaches to solving analysis problems, oral and written communications, professional interactions, group interaction and dynamics, and creativity. For example, the database course focuses on significantly fewer topics and instead gives deeper schema and normalization problems to students. In class, students present their solutions to the class and receive feedback.

3.4 Integrated Schedule and Assignments

As the Core development progressed, we saw the benefit of providing students with a combined, integrated schedule for each semester. The schedule is simply a spreadsheet with a column for each class and a row for each instruction day. Each course professor fills in his or her course column with topics, assignments, and exams. The combined schedule allows each professor to see what other professors are teaching each day. It facilitates spreading out assignments and exams in a relatively even fashion throughout the semester. It also allows professors to discover opportunities for further integration of topics and assignments. This integration has increased each year we have had the Core.

For example, the systems design and enterprise application development courses are among the most integrated of the courses. In these two classes, students spend the entire semester building a full business application for a video store, a ticket-selling venue, or another interesting case. The specific case for each year is selected before the first semester and is used in some assignments in the Systems Analysis and Database Management classes during the first semester. The second semester starts with the systems design professor teaching basic UML design concepts for two weeks. He then spends two additional weeks (weeks 3 and 4) designing the first development milestone with the students—usually the business objects and database of the system. Using UML charts like class diagrams and sequence diagrams, students complete the design of the system started during the first semester. The professor walks students through the logic of user objects, sales objects, and object-relational mappings.

When the design milestone is finished, the programming professor spends the next two weeks (weeks 5 and 6) programming the assignment with the students. Assignments during this period include creation of the database and business objects as designed earlier. The semester continues to alternate between design and programming milestones for the remainder of the semester. The students present a full, working system, including UML documentation and design documents, at the end of the semester. While this example is an extreme case that lasts all semester, it illustrates the type of integration we have tried to introduce into the courses.

The integrated schedule allows the Core faculty to focus on the overall education of the student rather than on individual courses. The Core requires a high degree of coordination and cooperation among faculty members. Faculty members essentially give up their own course to become part of a program. All course policies, materials, assignments, tests, etc. are the same across all sections of the Core. Such coordination and cooperation among faculty is unusual and a challenge to maintain over time.

3.5 Language and Platform Standardization

To maximize the time available for IS-related topics, we standardized on a single development language for the entire IS Core. Before, each teacher used the language and platform of his or her choice in class. As a result, students spent considerable time learning the syntax and style of the different languages rather than learning object-oriented or business programming concepts. We now standardize on Java in all introductory and Core classes because it provides a structured environment to explore important concepts like object encapsulation, inheritance, polymorphism, and data structures and algorithms. In addition, the Java enterprise edition introduces business-level programming topics like business objects, data access objects, relational database access, and both client and Web user interfaces.

As a side benefit, Java is a good "middle ground" language to support graduates who end up learning more complex languages like C or C++ as well as in scripting languages like PHP or Python.

3.6 Integrated Exercises (INTEX 1 and 2)

Students must learn how to apply factual pieces of information in real-world environments. This type of situated, authentic, or real world experience is referred to as mental apprenticeship because the student approaches, explores, and solves problems as if the student was a professional in the real world. Mental apprenticeship can take place through classroom problems, homework, internships, or interactions with professionals (Lave and Wegner, 1991). This type of learning is essential for students to develop practical knowledge (Brown et al., 1989; Mandl et al., 1996). Students are able to advance from formal knowledge to practical knowledge through the application of fundamental concepts to solve real world problems and thus become professional experts.

At the end of the first semester, regular classes are cancelled for a week for an intense integrated experience we call INTEX 1 (short for INTegrated EXercise). Where possible, students are asked to cancel work and other outside activities so they can spend their entire week on INTEX. Typically, student teams of four will spend 12 to 18 hours per day on INTEX 1. The teams are given a written case on Monday, turn in their written solutions on Friday afternoon, and present their solutions orally on Saturday. The students prepare written documents and oral presentations that give an analysis of the case, including cost/benefit and risk analyses, UML models, database schema, screen mockups, etc. On Saturday morning, groups present to faculty and consultants from professional firms such as PriceWaterhouseCoopers, Accenture, and other recruiters. Each year, representatives from the consulting firm sponsoring INTEX 1 remark that it is a valuable experience for their personnel as well as the students (it also allows the firm to have a first look at the IS students in action). After presentations and a pizza lunch, winning groups are selected and given prizes from the consulting firm during a shake-down meeting. In many ways, INTEX 1 has become a "rite of passage" for those going into the program; past students tell stories of their hard work in preparation for it, and current students look with great trepidation toward it. INTEX 1 is described in further detail in (McKell, et. al., 2008).

INTEX 2 is a similar experience in the second semester. However, rather than being confined to a single week, this experience runs across the entire second semester. It was partially described in the design and programming integration example earlier in the paper. During INTEX 2, students implement one of the integrated cases from the first semester. At the beginning of the semester, students are given an empty virtual server. Their task is to install the operating system, database management system, application server, network firewall, and other technical requirements. Throughout the semester, the students develop an installed client as well as a Web-based system. Similar to INTEX 1, they present their designs, networks, and running systems at the end of the semester on a Saturday morning to consultants from consulting firms.

We consciously use fabricated cases for the INTEX experiences to keep the experience at an apprenticeship level. If we allowed students to build different systems for real companies, we would not be able to have controlled, common class discussions about the case. The two mental

Month	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008
September	7	152	184	207	252
October	58	180	258	394	510
November	95	143	278	256	298
December	37	61	192	175	517
January	180	144	280	274	248
February	185	230	242	393	657
March	101	271	262	356	625
April	18	114	268	362	558
TOTAL	**681**	**1,295**	**1,964**	**2,417**	**3,665**

Table 3. Summary of Postings on the IS Core Email List

apprenticeship INTEX experiences are consistently perceived by both recruiters and students as the most rewarding (and most difficult) activities of the IS Core.

3.7 Cross-Course Group Work

Working in groups or learning from peers provides excellent opportunity for students to learn (Allan, 1976; Vygotsky, 1978; Wertsch, 1984; Webb, 1991; King, 1991; King, 1994). Collaboration does not refer to the common practice of students working on components of a problem and synthesizing an answer from their disparate portions; rather, it refers to the joint efforts of partners working together on the same problem (Brandon and Hollingshead, 1999). Collaboration allows more learners to be involved in the learning and teaching processes while allowing each to more actively participate for their own learning (Schauble and Glaser, 1995). Through group work in the Core, students learn not only the collaborative tools that are out there but also the etiquette and unwritten rules of collaboration in a professional work setting.

Group work is one of the major focuses of the IS Core. About half of the assignments given to students are done in groups. This provides ample opportunity for students to learn to work in business groups, to fulfill both leadership and subordinate roles, and to teach each other course concepts. Group evaluations and individual work allow students to differentiate themselves for grading purposes.

Although the students work together in groups on projects and assignments, in order to optimize time usage and increase efficiency, they do not work together on every task. Nevertheless, each student is responsible (through exams and other individual assessments) for understanding all the topics covered in the Core. Even on individual assignments, groups often get together and explain what they have done and teach each other how they accomplished their assigned tasks. This process of individual problem solving and then reporting and teaching the solution helps our students each become more proficient in specific areas. For example, in a group of four, one student may become the Web programming expert while another is the database expert. In addition, by providing common groups across classes, student groups also get a significant amount of time to build professional relationships with one another.

3.8 Current Events Quizzes

Throughout the Core, students are required to take a Web-based weekly news quiz. Although the students are unaware of the method, one of the professors calculates statistics on stories from an aggregator like Google News and creates multiple-choice questions from the most-reported items. The quiz is not designed to be difficult; if a student has read the news each day, he or she normally does well on each quiz. The quizzes are designed to encourage students to begin reading IS-related news articles.

In addition to requiring the reading of current events, the first few minutes of some Core classes are given to a review of important news articles. Teachers usually begin with a simple statement like, “What’s new today?” New technology news, consulting firm advancements, company earnings and announcements, and other news are presented by students. Students receive course participation credit for bringing news items to class.

3.9 Island and Email List

Throughout the Core, the students are encouraged to discuss course and extracurricular ideas through a Web site called Island (short for “ Information Systems Land”) and a supporting email list created solely for their use. On these mediums, students ask questions and give answers relating to courses, club events, and assignments. Island provides blog and wiki space for students and ad-hoc groups to share information about topics that interest them (called organic groups in some settings). Since participants on Island include Core and post-Core students, faculty, and program alumni, it provides a forum for discussion and ad-hoc mentoring. A full treatment of the research and theory behind Island is beyond the scope of this paper. While faculty members monitor the Web site and lists and answer questions posed on it, students often provide the best answers. Students learn to rely on one another to explain difficult concepts, provide advice, and work through problems. These technologies allow students to practice expert learning as they teach and share with their peers. Table 3 shows the number of email messages posted by the IS Core students to the list for the past five school years. Note that these numbers include only the students in the IS Core (those that have completed the IS Core are moved to a separate “Seniors” list).

3.10 Laptop Requirement

Each Core student must own a laptop and bring it to class each day. When students are able to rely upon university-sponsored labs, they have no responsibility to maintain and administer the computers they work on. When something goes wrong with a machine, they simply report the issue to IT support and move to the next station. By requiring students to own their own laptops, students must learn to administrate their operating systems and experience real-world problems when under a deadline just as they would in the professional world.

A common concern with a laptop requirement is that they may become distractions in the classroom. These have been minimal. We regularly remind the students to stay focused on the day's topic, and some professors ask the students to close their laptops at appropriate times. Because the entire Core faculty share the same policies regarding laptops, we are able to effectively manage them in the classroom.

3.11 Summary of Key Concepts and Learning Objectives

Based on the desire to increase the proficiency of our students' education, we formulated several objectives to help increase the overall learning of students and promote expertise. These are shown in Table 3, which also includes several examples of how we attempted to meet these objectives.

4. UNINTENDED BENEFITS

Some of the most important outcomes of the IS Core are unintended benefits rather than results of direct interventions. This section highlights two of these benefits: familiar settings and culturization to the IS field

4.1 Familiar Settings

Psychological research has identified the ability of retrieval cues—contextual, environmental, and state-dependent—to enhance the brain's ability to more readily recall information. Retrieval cues are described as stimuli that prompt and aid the brain in recalling information that was initially learned or successfully recalled in the presence of the given stimuli (Baddeley, 1999). Cues can be the physical location of the individual, any sensory information, or the current mood-state (Baddeley, 1999). Students exposed to numerous retrieval cues through the use of constant familiar settings, individuals, and contexts are better equipped to recall information (Dibbets et al, 2001; Richardson-Klavehn and Bjork, 2002).

The Core supports the idea of familiar settings by providing a single location, group, and environment for students to learn within. Positive synergies occur when IS students sit together in a common classroom for several hours per day for an entire school year. We have no doubt that this significantly contributes to the learning environment. In some ways, the students begin to feel that it is "their" Core because the professors, rather than the students, rotate in and out. They begin to feel responsible for their own learning environment and classroom. It is common to have students censure one another after inappropriate comments or behavior. The students become the focus and report that they genuinely look forward to coming to class to socialize and learn with their classmates. They begin to feel more empowered in their actions and questions in class. They are more willing to ask "stupid" questions and admit when they do not understand concepts. They develop a rapport with one another and with the teachers. These friendships continue into their careers. From a faculty perspective, Core professors have received standing ovations, personal notes, and other mementos of student appreciation. While these events are not limited to Core classes, they seem to be more frequent in the Core. The last day of class each year is usually full with emotion, with feelings similar to graduation exercises. Students often comment regular school will never be the same as the Core, and they pledge to maintain contacts and group activities.

4.2 Culturization to the IS Field

An extension of group learning that has been heavily researched is social learning. The model of social learning was first popularized by Vygotsky (1962). Social learning differs from group learning in that knowledge is co-constructed through social and cultural contexts and not merely from others (Gibson and Roberta, 2001). Social

Learning Objective	Implemented Concept & Example(s)
Increased expertise – being able to apply a variety of concepts to a given problem	• Integrated course curriculum and schedule: students in each Core course integrate concepts from the other courses into their course. • Concept-based learning: classes and topics are focused on concepts and the application of these concepts • Focus: Depth rather than breadth in many areas. • Integrated assignments: assignments are utilized across courses to encourage deeper learning of material • Standardization: A a single, middle-ground language for all courses
Realistic and meaningful assignments	• Group work: Increased, as much work is done in groups in the business world • INTEX 1 and 2: a fabricated assignment that more closely approximates a real-business world problem and setting
Increased peer-to-peer interaction	• Group learning: group work assigned to introduce students to the reality of groups in businesses, and to allow students to teach each other • Island and email listserv: Facilitates increased student-to-student communication • Integration: The Core is integrated with the student club where possible
Business-level, real world experience	• Orientation: Conference-style orientation meeting at the beginning of the year to set the tone and expectations for the Core • Current events: Quizzes to start habits of reading business and technology news • Laptop requirement

Table 4. Summary of Learning Objectives and Examples

learning, like constructivism, relies heavily upon social interactions to provide meaning to information (Money, 1995; Tynjala, 1999). Social knowledge is able to help the individual learner recreate their knowledge and learn material (Stahl, 2000).

One of the most important results of moving to the Core has been the culturalization that occurs in the students. The students certainly learn IS topics, but they also feel they are part of something greater than just a set of classes. A common culture occurs in the classroom. Especially in the first semester, the language of the students begins to change to include IS terms, jokes, and concepts. The news articles they bring to class increasingly concerns business news of technology and consulting firms. They start to appreciate the inherent and historical tensions in the IS field. They learn how to interact with other IS professionals, including working with business people and computer programmers. As mentioned previously, these familiar and constant surroundings increase the feelings of freedom and decrease feelings of restraint and hesitation. With these barriers removed, students can more freely and easily delve deep into and become part of the IS culture.

5. SURVEYS

The development and implementation of the IS Core occurred in an evolutionary way over several years. Therefore, we do not have empirical before and after surveys to measure its success. However, descriptive surveys and statistics provide some insight into the student perspective and success of the Core. Due to space limitations, we do not include the detailed results of these surveys. Instead, we provide important findings from these surveys in the following sections:

5.1 IS Core Survey

We gave 128 post-Core students a survey comprised of about 100 questions. Responses to the survey were anonymous, although we tracked the responses to allow follow-up emails to be sent to those who did not respond. In interest of space, this section details only a few interesting questions and responses; the full survey results are provided in Appendix 1.

The average student age in the Core was 23 years old. Students had an incoming GPA of 3.5 (with a very small standard deviation). Nearly all students strongly agreed that the Core was more difficult and was a significant step up in rigor compared to their other college courses. Incoming student proficiency in information systems topics was about 1.5/5, indicating students placed themselves at a beginner level before the Core. Students ranked their proficiency and competence at 4/5 after the Core.

It is interesting that the laptop requirement was widely supported by the students. In planning meetings, we debated this financially burdensome requirement. We finally decided to require laptops because students learn important skills when they have to administrate their own machines. The results show 4.48/5 agreement that the laptop requirement was an important factor in learning. Students rated their computer skills 2.88 before the Core and 4.15 after the Core. Also, while we worried about students "playing" on their laptops in class, only 17 percent of the students admitted to frequently using their laptops in class for distracting activities (and many of these stated they would have found other distractions if laptops hadn't been present).

One group of questions asked students where their most significant learning came from: group, in-class activities, professor lectures, self study, student help, TA sessions, textbook reading, etc. It is interesting that in-class activities and group work consistently ranked as the most significant across all courses. Out-of-class professor help was consistently ranked the most insignificant source of learning, showing the Core may have moved individual student load from professors to groups and other sources.

INTEX 1 and 2 were widely seen as the most important learning experiences of the first and second semesters, respectively. For example, the students responded with 4.75/5 agreement that INTEX 1 should be done again and 4.23/5 that INTEX 1 was the best course-related experience of the first semester. INTEX 2 showed similar results. Both were also seen as the most difficult part of the Core.

Following are excerpts of student comments from the survey. While a few comments focused on the negative or need for improvement, these excerpts are representative of most comments:

- *I had no life outside the Core, but I learned a ton.*
- *Group work was amazing.*
- *I believe the laptop requirement in the Core is a must. It is an inevitable distraction, yet an invaluable tool. Granted I played on my laptop significantly, but it only seemed to be when the professor lost excitement and practicality in his teaching and droned on. When professors made the material exciting, applicable, and meaningful, it wasn't hard at all to avoid using the laptop.*
- *[The Core was] insanely difficult and time consuming. I'm surprised I'm still married and hold a job. On the other hand, the skills were of great worth.*
- *The IS Core was the most difficult and rewarding educational crucible I've ever experienced. The rigorous, team-based nature of the program allowed me to see how the workplace really functions and prepared me to be an active contributor in a team.*
- *It was hard and frustrating at first, but if I could go back I wouldn't change the difficulty of it. It was a good learning experience to go through.*
- *INTEX 1 was awesome because we had already learned the course material in class. It was a challenge to pull everything together and it took a lot of hours, but it was an incredible experience.*
- *INTEX II was the most valuable experience of my college career. No single experience in or out of college has been as helpful in preparing me for my career.*

For completeness, we have included some of the negative comments students wrote on the survey:

- *Ridiculously too much [work load]. How can you learn when you have so much to cover? I am glad they are spreading the load over 4 classes a semester.*
- *I was burnt out after the Core.*
- *The process of being placed into groups seems almost like the professors are playing the lottery with our futures. If you have a group you can work well with, everything is good. If you are in a group that doesn't*

- *INTEX was a waste of time. Most people coming out of college don't go straight into Project management. Needs to be more practical. Most people will be using the stuff that was made during INTEX not making it.*

5.2 Graduation Survey

Exit surveys are given to all graduating BYU students. Before the IS Core was developed, IS students were the least satisfied students in the college. Since the Core, this satisfaction has increased each year. Results now indicate that IS graduates have the highest student satisfaction of any major in the college. When asked how they would rate their overall education experience at BYU, IS students responded as follows in Table 5:

Rating	Percentage
Poor	0%
Fairly Well	2%
Good	21%
Excellent	77%

Table 5. Graduate Ratings of IS Program

When asked: If you were starting your college career over, would you choose to graduate in the same major?

Response	BSIS	College Average	BYU Average
Definitely not	3%	2%	4%
Probably not	5%	8%	10%
Uncertain	5%	8%	14%
Probably yes	23%	33%	35%
Definitely yes	65%	50%	37%

Table 6. Graduates Willing to Reselect IS as a Major

5.3 Department Statistics

The IS Department has maintained varying statistics about its students for several years. We present a summary of these statistics below in Table 7. An additional statistic not included in the table below is the attrition rate of the program. As to date, this has been negligible, and when it has occurred, it has usually been related to visa or other non-school-related issues.

One interesting trend is the increase in the number of applicants in recent years. At a time when many programs are seeing declining enrollments, our applicant pool is rising significantly. Preliminary data for 2009 show that the number of applications will be over 200. While some programs may be tempted to decrease rigor to entice more applicants, we believe that the increased rigor and program quality is responsible for the increasing trend. In an informal survey given to Core students, nine in ten reported they found the Information Systems major through word of mouth from past students.

5.4 Other Results

There is pressure from external stakeholders to increase the number of graduates from the major. Recruiters have commented that our students perform on a completely different level than other recruits during internships and during initial employment. The number of recruiters coming to BYU is also increasing. Our IS student club is enjoying more sponsors and sponsorship donations than ever.

Finally, our IS students have competed at the AITP National Collegiate Competition since 2003. Since that time, BYU has placed second highest in the nation in this competition in terms of number of placements. This is all the more impressive because BYU takes only six students to the competition each year while some other universities, including the top winner, typically take 15-20 students, which allows for a broader set of narrow specializations.

6. LIMITATIONS

We recognize that the integrated model described in this paper cannot be done at some schools due to inherent limitations or structural differences from BYU's program. Some programs exist as major or minor tracks within business majors; others have two or three faculty teaching mostly introductory courses. We believe this approach will be most effective at schools where departments have full control over their courses and where the full suite of IS curriculum is taught.

In addition, changing to an integrated approach required the participation and willingness of all faculty involved. In some ways, faculty may see the move as a loss of freedom in their teaching because topics, scheduling, and integrated assignments had to work across courses. Faculty had to be willing to accept cross-Core policies and give up class time for the orientation meeting, INTEX, and other combined activities. Faculty buy-in is critical for successful integration across courses.

The faculty teaching our Core courses included mostly experienced, tenured faculty. One might expect resistance and lack of buy-in from professors who have taught the same courses for multiple decades. Surprisingly, and despite the needed increase in time commitments and workload, buy-in was never an issue. The experienced faculty knew there were problems with the previous approach and were waiting for a

	02-03	03-04	04-05	05-06	06-07	07-08
# of Applicants	127	107	103	98	150	168
# Admitted	106	97	95	93	132	137
# Entered	89	91	87	83	125	127
Average GPA	3.60	3.57	3.59	3.51	3.63	3.62
Job Placement	NA	NA	50%	93%	95%	-
Starting Salary	NA	$44,752	$44,153	$53,536	$58,071	-

Table 7. Summary of Bachelors of Information Systems Program Statistics

chance to try new methods. In fact, some of the more senior, "traditional" faculty became the most significant contributors in designing and implementing the Core—including changes to their teaching styles and beliefs—with little need for persuasion. Another factor that likely impacted faculty buy-in was the continued success of a similar Core in the accounting program ten years earlier.

7. CONCLUSION

IS firms growing ever more rapidly have an unquenchable demand for new hires with practical knowledge. Undergraduate IS programs are struggling to produce students with the expertness and professionalism these firms need as they place new hires on important business contracts. While our experience is that IS students find good jobs in most programs (regardless of their methodology), our recruiters report that this integrated method provides high quality training. At the least, this method seems to have had positive impacts on the number of IS enrollments.

For over a decade, IS analysis and design classes have been teaching methods beyond the traditional waterfall approach to system development. Today's systems implementation strategies include agile development, iterative approaches, and many other unique methods. In like manner, our teaching methods need to embrace more effective strategies than simply pushing students through a set of disjointed Core classes.

The IS Core model, as implemented at BYU, is preparing its students to become expert professionals by providing practical and integrated exercises through cross course assignments and semester-long collaborative projects. Students immersed in this program model are better prepared for professional work upon graduation. Due to the practical experiences and increased competence of these students, recruiters find them to be invaluable assets, uncommonly prepared to lead as experts in their places of employment.

We hope this paper provokes thoughts for change and ideas for implementation for a more effective and integrated IS curriculum teaching model. The authors urge those who are in positions of influence to begin making a difference by exploring ways to implement a similar integrative model of teaching within their own programs.

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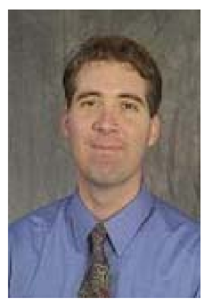

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APPENDIX 1: STUDENT SURVEYS

Descriptive Statistics

	N	Mean	Std. Dev.	Scale	Description
Competency					
Competenciesconfidence	128	4.35	0.961	1 (disagree) - 5 (agree)	The Core helped me feel confident in completing IS projects
competenciesconfrontation	128	4.23	0.966	1 (disagree) - 5 (agree)	The Core group work helped me learn to deal with confrontation
competenciesculture	128	4.16	1.002	1 (disagree) - 5 (agree)	The Core helped me understand the IS "culture"
competenciesethics1	128	4.40	0.863	1 (disagree) - 5 (agree)	The Core helped me solidify my ethical values
competenciesethics2	128	4.10	1.034	1 (disagree) - 5 (agree)	The Core helped me think about ethical issues faced by business professionals
competenciesethics3	128	4.15	1.036	1 (disagree) - 5 (agree)	I fell better prepared to face business ethical dilemmas after the Core
competenciesethicsbefore	128	4.74	0.605	1 (disagree) - 5 (agree)	I had solid ethical values coming into the Core
competenciesnews	128	3.88	1.214	1 (disagree) - 5 (agree)	The Core helped me build habits for reading IS and business news
competenciesworkwithothers	128	4.52	0.851	1 (disagree) - 5 (agree)	The Core group work helped me learn to work with others
competenciessem1group	128	4.07	0.998	1 (ext. disfunc) - 5 (ext. func)	Semester 1 group rating
competenciessem2group	128	4.05	1.037	1 (ext. disfunc) - 5 (ext. func)	Semester 2 group rating
competenciespowerpointafter	128	4.66	0.645	1 (disagree) - 5 (agree)	I felt confident in my ability to create PPT after the Core
competenciespowerpointbefore	128	4.17	0.940	1 (disagree) - 5 (agree)	I felt confident in my ability to create PPT before the Core
competenciespresentafter	128	4.45	0.812	1 (disagree) - 5 (agree)	I felt confident in my presentation ability after the Core
competenciespresentbefore	128	3.82	1.180	1 (disagree) - 5 (agree)	I felt confident in my presentation ability before the Core
competencieswriteafter	128	4.39	0.734	1 (disagree) - 5 (agree)	I felt confident in my business writing ability after the Core
competencieswritebefore	128	3.63	1.122	1 (disagree) - 5 (agree)	I felt confident in my business writing ability before the Core
Laptop Usage					
laptopsplaying	128	17.500	15.9724	0, 10, 20, …, 100 percent	Estimated "playing" time on laptop during clas lectures
laptopseffective	128	4.71	0.712	1 (disagree) - 5 (agree)	Laptop requirement (meaning all had laptops) made group work more effective
laptopsplayanyway	128	3.18	1.519	1 (disagree) - 5 (agree)	I would have been distracted from lectures anyway (even without a laptop)
laptopsrequirement	128	4.48	0.947	1 (disagree) - 5 (agree)	The laptop requirement was an important factor in my learning
laptopssem1collab	128	4.30	1.060	1 (disagree) - 5 (agree)	Group in semester 1 used distributed communication (chat, email, file sharing)
laptopssem2collab	128	4.66	0.692	1 (disagree) - 5 (agree)	Group in semester 2 used distributed communication (chat, email, file sharing)
laptopsunreasonable	128	1.74	1.044	1 (disagree) - 5 (agree)	Laptop requirement was an unreasonable financial burden
laptopsskillsafter	128	4.15	0.785	1 (begin) to 5 (expert)	Student computer skills after Core
laptopsskillsbefore	128	2.88	1.171	1 (begin) to 5 (expert)	Student computer skills before Core

Course					
Corerigordifficult	128	4.39	1.052	1 (disagree) - 5 (agree)	The Core was more difficult than other BYU semesters
Corerigorstepup	128	4.49	0.914	1 (disagree) - 5 (agree)	The Core was a significant step up in rigor
Corerigorassignment	126	7.5794	5.17587	free numeric text	Hours/week spent on individual assignments
Corerigorgroup	126	9.8056	6.76313	free numeric text	Hours/week spent on group assignments
Corerigorreading	127	5.7402	4.86886	free numeric text	Hours/week spent reading material
Corerigortotalhours	124	19.2702	10.79491	free numeric text	Hours/week out of class spent on Core (in total)
Course - 401					
courseloaddifficultyi401	128	4.30	1.570	1 (most diff) to 6 (least diff)	Ranking of difficulty for 401
courseloadgroupi401	128	3.37	1.626	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 401
courseloadi401	128	4.6953	2.74882	free numeric text	Average hours spent out of class on 401
courseloadindividuali401	128	4.02	1.461	1 (most time) to 6 (least time)	Ranking of amount of Individual time spent on 401
Course - 402					
courseloaddifficultyi402	128	3.38	1.431	1 (most diff) to 6 (least diff)	Ranking of difficulty for 402
courseloadgroupi402	128	3.98	1.403	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 402
courseloadi402	128	4.8125	3.09938	free numeric text	Average hours spent out of class on 402
courseloadindividuali402	128	3.73	1.407	1 (most time) to 6 (least time)	Ranking of amount of Individual time spent on 402
Course - 403					
courseloaddifficultyi403	128	2.66	1.421	1 (most diff) to 6 (least diff)	Ranking of difficulty for 403
courseloadgroupi403	128	3.99	1.709	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 403
courseloadi403	128	8.9258	5.27999	free numeric text	Average hours spent out of class on 403
courseloadindividuali403	128	1.91	0.980	1 (most time) to 6 (least time)	Ranking of amount of Individual time spent on 403
Course - 411					
courseloaddifficultyi411	128	4.70	1.488	1 (most diff) to 6 (least diff)	Ranking of difficulty for 411
courseloadgroupi411	128	3.34	1.432	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 411
courseloadi411	127	4.5551	3.33347	free numeric text	Average hours spent out of class on 411
courseloadindividuali411	128	4.44	1.499	1 (most time) to 6 (least time)	Ranking of amount of Individual time spent on 411
Course - 412					
courseloaddifficultyi412	128	3.19	1.561	1 (most diff) to 6 (least diff)	Ranking of difficulty for 412
courseloadgroupi412	128	4.28	1.469	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 412
courseloadi412	128	4.7031	3.48757	free numeric text	Average hours spent out of class on 412
courseloadindividuali412	128	4.23	1.417	1 (most time) to	Ranking of amount of Individual time spent on

				6 (least time)	412
Course - 413					
courseloaddifficultyi413	128	2.25	1.469	1 (most diff) to 6 (least diff)	Ranking of difficulty for 413
courseloadgroupi413	128	1.56	1.114	1 (most time) to 6 (least time)	Ranking of amount of Group time spent on 413
courseloadi413	125	10.1720	6.27755	free numeric text	Average hours spent out of class on 413
courseloadindividuali413	128	2.11	1.564	1 (most time) to 6 (least time)	Ranking of amount of Individual time spent on 413
Faculty					
knowledgeexamples	128	4.46	0.822	1 (disagree) - 5 (agree)	The faculty were strong examples of IS professionals
knowledgeexperts	128	4.55	0.730	1 (disagree) - 5 (agree)	The faculty were experts in their fields
knowledgelearn	128	4.29	0.898	1 (disagree) - 5 (agree)	The faculty exhibited a desire to learn with the students
knowledgeinspire	128	4.52	0.813	1 (disagree) - 5 (agree)	The faculty inspired and motivated me to learn
knowledgemasters	128	3.95	1.064	1 (disagree) - 5 (agree)	I felt like I was sitting at the feet of masters in the Core
facultyrelationshipapproachable	128	4.62	0.744	1 (disagree) - 5 (agree)	The faculty were approachable for academic questions
facultyrelationshipavailable	128	4.48	0.832	1 (disagree) - 5 (agree)	The faculty were available to help me individually
facultyrelationshiplisten	128	4.32	0.963	1 (disagree) - 5 (agree)	The faculty were willing to listen to student opinions
facultyrelationshipmissedclass	128	4.36	0.920	1 (disagree) - 5 (agree)	The faculty worked with me on problems (flybacks, grading problems, etc.)
TA					
tasapproachable	128	3.97	1.011	1 (disagree) - 5 (agree)	The TAs were approchable for academic concerns or issues
tasavailable	128	4.04	1.060	1 (disagree) - 5 (agree)	The TAs were available to help me individually
tasexamples	128	3.96	0.967	1 (disagree) - 5 (agree)	The TAs were strong examples of IS professionals
tasknowledge	128	4.22	0.939	1 (disagree) - 5 (agree)	The TAs understood the topics they were TAing
taslisten	128	3.95	1.034	1 (disagree) - 5 (agree)	The TAs were willing to listen to student opinions
taslab	128	3.37	1.374	1 (disagree) - 5 (agree)	The TA lab with established times was important to my success
INTEX I					
INTEX1again	128	4.75	0.784	1 (disagree) - 5 (agree)	INTEX 1 should be done again next year
INTEX1bestexperience	128	4.23	1.152	1 (disagree) - 5 (agree)	INTEX 1 was the best course-related experience of the first semester
INTEX1difficult	128	3.93	1.262	1 (disagree) - 5 (agree)	INTEX 1 was difficult but did not expect too much from me
INTEX1easy	128	1.42	0.819	1 (disagree) - 5 (agree)	INTEX 1 was easy
INTEX1important	128	4.63	0.895	1 (disagree) - 5 (agree)	INTEX 1 was an important part of the first semester
INTEX1important2	128	3.96	1.180	1 (disagree) - 5 (agree)	INTEX 1 was THE most important part of the first semester

INTEX1integration	128	4.20	1.102	1 (disagree) - 5 (agree)	INTEX 1 pulled the 401 and 402 classes together for me
INTEX1internship	128	3.52	1.190	1 (disagree) - 5 (agree)	INTEX 1 helped prepare me for my internship
INTEX1toomuch	128	2.14	1.228	1 (disagree) - 5 (agree)	INTEX 1 expected too much from me.
INTEX1worthit	128	4.41	1.054	1 (disagree) - 5 (agree)	INTEX 1 was worth the effort
INTEX II					
INTEX2again	128	4.25	1.057	1 (disagree) - 5 (agree)	INTEX 2 should be done again next year
INTEX2bestexperience	128	4.09	1.053	1 (disagree) - 5 (agree)	INTEX 2 was the best course-related experience of the first semester
INTEX2difficult	128	3.38	1.249	1 (disagree) - 5 (agree)	INTEX 2 was difficult but did not expect too much from me
INTEX2easy	128	1.74	0.949	1 (disagree) - 5 (agree)	INTEX 2 was easy
INTEX2important	128	4.31	0.978	1 (disagree) - 5 (agree)	INTEX 2 was an important part of the second semester
INTEX2important2	128	4.13	0.999	1 (disagree) - 5 (agree)	INTEX 2 was THE most important part of the second semester
INTEX2integration	128	4.04	1.045	1 (disagree) - 5 (agree)	INTEX 2 pulled the 401 and 402 classes together for me
INTEX2internship	128	3.70	1.139	1 (disagree) - 5 (agree)	INTEX 2 helped prepare me for my internship
INTEX2toomuch	128	2.77	1.295	1 (disagree) - 5 (agree)	INTEX 2 expected too much from me.
INTEX2worthit	128	4.18	0.992	1 (disagree) - 5 (agree)	INTEX 2 was worth the effort
Learning - Professional					
learninggeneralconfidence 1	128	3.98	1.027	1 (disagree) - 5 (agree)	I felt confident as an IS professional after the Core
learninggeneralconfidence 2	128	4.37	1.071	1 (disagree) - 5 (agree)	The Core helped me gain confidence as an IS professional
learninggeneralconfidence 3	128	4.19	1.085	1 (disagree) - 5 (agree)	I feel prepared to enter the IS profession because of the Core
Learning - 401					
sourcei401group	128	2.33	0.689	1 (insig) - 3 (signif)	The source of learning for 401 - group work
sourcei401inclass	128	2.23	0.712	1 (insig) - 3 (signif)	The source of learning for 401 - in-class activities
sourcei401lectures	128	2.41	0.715	1 (insig) - 3 (signif)	The source of learning for 401 - in-class lectures
sourcei401professor	128	1.33	0.563	1 (insig) - 3 (signif)	The source of learning for 401 - out of class professor help
sourcei401selfstudy	128	2.46	0.626	1 (insig) - 3 (signif)	The source of learning for 401 - self study of topics
sourcei401students	128	2.11	0.712	1 (insig) - 3 (signif)	The source of learning for 401 - other students
sourcei401ta	128	1.35	0.583	1 (insig) - 3 (signif)	The source of learning for 401 - TA help
sourcei401textbook	128	2.20	0.703	1 (insig) - 3 (signif)	The source of learning for 401 - textbook study
sourcei401web	128	1.56	0.707	1 (insig) - 3 (signif)	The source of learning for 401 - web sites, online tutorials
Learning - 402					

sourcei402group	128	2.13	0.746	1 (insig) - 3 (signif)	The source of learning for 402 - group work
sourcei402inclass	128	2.54	0.614	1 (insig) - 3 (signif)	The source of learning for 402 - in-class activities
sourcei402lectures	128	2.63	0.600	1 (insig) - 3 (signif)	The source of learning for 402 - in-class lectures
sourcei402professor	128	1.59	0.747	1 (insig) - 3 (signif)	The source of learning for 402 - out of class professor help
sourcei402selfstudy	128	2.59	0.581	1 (insig) - 3 (signif)	The source of learning for 402 - self study of topics
sourcei402students	128	1.95	0.735	1 (insig) - 3 (signif)	The source of learning for 402 - other students
sourcei402ta	128	1.59	0.705	1 (insig) - 3 (signif)	The source of learning for 402 - TA help
sourcei402textbook	128	2.35	0.705	1 (insig) - 3 (signif)	The source of learning for 402 - textbook study
sourcei402web	128	1.57	0.739	1 (insig) - 3 (signif)	The source of learning for 402 - web sites, online tutorials
Learning - 403					
sourcei403group	128	2.43	0.695	1 (insig) - 3 (signif)	The source of learning for 403 - group work
sourcei403inclass	128	2.43	0.695	1 (insig) - 3 (signif)	The source of learning for 403 - in-class activities
sourcei403lectures	128	2.48	0.676	1 (insig) - 3 (signif)	The source of learning for 403 - in-class lectures
sourcei403professor	128	1.92	0.790	1 (insig) - 3 (signif)	The source of learning for 403 - out of class professor help
sourcei403selfstudy	128	2.66	0.592	1 (insig) - 3 (signif)	The source of learning for 403 - self study of topics
sourcei403students	128	2.59	0.621	1 (insig) - 3 (signif)	The source of learning for 403 - other students
sourcei403ta	128	2.16	0.827	1 (insig) - 3 (signif)	The source of learning for 403 - TA help
sourcei403textbook	128	1.32	0.614	1 (insig) - 3 (signif)	The source of learning for 403 - textbook study
sourcei403web	128	2.75	0.517	1 (insig) - 3 (signif)	The source of learning for 403 - web sites, online tutorials
Learning - 411					
sourcei411group	128	2.14	0.771	1 (insig) - 3 (signif)	The source of learning for 411 - group work
sourcei411inclass	128	2.04	0.757	1 (insig) - 3 (signif)	The source of learning for 411 - in-class activities
sourcei411lectures	128	2.14	0.761	1 (insig) - 3 (signif)	The source of learning for 411 - in-class lectures
sourcei411professor	128	1.54	0.720	1 (insig) - 3 (signif)	The source of learning for 411 - out of class professor help
sourcei411selfstudy	128	2.01	0.726	1 (insig) - 3 (signif)	The source of learning for 411 - self study of topics
sourcei411students	128	1.95	0.751	1 (insig) - 3 (signif)	The source of learning for 411 - other students
sourcei411ta	128	1.35	0.659	1 (insig) - 3 (signif)	The source of learning for 411 - TA help
sourcei411textbook	128	1.80	0.784	1 (insig) - 3 (signif)	The source of learning for 411 - textbook study
sourcei411web	128	1.40	0.580	1 (insig) - 3 (signif)	The source of learning for 411 - web sites, online tutorials
Learning – 412					
sourcei412group	128	2.21	0.770	1 (insig) - 3 (signif)	The source of learning for 412 - group work

sourcei412inclass	128	2.53	0.663	1 (insig) - 3 (signif)	The source of learning for 412 - in-class activities
sourcei412lectures	128	2.45	0.650	1 (insig) - 3 (signif)	The source of learning for 412 - in-class lectures
sourcei412professor	128	1.44	0.661	1 (insig) - 3 (signif)	The source of learning for 412 - out of class professor help
sourcei412selfstudy	128	2.35	0.694	1 (insig) - 3 (signif)	The source of learning for 412 - self study of topics
sourcei412students	128	2.08	0.800	1 (insig) - 3 (signif)	The source of learning for 412 - other students
sourcei412ta	128	2.27	0.801	1 (insig) - 3 (signif)	The source of learning for 412 - TA help
sourcei412textbook	128	1.86	0.761	1 (insig) - 3 (signif)	The source of learning for 412 - textbook study
sourcei412web	128	2.20	0.746	1 (insig) - 3 (signif)	The source of learning for 412 - web sites, online tutorials
Learning – 413					
sourcei413group	128	2.73	0.543	1 (insig) - 3 (signif)	The source of learning for 413 - group work
sourcei413inclass	128	2.49	0.721	1 (insig) - 3 (signif)	The source of learning for 413 - in-class activities
sourcei413lectures	128	2.48	0.652	1 (insig) - 3 (signif)	The source of learning for 413 - in-class lectures
sourcei413professor	128	1.98	0.778	1 (insig) - 3 (signif)	The source of learning for 413 - out of class professor help
sourcei413selfstudy	128	2.55	0.674	1 (insig) - 3 (signif)	The source of learning for 413 - self study of topics
sourcei413students	128	2.66	0.594	1 (insig) - 3 (signif)	The source of learning for 413 - other students
sourcei413ta	128	2.06	0.830	1 (insig) - 3 (signif)	The source of learning for 413 - TA help
sourcei413textbook	128	1.34	0.655	1 (insig) - 3 (signif)	The source of learning for 413 - textbook study
sourcei413web	128	2.70	0.583	1 (insig) - 3 (signif)	The source of learning for 413 - web sites, online tutorials
Proficiency					
PreCoreanalysis	128	1.31	0.696	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in analysis (401)
PreCoredatabase	128	1.49	0.832	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in database (402)
PreCoredesign	128	1.45	0.811	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in design (411)
PreCoreentdev	128	1.60	0.950	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in ent. devel. (413)
preCorenetworking	128	1.66	0.916	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in networking (412)
preCoreprogramming	128	1.82	0.992	1 (beg) - 5 (expert)	How proficient the student felt (preCore) in programming (403)
Studentage	128	22.977	3.7321	free numeric text	The age of the student at Core time
studentpreCoregpa	127	3.5344	0.26294	free numeric text	The student's GPA coming into the Core

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