Revising Instructional Strategies in Systems Analysis and Design

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ABSTRACT

Systems Analysis and Design is a core component of an education in information systems. To appeal to a wide range of constituents, the content of a traditional Systems Analysis and Design course has been supplemented with three separate instructional strategies. This paper presents a course model that incorporates active learning techniques, a model from accounting literature (REA), and prototyping, along with traditional Systems Analysis and Design topics. Feedback from students indicates increased satisfaction with the learning process and retention of material.

Keywords: Systems Analysis and Design, Active Learning, REA Modeling, Prototyping

INTRODUCTION

A Systems Analysis and Design (SAD) course is a core component of the information systems degree. This course can typically contain a rather broad set of topics, ranging from planning strategies, project management, system analysis, and system design to related topics such as object-oriented development methodologies. The breadth and depth of topics that are frequently covered in SAD make it a difficult course for not only students, but also for the instructor. In addition to the material presented to students in a SAD course, it typically comes at a time in their education, their third year, when students should be making the transition from Bloom's (1956) learning levels of knowledge, comprehension, and application to levels of analysis, synthesis and evaluation (Leamnson, 1999). The combination of introducing considerable new material, in addition to progressing to higher learning levels, contributes to not only the difficulty in teaching the material, but also to frustrations exhibited by many undergraduates.

SYSTEMS ANALYSIS AND DESIGN COURSE

The Information Systems Model Curriculum (ISMC) (Davis, Feinstein, Gorgone, Longenecker, and Valacich, 2003) provides a perspective on the overall content of an Information Systems program. One of the components of the guidelines is IS2002.7, Logical Analysis and Design. Scope and topics for the course are presented in the discussion as follows:

> SCOPE This course examines the system development and modification process. It emphasizes the factors for effective communication and integration with users and user systems. It encourages interpersonal skill development with clients, users, team members, and others associated with development, operation and maintenance of the system. Structured and object oriented analysis and design, use of modeling tools, adherence to methodological life cycle and project management standards.
>
> TOPICS Life cycle phases: *requirements determination*, *logical design*, *physical design* and implementation planning; *interpersonal skills*, *interviewing*, presentation skills; *group dynamics*; *risk and feasibility analysis*; group-based approaches: *project management*, joint application development (JAD), structured walkthroughs; structured versus object oriented methodologies; *prototyping*; database design; software package evaluation, acquisition, and integration; global and inter-organizational issues and *system integration*; professional code of ethics. (Davis et al., 2003) (italics added)

The broad scope of the subject and numerous topics leaves little room for the instructor to introduce students to additional related topics, or to cover many of the topics in any depth. Our course contains the italicized topics as indicated above. We will refer to this course as Systems Analysis and Design, or SAD, throughout the remainder of this manuscript.

Within the ISMC, the SAD course is a prerequisite to IS2002.8, Physical Design and Implementation with DBMS, as well as to IS2002.10, Project Management and Practice. Our specific curriculum is consistent with the ISMC in that our SAD course is a prerequisite/corequisite to Database Design, which is in turn a prerequisite for the Project Management and Practice, titled Advanced SAD in our curriculum.

Textbooks focusing on structured methods for the SAD course (Whitten, Bentley and Dittman, 2004; Dennis and Wixom, 2003; Hoffer, George, and Valacich, 2005), typically present the material in the planning, analysis, design, implementation sequence represented by the waterfall method. Such textbooks address both the scope and topics specified for IS2002.7 in the Information Systems Model Curriculum. Our course follows this structure, but ends prior to the implementation phase.

In addition to conforming to the ISMC, our curriculum must also serve multiple stakeholders. The SAD course is a requirement for both the Computer Information Systems and Accounting majors within the College of Business. In addition, Computer Science majors from the College of Engineering are also required to satisfactorily complete this course. The common denominator for students is completion of an introductory programming course and junior standing at the university. Students from other majors, that meet these requirements also take the course, as do students enrolled in the Masters of Business Administration program.

Providing meaningful content to a broad set of students is a challenge. To help deliver the material effectively, we report three separate strategies utilized in our SAD course. The initial strategy is an employment of active learning strategies within the classroom, in addition to the typical 'team time.' Next, we introduce the students to a model utilized in Accounting Information Systems (AIS), the Resource, Event, Agent (REA) model proposed by Bill McCarthy (1982, 2003). Finally, we focus on prototyping using Microsoft Access.

STRATEGIES UTILIZED

Active Learning

Active/collaborative learning refers to instructional methods that encourage students to work together on academic tasks (Hiltz, 1997), stressing students' active involvement in their own learning (Hall, Waitz, Brodeur, Soderholm, and Nasr., 2002). Mead (1934) explains that active approaches present learning as a social process that takes place through communication with others. Students at various performance levels work together in small groups to achieve a common goal, and take responsibility not only for their own learning, but also that of their peers (Gokhale, 1995) Students work together as members of a learning community, working on problem-solving tasks by discussing and sharing information and questioning each other (Le, 2002). Peer interaction through the process of reacting and responding to others forces students to verbalize their ideas and construct knowledge (Bouton and Garth, 1983; Alavi, 1994; Hiltz, and Benbunan-Fich, 1997). The success of one student helps others to be successful (Gokhale, 1995).

Active/collaborative learning has both immediate and long term benefits for the student. Not only is their learning enhanced, but they are also better prepared for the workforce. Although lectures are traditionally the mainstay of university education, lectures in their traditional sense do not necessarily meet the demand of learners, as lectures can only function in a very limited context (Le, 2002). Active/collaborative learning approaches promote the active exchange of ideas within small groups, a process that not only increases interest and participation in class but also promotes critical thinking (Astrachan, Duvall, Forbes, Rodger, 2002; Gokhale, 1995).

Research shows that students master material to a greater degree and retain more information when active/collaborative learning methods are incorporated into the classroom (Johnson, Johnson, and Smith, 1991; Slavin, 1995; Bonwell and Eison, 1991; Penner, 1984; Drummond, 1995; Astrachan, et al., 2002). Johnson and Johnson (1986) point out that there is considerable evidence that students who work as part of cooperative teams achieve at higher levels of thought and retain information longer than students who work as individuals. Students tend to perform at higher intellectual levels in collaborative situations than when working individually (Vygotsky, 1978).

Additional research (Gokhale 1995, Johnson and Johnson 1986, Rau and Heyl 1990) indicates that active/collaborative learning methods enhance both social and cognitive skills. This can be attributed in large part to group diversity and the opportunity to experience different viewpoints. The perspectives, experiences, and backgrounds of all students are important for enriching learning in the classroom (Tinzmann, Jones, Fennimore, Bakker, Fine, and Pierce, 1990). Group diversity in terms of knowledge and experience contributes positively to the learning process (Gokhale, 1995). Bruner (1985) asserts that active/collaborative learning methods improve problem-solving strategies because the students are confronted with different interpretations of the given situation. Shared learning provides students with an opportunity to engage in discussion, take responsibility for their own learning, and to improve their critical thinking skills (Totten, Sills, Digby, and Russ, 1991). The peer support system inherent in active/collaborative learning makes it possible for the student to internalize both external knowledge and critical thinking skills and to convert them into tools for intellectual functioning (Gokhale, 1995).

Because learning beyond the classroom increasingly requires the consideration of diverse perspectives, it is essential to provide students with opportunities to do this in multiple contexts in schools (Le, 2002). Further, advances in technology and changes in the organizational infrastructure put an increased emphasis on teamwork within the workforce (Gokhale, 1995). Workers must be able to think creatively, solve problems, and make decisions as a team. Therefore, the development and enhancement of critical-thinking skills through active/collaborative learning should be a key component of a student's education (Gokhale, 1995).

Active/collaborative learning methods include a myriad of instructional strategies, including cooperative learning methods, problem-centered methods, peer teaching or coaching, and discussion groups (Dirkx, 1998). The approach that we currently employ incorporates features of both peer teaching and discussion groups. Peer teaching or coaching is a process in which learners teach their fellow learners. It probably represents the oldest form of collaborative learning in American education (Godsell, Mahar, Tinto, Smith, and MacGregor, 1992). While peer teaching is less structured than the other forms of collaborative learning, it provides a strong, non-authoritarian, supportive environment for learners (Dirkx, 1998). Discussion groups, perhaps the most widely-known and least structured form of collaborative learning, provide a context in which learners can reflect on the meaning of their experiences. Characteristic of this form of collaborative learning is dialogue among teachers and students in which they engage in a free exchange of opinions and ideas about particular topics, issues, or problems. Discussion groups provide for both an analysis of existing ideas and the emergence of new ideas among its members (Dirkx, 1998). Students are encouraged to carefully and thoughtfully examine, and possibly reevaluate, their own beliefs and values regarding the topic under discussion (Christensen, 1991).

The active/collaborative learning approach that is currently used in our class is to pair up students on a completed homework assignment. Students are instructed to "take sides" or review their solution independently. They are expected to discuss their perspective with each other, and reach consensus on a solution. This involves facets of peer teaching. In particularly difficult assignments we may further have them pair up with another set of students and again attempt to reach a consensus. When all teams have arrived at a consensus, the entire class then discusses the various solutions, which involves features of discussion groups.

Reinforcement of the collaborative learning process continues throughout the semester. Students collaborate on a semester project in which they work in small teams to analyze and design a small system. In addition, students continue to collaborate in class throughout the semester as they work together with data and process models, as well as design issues.

Modeling with REA

The REA model was introduced into the accounting literature in 1982 (McCarthy, 1982). Focusing on an economic event as a key business occurrence, McCarthy illustrates that the nature of an event is that an agent gives up a resource in receipt of another resource. For example, the script for a typical business transaction is as follows:

> A customer (external agent) enters a retail establishment and shops for one or more items (resource). The customer selects these items and proceeds to pay for them (event) at a checkout stand (internal agent). The customer has given up the coin of the realm for the basket of goods. Likewise, the retailer receives said coin and gives up said basket.

McCarthy's perspective provides a starting point for investigating organizational events at a general level. In the preceding script, a change in scenario from a brick and mortar retail establishment to the World Wide Web does little to alter the essence of the economic event.

The generalizability of McCarthy's model was derived, in part, from the typical debit-credit model (DC) in accounting. The model represents the duality of the economic event presented to students in introductory accounting courses. Furthermore, the symbolic component in the model was developed by McCarthy based on Chen's relational model (Chen, 1976), as the resource and agents (entity) are associated via the event (relationship).

In addition, McCarthy has extended this model to the enterprise, providing a Value-Chain perspective (McCarthy, 2003, Dunn, Cherington, and Hollander, 2005). The strength of McCarthy's model flows from its enterprise perspective. Dunn, et al (2005), present a value chain viewpoint that categorizes overall processes into five broad processes: financing, acquisition/payment, payroll, conversion, and sales/collection. By providing students with a perspective on grouping organizational events into logical categories, the REA model helps students focus on not only the interrelatedness of different processes, but also on how consistent processes are across organizations.

This association of REA with both entities and processes flows readily into a presentation of structured methods. Multiple examples can be obtained for converting REA models into the entity-relationship model (Dunn et al., 2005). Focusing on common processes allows the students to consider organizational idiosyncrasies as they decompose general processes into those specific to an organization. In addition, the REA model is touted as an ontology that frames organizational information needs as a set of basic, enterprise components. The basic framework can readily generate an enterprise set of specifications that can be represented in an generalized REA model, whose events can be further decomposed into specific tasks (Geerts and McCarthy, 2001).

Prototyping

Prototyping is a development strategy 'for quickly building a functioning, but incomplete model of the information system using rapid development tools' (Whitten, Bentley, and Dittman., 2004, p. 70). The concept of prototyping is presented as a development strategy in SAD (Whitten, et al., 2004, Dennis and Wixom, 2003), as well as database (Watson, 2004) textbooks.

Furthermore, prototyping can be divided into two separate strategies. Evolutionary prototyping is a strategy in which a tool is utilized to iterate through development cycles to eventually deliver a final product (Dennis and Wixom, 2003). In contrast, throwaway prototyping is utilized to provide a visual framework for a proposed system, and differs from evolutionary prototyping in that the prototype will not become the working system. In throwaway prototyping, the system is often developed with different languages and toolsets than those used in the prototype (Dennis and Wixom, 2003).

Students enrolled in our SAD course have completed a programming course, but generally have little exposure to business applications. Furthermore, there is no requirement that they be proficient in, or even exposed to, database applications. The course requirements specify that term projects be accompanied by a prototype that conforms to the models utilized in the Analysis section of our course (Entity Relationship and Data Flow Diagrams) and those refined by Design (Structure Charts, Relational Model).

To overcome the lack of esposure to database applications, we have begun to instruct the students in the use of Microsoft Access as a tool for prototyping the system. Initial instruction in this software package is used to help reinforce the linkages between the traditional course material and a software tool. In general, students perceive advantages in learning a database product, including benefits in future courses as well as in their current employment or service.

We combine both evolutionary and throwaway prototyping in the term project. The students know that they will not be building an actual system, but will be creating the necessary documents to effectively build the system--throwaway prototyping. In the process of learning the software tool and refining their system models, they are moving through evolutionary prototyping as well. In addition, because we require that the prototyped systems are formally documented, follow a traditional SDLC, and are framed within a model that conforms to the enterprise, we believe that drawbacks associated with prototyping (Hoffer, George, and Valacich, 2005) are avoided.

THE COURSE

The course has evolved as represented by the syllabus attached in Exhibit A. With the exception of lab exercises and assignments with Microsoft Access and exposure to the REA model, introduction to the course follows a rather conventional approach, focusing on the alignment of IS with the organization. Students are then introduced to systems development methodologies, including prototyping. Homework assignments are utilized in the initial course segment to provide a framework for student discussions. These discussions are enhanced by the frequent of pairing of students with different majors. These dyads discuss homework assignments, and are later paired with another dyad of students to further discuss the assignments. To complete the exercise, the entire class works out a common solution with the instructor. Feedback from students indicates that they were appreciative of different perspectives and the opportunity to discuss complex topics. An additional benefit of the strategy is that it introduces students to others, and provides a basis for the formation of student teams.

The pairing of students as part of the daily class structure continues throughout the early portion of the course, and is supplemented by sessions in the computer laboratory as part of the in-class experience. Pairing of students continues throughout the course, with later homework assignments designed to develop team dynamics.

After a project management module and introduction to Microsoft Project, the next segment of the course contains modules that are consistent with structured analysis and design instructional strategies. Students are introduced to a framework of collecting information regarding events, such as event tables or use cases. The relationship between REA and organizational information issues continues to be emphasized, as is the relationship between the evolved REA and Value-Chain framework with both entity-relationship and data flow diagrams respectively.

A term project is assigned as the course shifts to the analysis module. Requirements for the project include team deliverables of various models (DFD, ERD, SC) developed with a CASE tool, along with the corresponding data repository. Other project deliverables include an executive summary, system requirements, a CPM chart, and a feasibility analysis. During the design phase students are provided the opportunity to adjust their initial models.

During the analysis and design modules of the course, active learning strategies shift slightly, with rotating team membership for in-class exercises. Some of the in-class assignments associated with these modules require that students pair up with students not in their team, whereas others require pairing up with a fellow team member.

The design modules of the course require students to continuously iterate between the formal models that they have developed and the prototype, with the goal of making the two consistent with each other. During this process, students begin to focus on delivering a product that could easily be implemented.

Results from the approach have been positive. Prior to this strategy, students were less than satisfied with the learning process. However, faculty members teaching the subsequent senior-level advanced SAD course have expressed satisfaction with overall the preparation of students.

The positive aspect of this approach has been its acceptance by students. The instructor consistently addresses feedback throughout the term in the form of reflection papers. In addition, weekly feedback (learned, didn't learn, please cover again) was obtained from the students and used to adjust the course in "midstream." Feedback on both of these dimensions was favorable throughout the semester, with final evaluations indicating higher approval in comparison to prior terms. In addition, end-of-semester "official" reporting showed improvements on all measured dimensions for instructor evaluations. Additional feedback in the future will be solicited from senior-level course instructors regarding the preparedness of this body of students.

In conclusion, this course contained traditional lectures, active learning, modeling with REA, and the use of software, particularly for prototyping, to continually introduce and reinforce traditional SAD course material. Today's students have utilized software applications for learning throughout their educational process. Students who experience this approach throughout the revised SAD course comment that they are learning, and indicate that lab time is important, if not critical, to them. They believe that their learning is enhanced by the opportunity to utilize technology as part of their learning process.

The end goal of this course has always been to have the "light bulbs" go on for the majority of students prior to the end of the course. This approach seems to make this occur for more students, and at an earlier point in the semester.

RESTRICTIONS

This process was tailored to a specific set of students. Typically, between 40 and 50% of the students in any one SAD course are declared accounting majors, with a similar percentage of Information Systems majors. The remainder is composed of students typically from other colleges. This diverse group of students has little experience with the building of programs and systems. Most also have little exposure to a relational database management system and corresponding software.

The strategy can require additional effort on the part of the instructor, assuming that little of the core SAD course is dropped due to the adoption of the additional strategies. Additional grading due to an increased load in homework assignments takes time. In addition, unless groups are assigned early in the term, or an assistant is readily available, the instructor may also be called upon to perform 'system support.'

CONCLUSIONS

Our results in utilizing the three additional strategies to deliver the SAD course have been well received by our student population. First, students perceive learning a database management system to be a valuable experience. Iterating though the prototyping of a small system in a team-focused classroom environment assists them in assessing their overall IS skills as well as enhancing their interpersonal knowledge, skills, and abilities.

Active learning sessions based upon homework assignments enable students to clarify their ideas with others. In addition, the diversity of our students by major assists in providing a variety of perspectives in assessing 'soft' problems often encountered early in the course. Later active sessions provide students the opportunity to focus on a standard set of SAD skills, as well as to work on skill sets for specific software applications and team-related issues.

The final component of our strategy, the REA model, helps introduce students to the enterprise perspective. Because the model is partially derived from a model that many of them have been introduced to, many of the concepts are not new. The ability to represent parts of the model as scripts helps enable the student to see both the general and specific issues in a given situation. Finally, the model as presented in our course is linked to value chain concepts, as well as both data and process modeling. We believe that this perspective is beneficial in linking business and technical concepts, thereby enhancing our students' future career performance.

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Exhibit A – Syllabus with topics only

Week	General Topic
1	Introduction to Course Introduction to Access
2	SAD Methods REA Introduction
3	More Access
4	Value System/Chain IS Building Blocks
5	IS Development Project Management
6	Catch-up/Review
7	Systems Analysis
8	Fact Finding Business Process Modeling
9	Data Modeling/Analysis
10	Data/Process Modeling
11	Process Modeling
12	Feasibility
13	Catch-up/Review
14	Systems Design Output and Input Design User Interface
15	Catch-up / Review
16	Final Exam