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Applied Learning with the Virtual Teaching Assistant

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ABSTRACT

The relevance of a university degree depends upon the ability of graduates to apply their learning in complex problem solving situations. This ability should be taught and practiced wherever possible in the curriculum, but often requires a substantial commitment of face-to-face instructor time. However, in many disciplines software systems can be constructed to provide or supplement relevant learning environments. This paper describes a system developed through the use of the design and development research technique. The case shows how collaborative, intentional, and project-based learning can be incorporated in and stimulated by design decisions informed by the research technique. The paper provides details about a system built around realistic role playing and supported by a range of tools. The combination of a scenario with a real-world context, along with a software system that evaluates student work as well as interactively mentoring students, provides the services of a virtual teaching assistant.

Keywords

Education, simulation, project-based learning, design and development research, pedagogical agents

INTRODUCTION

Educational research has consistently found that deep learning requires involvement by students in their learning (Cope, 2003). Although passive learning approaches such as lectures and structured homework assignments 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, 2001). While students seem most comfortable with passive learning approaches, it is widely accepted that they will learn more and retain knowledge longer if teaching approaches encourage active learning, project-based learning, and intentional learning (Dunlap, 2005; Sullivan, 1993; McKinney and Denton, 2005; Nilsen, 2009). A significant gap exists between educationally desirable learning environments and those that can be delivered with the standard levels of staffing in most institutions. As IT professionals we should be able to supply tools and systems in an integrated way that allows the best learning environments to be made available within budget, just as systems have been used in other industries. This paper describes the tools and systems that can be made available to support active learning and illustrates these with a description of the delivery of these tools in a specific teaching case. The system relies upon a virtual teaching assistant software system that simulates a real-world scenario and uses animated characters to interact with students to provide immediate assessment of their work and corresponding feedback.

The simulated real-world-like case is designed to accomplish a variety of goals, including

- Providing students with an opportunity to apply their learning in a complex problem-solving situation.

- Providing a scenario structured to capture the complexities and ambiguities of the real world.

The case makes extensive use of animated pedagogical agents to assess and grade student work, to provide feedback, and to guide students through the problem-solving process. These pedagogical agents are animated characters that can be used to enhance communication with students because they are specifically designed to interact with users in computer-based environments. These agents enable interaction with students through tutorial dialogue in the role of a coach or mentor (Burton and Brown, 1982). The use of animated pedagogical agents enhances the rate and quality of student learning because students interact with them in an essentially natural way, following their verbal and non-verbal navigational directives (Gulz and Haake, 2006). Pedagogical agents are used to

- Increase student engagement in and student understanding of core course concepts by providing students with written and oral explanations of course concepts that students don't seem to grasp (as revealed by student errors) and to guide them through the problem-solving process.

- Provide an alternative to professors administering such a project in a face-to-face scenario, thereby freeing up professor time while still providing guidance and providing timely feedback to students.

In this way the system provides teaching support so that students can take a multitude of paths through a realistic case study while receiving constant individual support, while the instructor is freed up to monitor the class as a whole. Routine feedback is delivered by the system and in-depth support can be provided by the teacher at significant moments.

Student feedback indicates that the animated pedagogical agent is engaging and increases their enthusiasm for learning. This favorable impression comes about in spite of the negative perception fostered by Microsoft's Clippy, the animated paper clip best known for barging in and interrupting users. One lesson learned from Clippy's failure is that the dialogue management of a conversational agent is absolutely crucial to its success (Graesser, 2008). Further, the conformity of an agent's appearance to the domain in which it is used influences user expectations and even learning outcomes (Veletsianos, 2007). The virtual teaching assistant utilizes an animated agent with a professional appearance and carefully crafted dialogue.

LEARNING APPROACHES

As noted earlier, passive learning approaches have serious shortcomings. Therefore alternative learning approaches were investigated.

Active/collaborative learning

Active/collaborative learning approaches encourage students to work together on academic tasks (Hiltz and Benbunan-Fich, 1997), stressing students' active involvement in their own learning (Hall et al., 2002). The rationale behind active learning is that students must learn to put knowledge to work, and to accomplish this they must become actively involved in their own learning (Cohen and Boyd, 1996). Active/collaborative learning approaches not only increase interest and participation in class but also promote critical thinking (Astrachan et al., 2002; Gokhale, 1995).

Intentional learning

Intentional learning makes learning itself the goal (Bereiter and Scardamilia, 1989; Martinez, 2000). Activities involving high interaction and cognitive processing promote intentional learning (Martinez, 2000). Educational approaches that require a high level of engagement increase the levels of student motivation and interest (Daniels et al., 2002; Smith et al., 2005). Intentional learning can be encouraged by structuring lessons in ways that engage students in problems that require understanding and identifying core concepts with an emphasis on small group work and peer collaboration, and a focus on learning through active discussion (Bereiter and Scardamilia, 1987).

Project-based learning

Project-based learning has similarities to both active learning (Thomas, 2000) and intentional learning (Scardamalia and Bereiter, 1991), as well as "problem-based learning" (Gallagher et al., 1992), "project-focused learning" and "experiential education" (Thomas, 2000). Project-based learning organizes learning around projects (Thomas, 2000) and is based on the idea that the best form of professional development is learning by doing (Von Kotze and Cooper, 2000). Project-based learning provides a context in which students move toward thinking as a knowledge domain expert might think (Cavanaugh, 2004).

DOMAIN SELECTION

Because it can benefit greatly from utilization of the above learning approaches, accounting education was selected as the educational domain for this study. There is an urgent need for accounting graduates with the ability to apply their knowledge in practice. However, a widely accepted limitation of accounting education is that accounting students receive little or no exposure to ill-structured problems in a real-world context. For over two decades accounting educators have struggled with curriculum design in an effort to develop graduates with skills more appropriate for modern accounting and business professional careers. A common criticism of accounting education is that courses spend too much time on content mastery and too little time and effort helping students to develop skills that will enrich their lives and make them successful (Albrecht and Sack, 2000). Accounting classes provide little time for real-life experiences with accounting concepts, leaving little opportunity for students to experience the ambiguities and complexities of our global society and the demand for increased decision-making skills (Hocking and Hocking, 2009).

Educators and practitioners agree that the most important skills that graduates need upon entering the accounting profession include critical thinking, communications, technology, decision making, interpersonal, continuous learning, and teamwork (Albrecht and Sack, 2000). If students are to perform at the higher levels of thinking the profession has identified, students must learn to solve unfamiliar, ill-structured problems that will arise in practice (Springer and Borthick, 2004). However, for over two decades accounting educators have struggled with curriculum design in an effort to develop graduates with skills more appropriate for modern accounting and business professional careers (Albrecht and Sack, 2000). Among the deficiencies in accounting education are a focus on less relevant content, failure to prepare students for the ambiguities of the

business environment, lack of creativity and exposure to real business situations, and failure to develop appropriate skills (Albrecht and Sack, 2000). The Accounting Education Change Commission (AECC, 1990) set forth several objectives including enhanced personal and professional skills in communication, critical thinking, systematic structuring of complex situations, intellectual and interpersonal skills, as well as a common knowledge base and a professional orientation. In August 2000, the American Accounting Association stated that the survival of accounting education is dependent upon closing the gap between irrelevant accounting education and current professional accounting practices (Albrecht and Sack, 2000).

As the centerpiece of the financial accounting curriculum, the intermediate accounting course should play a pivotal role in accomplishing these objectives (Catanach et al., 2000; Jennings, 1998). However, an informal survey of several intermediate accounting textbooks shows that many provide one or more traditional practice sets to reinforce course content, and such assignments frequently lack certain aspects of skills development and do not address many of the pedagogical issues described below. Problems with current textbook-oriented teaching approaches include:

- Students tend to work with provided, structured data and have great difficulty identifying solutions to unstructured, complex situations. Exercises and problems included in textbooks present the data, and the student merely has to figure out how to use that data.

- Students often solve exercises and problems in the textbook by looking up a similar solution in the chapter and copying it. The student reinforces copying skills, but does not understand how to structure a solution starting from scratch.

- Students can solve narrowly focused problems, but lack understanding of the underlying process or the purposes of those processes. Homework assignments tend to be isolated, independent fact situations that seldom require the student to understand the overall process that progresses from the collection of data items like invoices, to the classification of that data, and finally to how it should be recorded.

- Students are weak in deductive and inductive reasoning. Because most problems focus only on small situations with limited data given to the student, the reasoning necessary for a solution is limited to arriving at a reasonable answer using the given data.

- Students have weak research skills and lack the ability required to interview clients thoroughly to obtain information critical to successful problem solving.

- Students often copy from one another when completing assignments. Students tend to focus on getting the answer and then believe that they have learned.

- Prior semesters' practice set and textbook problem solutions are often available to students, and some seem to find it difficult to resist the temptation to find and copy old answers.

RESEARCH APPROACH

In order to address the problems associated with current textbook-oriented teaching approaches, an integrated, computer-assisted teaching tool was proposed. It was determined that the agile systems approach to pedagogical software development would be most appropriate (Davey and Parker, 2010). Further, the overall study followed the design and development research approach. Design and development research is "the systematic study of design, development and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and non-instructional products and tools and new or enhanced models that govern their development" (Richey and Klein, 2007, xv). It is a practical form of research that attempts to test theory and validate practice (Tracey, 2009).

More widely accepted research approaches focus on descriptive knowledge and do not provide prescriptions with useful solutions for many design and development problems in education (van den Akker, 1999). Van den Akker (1999, 8-9) clarifies the differences between research conducted with predictive goals and that inspired by development goals:

> More than most other research approaches, development research aims at making both practical and scientific contributions. In the search for innovative 'solutions' for educational problems, interaction with practitioners…is essential. The ultimate aim is not to test whether theory, when applied to practice, is a good predictor of events. The interrelation between theory and practice is more complex and dynamic: is it possible to create a practical and effective intervention for an existing problem or intended change in the real world? …An iterative process of 'successive approximation' or 'evolutionary prototyping' of the 'ideal' intervention is desirable. Direct application of theory is not sufficient to solve those complicated problems.

Reeves et al. (2004) point out that design and development research has the following characteristics:

- It focuses on broad-based, complex problems critical to education.
- It involves intensive collaboration among researchers and practitioners.
- It requires continual refinement of protocols and questions.

Peffers et al.(2007) identify six major milestones in design and development research including: a) identify the problem motivating the research; b) describe the objectives; c) design and develop the artifact; d) subject the artifact to testing; e) evaluate the results of testing; and f) communicate those results. In this study, the problem as detailed in the introductory section is the gap that exists between educationally desirable learning environments and those that can be delivered with the standard levels of staffing in most institutions. The objective is to supply IT-based tools and systems in an integrated way that allows the best learning environments to be made available within budget. The virtual teaching assistant is the result of the design and development phase. The system was tested in several intermediate accounting classes.

This study is a work in progress, with milestones 5 and 6 forthcoming. The evaluation approach will be modeled after that used by Springer and Borthick (2007), comparing course grades for students in the subsequent accounting course of students who previously completed the intermediate accounting course using standard practice sets to those who completed it using the virtual teaching assistant.

OBJECTIVES

The mandate of the integrated, computer-assisted teaching tool was to increase student engagement in and student understanding of intermediate accounting concepts by embracing active learning, intentional learning, and project-based learning to teach students to think critically and systematically. The objectives of this virtual teaching assistant include the following:

1. To simulate a real-world experience.
2. To review and reinforce accounting concepts.
3. To review the basics of the accounting cycle and the preparation of financial statements.
4. To develop the ability to handle the complexity that comes from missing, erroneous, and/or unstructured data, and to develop the ability to think "outside the box" so that the student will look beyond the information that has simply been provided.
5. To develop information research skills.
6. To develop the skill of interviewing others to obtain information.
7. To develop team management skills.

While the goals are similar to those associated with textbook practice sets, the interactive practice set is designed to provide students with exposure to a less structured, more realistic scenario. Further, active student engagement in their learning environment through teamwork assignments such as practice cases, role playing, and simulations is advocated by many in the profession (Albrecht and Sack, 2000; Bedford et al., 1986; Hocking and Hocking, 2009; Perspectives, 1989; Sundem, 1999).

During the development process it quickly became apparent that the general approach being used is applicable across a wide range of disciplines. The components of the virtual teaching assistant quickly coalesced into the system being described here.

SCENARIO AND TASKS

The first-of-a-series prototype of the virtual teaching assistant is built around an accounting case that addresses many technical accounting issues beyond those covered in a typical intermediate accounting class (Bezik, Smith and Parker, 2005). Specifically, the scenario tracks a fictional company through the early years of its existence. The students are put in the role of the accountants hired by the company. They required to interact with various professionals in the business community to obtain information needed to complete the company's financial statements. During this process, students are faced with complex, ambiguous, and realistic accounting issues. Students are required to research many of these issues rather than simply taking notes during lectures and reading a textbook.

About three weeks into a 15-week semester the students are organized into teams and given the business situation, the project objectives, general directions as to the type of accounting system to be used, the general process that should be followed, and due dates for project deliverables. The scenario upon which the interactive practice set is based involves a start-up web-site development and computer hardware sales company that approaches a small accounting firm, represented by student teams, and requests a financial report to accompany a bank loan application. Their records are an unorganized collection of business documents saved in a shoebox. The students are provided with the shoebox, which contains checks, invoices, business cards,

and miscellaneous other documents that the business has collected. This simulates the real world scenario cited in objective 1. Students are also given a sample chart of accounts that includes valid accounts as well as many extra accounts that will not be needed. This chart is used to provide some standardization to student submissions to the interactive feedback component used to evaluate and help refine their solutions.

Students are to design an accounting system that they will use to analyze and record transactions and other events. The teams are expected to plan the engagement, design an accounting system, record basic transactions and adjustments, and develop a financial report using Excel. This satisfies objectives 2 and 3. Some of the shoebox documents have some inconsistencies that must be clarified. In addition, some transactions are omitted and must be discovered at some point through other means such as interviews or the analysis of the bank statements. In addition, students must detect some issues relating to improper valuation by the owners, such as a barter transaction or improper timing of revenue recognition. Thus, objective 4 is met.

As the accounting teams analyze the documents, certain accounting issues must be researched (objective 5) and the students can arrange interviews with real-world members of the business and professional community, such as the small business advisor from the local department of labor, to gather sufficient information with which to complete their financial reports (objective 6).

Team members must learn to cooperate and to reliably complete their assigned tasks. Each member is responsible for insuring that the engagement is completed in an accurate and timely manner. This addresses objective 7.

The process requires students to assume three different roles. First, each student is a member of an accounting firm and should focus on how to operate the organization systematically. This involves planning an engagement, dividing the workload, assisting and teaching others, and client billing. Second, as an accounting professional each student interacts with real-world business professionals who must be interviewed to obtain additional information. Third, in the role of student each team member has the responsibility to learn from this experience and to convince the professor that this goal has been achieved.

SOFTWARE COMPONENTS

The supporting software contains two primary modules: a document generation module and an interactive feedback module.

The document generation module is used by the instructor prior to the beginning of the project to generate the shoebox of documents. The document set consists of a series of checks written by the company, deposits slips, invoices submitted to the company by various vendors, invoices from the company to customers, contracts with customers, and various other items. All documents are linked, so that values are consistent throughout the document set, unless the program intentionally generates inconsistent values (which it can be instructed to do). For example, if the company ordered ten computers and was billed for them, the quantity of computers and/or the related dollars should appear on 1) the invoice from the vendor, 2) any related shipping document 3) the check written to the vendor, 4) the bank statement (if not outstanding at the end of the period), etc. The document set is accompanied by an answer key and a bank reconciliation that automatically reflect the values contained in the documents.

All documents resemble original, real-world documents as closely as possible. Handwritten notations were scanned and then embedded in the documents to give them a more "genuine" appearance. Further, documents such as a State Certificate of Assumed Business Name were duplicated right down to the seal of the State. A letter from the Dean of the College of Business acknowledging a donation required duplication of the College of Business letterhead. Figure 1 shows a sample invoice.

Once the document set was finalized, various program features were developed to make the document set dynamic. The professor has the following options:

- Revise/update dates on all documents to correspond to the current semester. Safeguards are included to insure that the dates cannot exceed the current semester.

- Individually change designated modifiable fields in the documents. For example, the number of web pages to be designed or the price of a website could be changed if the instructor so desired. This insures that the document sets vary from semester to semester.

- Increase or decrease designated modifiable fields in the documents by a certain percentage. This allows all documents in the document set to be changed at once. Again, this insures that the documents sets vary from semester to semester.

MICRO CENTER AND SPORTS
1433 East Pokey Road
Pocatello, ID 83222
Phone: (208) 282-4769

8/19/2010

Dear Mr. Tater,

   Enclosed is my check that represents 50% of the total cost of the web site that you have agreed to develop for us. I understand that this price includes support for the web site for the number of months upon which we agreed.

My check #576432	$2,500.00
Support Included (months)	4
Agreed on support hours per month	5

   I also agree to purchase a computer system from you with the following items to be included:

Number of computers	2
Number of printers	1
The total agreed on price of this system, including installation:	$3,000.00

I understand this amount is due upon delivery of the system.

Sincerely,

Cindy

Cynthia Burness
President

Agreed TT

Lennie's cute. Have him call me!

Figure 1. Sample Generated Invoice

- Produce checks that are realistic in appearance. A routine is included that writes, in script, the amount of each check based upon the numeric representation of the check. Thus, $42.25 would also appear in the appropriate place as Forty-Two and 25/100 Dollars. In addition, each check includes a scanned signature. Figure 2 shows an example of a check generated by the module. A routine was developed that groups three checks or deposit slips on a page so that checks can be printed three to a page on perforated paper so that they more closely resemble actual checks.

- Generate a bank statement that reflects the current transactions, and even provides an "insta-loan" feature that is triggered whenever the balance in the account drops below zero dollars.

- Print all documents quickly and easily, including checks in the three-per-page format, deposits in the three-per-page format, and then the remaining documents.

Tom Tater   1006
1234 Tater Tot Dr.
Pocatello, ID 83299
208-555-6789   Date   *8/5/2004*

Pay to the Order of   *Computer Wholesale* $ 84.00

Eighty Four Dollars and No Cents   Dollars

Poky Bank and Trust

For: _____   *Tom Tater*

⑆123456789⑆ 00987654321   1006

Figure 2. Sample Generated Check

These features allow the instructor to make parameter changes for different transactions and to print updated document sets with corrected dates and amounts for each team. Thus, the source data can be changed each semester and the documents are all modified electronically to be consistent with the new parameters. The automated answer key is updated each time any document or event is changed, added, or deleted by the professor.

The second primary module is the assessment module, which provides timely feedback to each student team to allow them to recognize when they have made errors or failed to recognize an issue. The module makes use of animated pedagogical agents to enhance communication with students. Pedagogical agents are a means of integrating technology into the curriculum to improve teaching and student achievement. Agents can use locomotion, gaze, and gestures to focus the student's attention (Lester et al., 1999; Noma and Badler, 1997; Rickel and Johnson, 1997). Such nonverbal devices are a natural component of human dialogues. It has been shown that the presence of an anthropomorphic agent stimulates students and increases their motivation to better perform tasks (Lester et al., 1997; Walker et al., 1994). Unlike a textual interface, students are required to utilize multiple senses and therefore attend to animated agents in a balanced way (Prendinger et al., 2005). Although the prototype was designed using Microsoft Agent technology, Microsoft is phasing out the technology so alternatives like SitePal are being investigated.

Students are provided with an Excel trial balance template in which they input account balances. The grading system requires that students upload their solution file (Figure 3), which the system then opens and evaluates. Beginning with a test as to whether the trial balance actually balances, the pedagogical agent provides students with feedback as to the likely correctness of their account balances, procedures followed, and hints about how to identify errors that might have caused differences between the answer key and the submitted solution. An example of error detection appears in Figure 4.
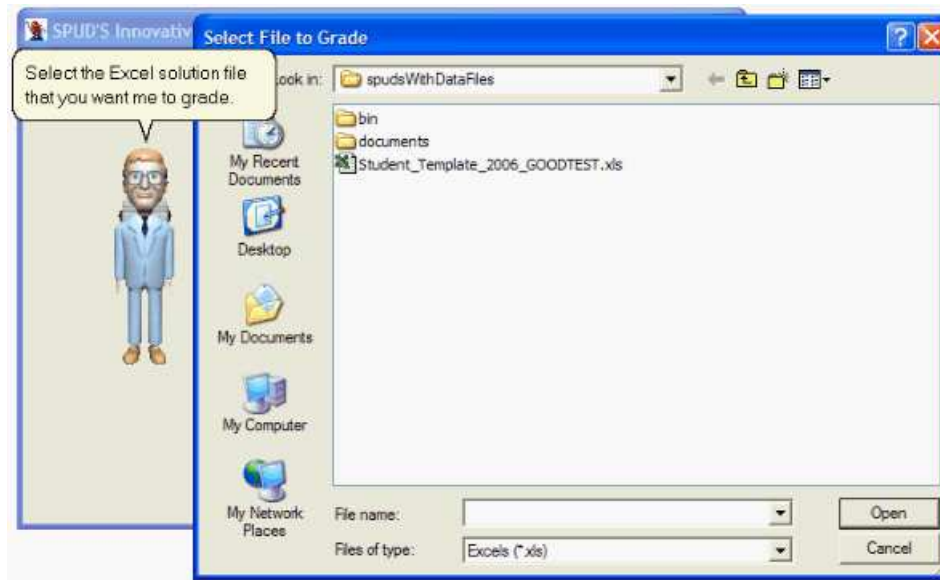

Figure 1. Solution File Request

If critical errors are detected, the system logs off the student with instructions to correct their errors and then resubmit the solution. If the solution is acceptable the system then enters the next grading phase. For instance, after the cash balance is checked, students are asked if they have prepared a bank reconciliation (Figure 5). If the bank reconciliation has been completed the system grades it against a best solution, and if critical errors are detected appropriate hints are given and the system requires that they be corrected before proceeding. If the reconciliation was not prepared the system provides a template for the team and the grading session is terminated until the team members use the template to complete a reconciliation and submit it for testing.

At each step, the student earns or loses points based upon the "correctness" of the solution. This process continues for the Accounts Receivable subsidiary ledger, the Inventory Quantity list, the Prepaid Items list, Fixed Assets ledger, and the Unearned Revenues list. Presumably, after each session the student team will analyze feedback provided by the grading system, discuss issues with the professor, and make corrections, thereby enabling them to progress further through the trial balance each session until they have successfully finished the computerized feedback process.
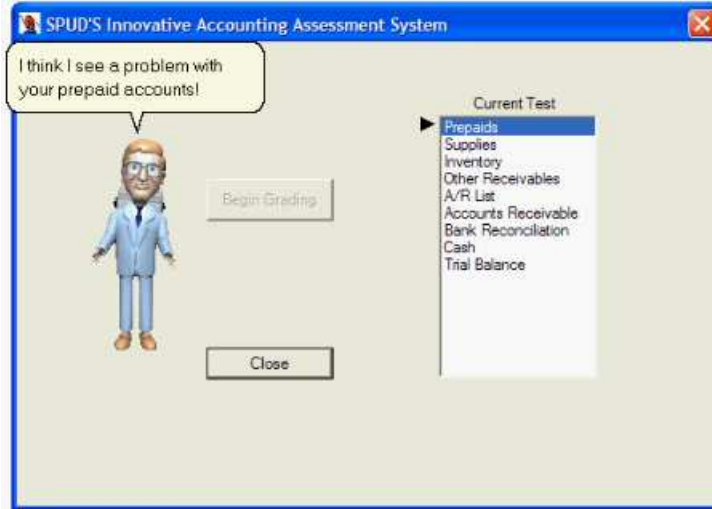
Figure 4. Example of Error Detection

The software monitors the number of log-ins, time spent each session, the point at which mistakes were found, or processes not performed. Mistakes are discovered by comparing the student answer to the automated answer key generated by the system and unavailable to students. Error messages are recorded and made available to the student in a printable report that is generated upon exiting (Figure 6). A record of each attempt made by a student team, along with any errors found in that attempt, is recorded in a database for grading purposes. A professor utility generates a detailed grading report for the selected team, listing details for all sessions including session number, session date, time started and time completed, error details, and suggested point deduction. The report also provides a final score for the team.
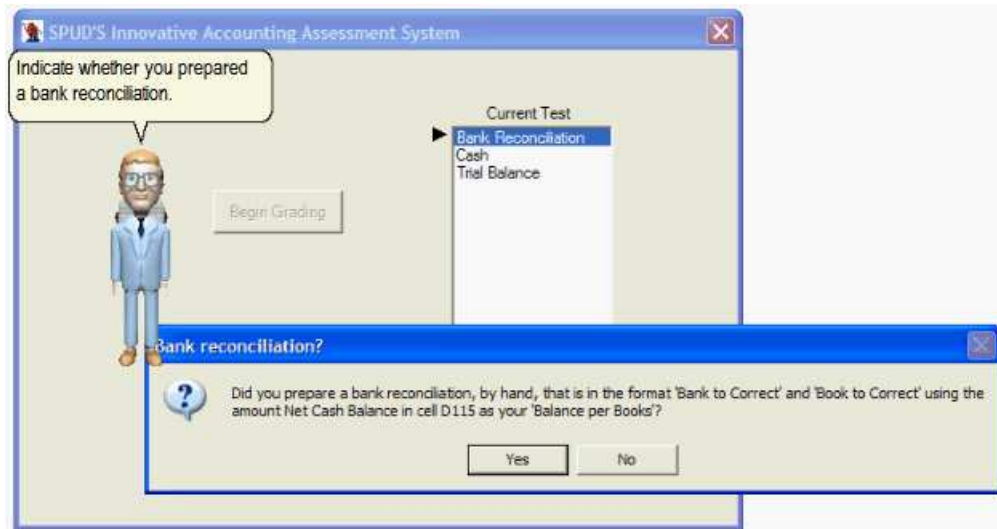
Figure 5. Bank Reconciliation Request

A flowchart that shows how the tool is used by instructors and students is provided in Figure 7. It shows both the document generation module and the assessment module described above. Student interaction with the modules is shown as well.

ISSUES ADDRESSED

While an earlier section described various learning approaches, there are various learning styles as well. Some students learn visually while others learn more through reading and writing. Still others learn best by hearing, while some learn best by "doing." The virtual teaching assistant design incorporates all of these learning styles to develop students' professional skills. Researching an issue that needs resolution may be done through reading. Interviewing requires writing questions that need to be asked, as well as a great deal of listening, questioning, and then listening some more. Finally, throughout the whole process, the student is involved in hands-on work – getting very close to real-world work situations.
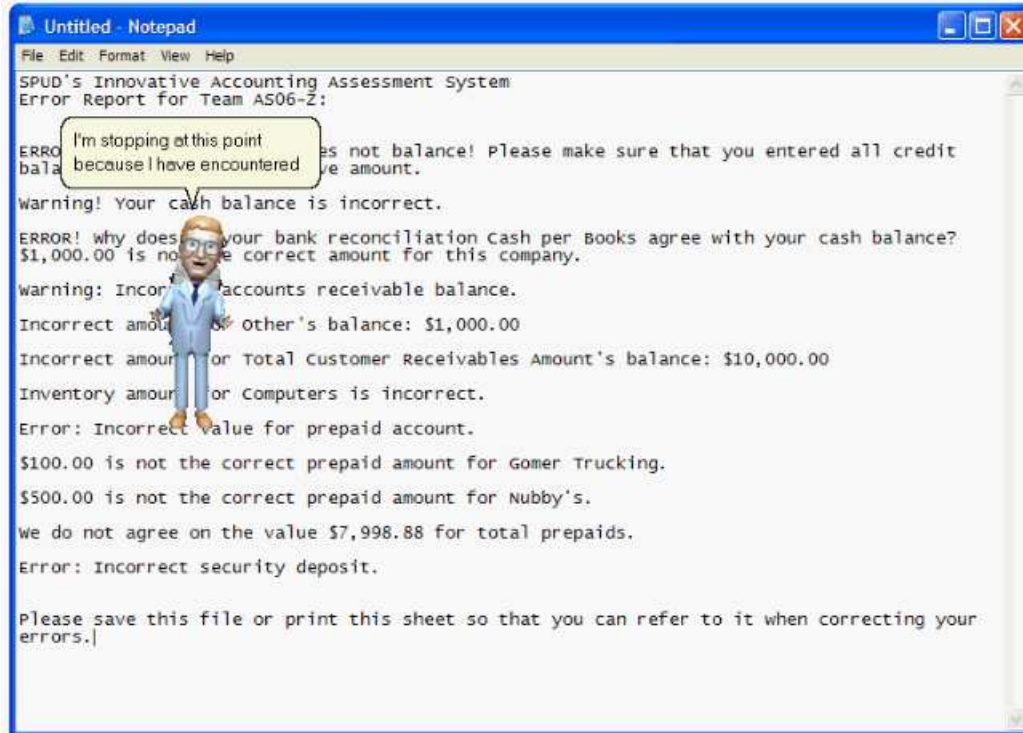
Figure 6. Example of Error Report

Several problems with traditional practice sets were listed and explained in an earlier section. The following discusses how those problems are addressed by the proposed system.

- The generated data set is unstructured and describes a realistic, complex situation. As in real life, some irrelevant data is included to provide students with experience assessing meaningful information.

- Students are forced to deal with an unfamiliar situation without the crutch of finding a similar problem in a text. They are therefore forced to structure a solution starting from scratch.

- The scenario around which the prototype is built is relatively broad and realistic. In order to plan the engagement, design an accounting system, develop interview questionnaires, and formulate interview questions in order to develop a financial report, students must have an understanding of the overall process that progresses from the collection of data items like invoices, to the classification of that data, and finally to how it should be recorded.

- Students' lack of deductive and inductive reasoning skills is addressed by the much broader scope of the virtual teaching assistant's scenario. While it is scaled in such a way that it is manageable as a class project, it is sufficiently broad to challenge students and to force them to think about a variety of factors that impact the client's situation. The inclusion of extraneous documents is intended to tax students' reasoning skills.

- The inclusion of real world resources like the department of labor representative gives students the opportunity to practice interviewing clients thoroughly to obtain information critical to successful problem solving. Students are directed to use various research sources such as accounting standards to explore what is available to enable them to make sound decisions.

- The problem of students copying others' work may be alleviated somewhat by the greater scope of this project, since arriving at a final acceptable answer requires a great deal more effort than solving small problems, making students more reluctant to share. However, if all students are provided with the same shoebox contents they may still be tempted to copy.

- Prior semesters' solutions will be of little use to students because instructors have the option of increasing or decreasing designated modifiable fields in the documents by a certain percentage or individually changing designated modifiable fields in the documents. For example, the number of printers sold or the price of a printer could be changed if the instructor so desired. This feature is provided so that the documents sets, and therefore solutions, vary from semester to semester.
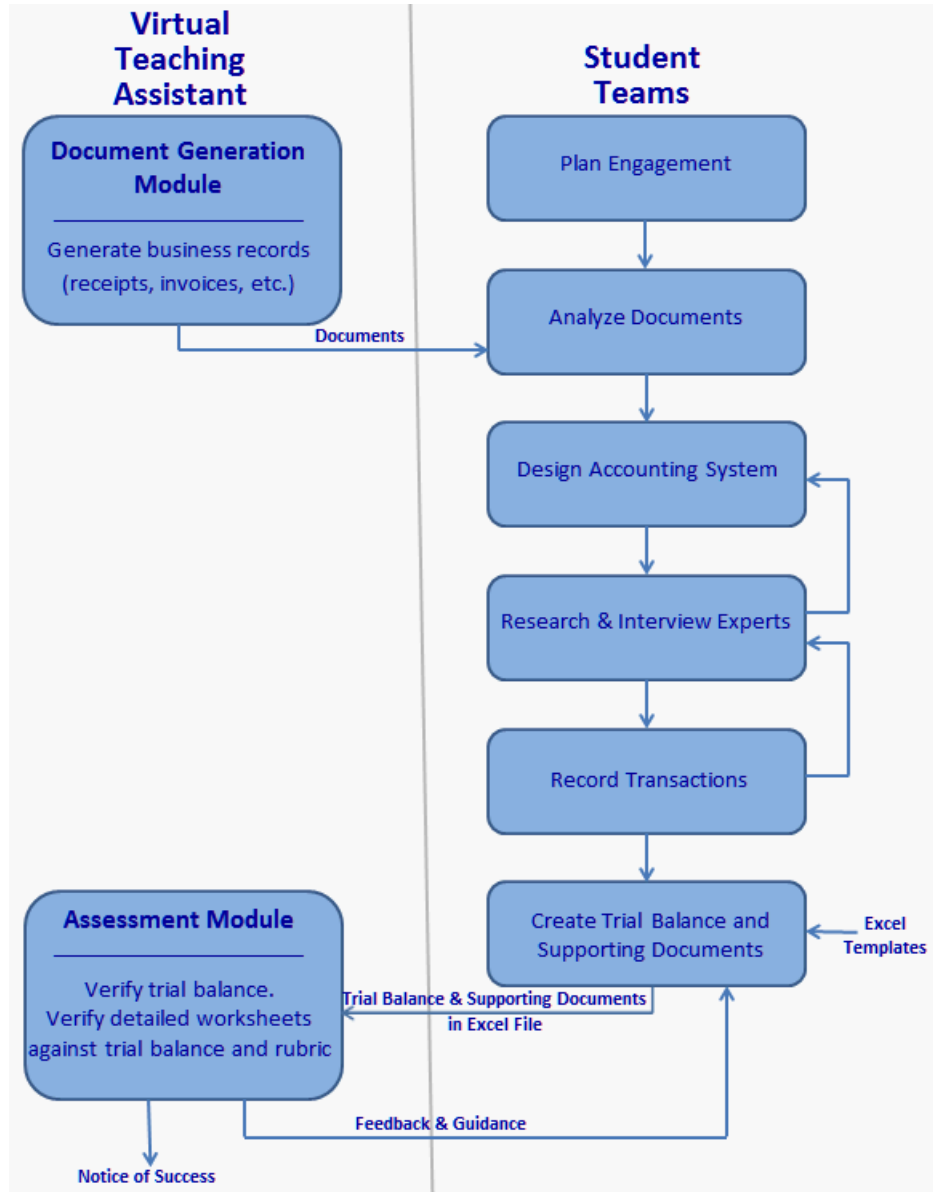
Figure 7. System Flowchart of Tool Use

CONCLUSION

This paper describes a structure for an interactive teaching software system that simulates a real-world scenario. Professors constructed a scenario rife with complexity and ambiguity, developed a rubric with which to assess student outcomes, and then designed and implemented a complex software system that not only evaluates student work but also mentors and guides them when they make errors or encounter a difficult aspect of the case. It provides students with an opportunity to develop higher levels of critical thinking, communication, and interpersonal skills as well as the research and analytical skills necessary to thrive in an ever-changing environment. The most recent AACSB Accreditation Review report of our university recognized this teaching approach as the first of three Best Practices for the accounting program because it successfully integrates technology to simulate real-world experiences.

Educators must incorporate pedagogical methods into their teaching that do not simply rely on memorization of knowledge, but that allow students to apply that knowledge in practice and critically reflect on the experiences in the classroom (Hocking and Hocking, 2009). The AECC points out

> The process of learning should focus on developing the ability to identify problems and opportunities, search out the desired information, analyze and interpret the information, and reach a well reasoned conclusion. Understanding the process of inquiry in an unstructured environment is an important part of learning to learn (AECC, 1990 Appendix A).

The virtual teaching assistant system was designed to do just that. It addresses the educational needs stated by Hocking and Hocking (2009):

- To find experiences for students that will help them to make sense of the textbooks they are reading.

- To find experiences that enhance student understanding and application of the concepts and information that they read about to solve problems and become critical thinkers in a rapidly changing world.

- To enhance course content and facilitate the skills that students need to be creative and critical thinkers in an ambiguous and complex world.

The virtual teaching assistant helps students to learn content and develop skills by engaging in tasks that involve the skills and content to be learned, and provides a real-world context for learning. It requires students to assume a real-life role and apply the tools of a knowledge domain in completing a project. This approach requires students to deal with complex questions and undertake projects that involve synthesizing understandings and considering real-world issues.

Although the evaluation of the tool has not been completed, student feedback indicates that the combination of a realistic scenario, immediate assessment provided by the software component, and the engaging interactive learning environment with animated pedagogical agents to provide feedback and guidance succeeds in making the learning process more enjoyable and increases students' enthusiasm. More importantly, however, the described approach employs active learning, project-based learning, and intentional learning to reinforce course content in hopes of enhancing students' analytical abilities and retention of material.

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