AC 2012-3945: DEVELOPMENT OF A VIRTUAL TEACHING ASSISTANT SYSTEM APPLYING AGILE METHODOLOGY

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Development of a Virtual Teaching Assistant System Applying Agile Methodology

Abstract

This research describes a case study of a project to develop a web-based Virtual Teaching Assistant System (ViTAS) for college students and instructors. ViTAS, a digital homework assignments submission and grading system, is an innovative idea to provide homework assignments grading system for the instructors and to provide an interactive learning environment outside the lecture period for the students. Using ViTAS, students will be able to submit the homework assignments online, to engage in anonymous homework review, and to discuss with their peers. The idea of students grading the homework assignments of their peers is very beneficial, because during the process of grading other’s homework, the students get the opportunity to learn/review their own work/mistakes. Also, the instructors finalize all grades and post them on the website to confirm the students’ learning activities. In particular, this project focuses on the Agile software development process, which is a group of software development methodologies based on iterative, interactive, and incremental development, where requirements and solutions evolve through collaboration between self-organizing and cross-functional teams; i.e., software development and user-experience design of the ViTAS. Also, the research considers that the teams are working cooperatively rather than collaboratively and this cooperation is implemented via articulation work, meaning that the developers had additional tasks to ensure that the user-experience design is accomplished. Overall, the paper provides an insight into a culture where developers and user experience designers work together, adds evidence to support the Agile principle of self-organizing teams and recommends the recognition of interaction tasks as valuable work in Agile software development.

Key words: Agile methodology, virtual teaching assistant, user experience design, web-service.

Introduction

A Hispanic serving institution, such as Texas A&M International University (TAMIU), intends a Minority Science and Engineering Improvement Program (MSEIP) with the objective to reduce the class drop rate by 50% for early college education in engineering, mathematics, and physics curriculums. The objective will be achieved through the development and implementation of a visual teaching assistant system across eight target courses to assists the students in learning and enhancing course materials beyond the classrooms.

According to the enrollment in fall 2011 the university has more than 7,037 students who are studying in various degree programs of science, engineering, education, and business. The enrollment data indicates that the 90% of the students are Hispanic and over 50% of them are first-generation of college students. Therefore, a significant number of first-generation college students do not get the academic support from their family members. Table 1 represents the enrollment data based on students’ profiles from fiscal year 2008 to 2011. Therefore, the students need to rely on the teachers and mentors for their success in their college career.
Table 1. Enrollment statistics based on students’ profile*

<table>
<thead>
<tr>
<th>Students’ Profile</th>
<th>Year 2008-09</th>
<th>Year 2009-10</th>
<th>Year 2010-11</th>
<th>Year 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall 08</td>
<td>Spring 09</td>
<td>Fall 09</td>
<td>Spring 10</td>
</tr>
<tr>
<td>Total Students</td>
<td>5856</td>
<td>5558</td>
<td>6419</td>
<td>6088</td>
</tr>
<tr>
<td>Female</td>
<td>3599</td>
<td>3426</td>
<td>3844</td>
<td>3678</td>
</tr>
<tr>
<td>Male</td>
<td>2257</td>
<td>2132</td>
<td>2575</td>
<td>2410</td>
</tr>
<tr>
<td>Concurrent HS</td>
<td>736</td>
<td>549</td>
<td>889</td>
<td>625</td>
</tr>
<tr>
<td>First-Time in College</td>
<td>643</td>
<td>54</td>
<td>713</td>
<td>63</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5282</td>
<td>5002</td>
<td>5822</td>
<td>5535</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>4794</td>
<td>4453</td>
<td>5315</td>
<td>5024</td>
</tr>
<tr>
<td>First-Generation Undergrads</td>
<td>2298</td>
<td>2439</td>
<td>2392</td>
<td>2559</td>
</tr>
</tbody>
</table>

* The data collected from the office of Institutional Research at Texas A&M International University.

Due to lack of proper education in the high school level, the incoming freshmen at TAMIU have faced difficulty to deal with college level mathematics. Therefore, a significant class drop rate is found in such lower division courses. Table 2 represents the student enrollment, successful completion, and class drop rate data in college algebra, business mathematics I and II. The need for improving student success in early college education can be determined by the high class drop rate in lower division courses such as college algebra, business mathematics, etc. According to the undergraduate curriculum, all undergraduate students of TAMIU are required to take college algebra or equivalent core curriculum in their degree programs. The drop rates in lower division mathematics courses are not uncommon. These courses cover systems of linear equations, matrices, limits, and basics of calculus. These are the foundation courses for the students to study upper level business, education, social sciences, and engineering programs.

Table 2. Student drop rate for College Algebra, Business Math I and II between 2008 and 2011*

<table>
<thead>
<tr>
<th>Semester</th>
<th>Fall 08</th>
<th>Spring 09</th>
<th>Fall 09</th>
<th>Spring 10</th>
<th>Fall 10</th>
<th>Spring 11</th>
<th>Fall 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolled</td>
<td>95</td>
<td>96</td>
<td>147</td>
<td>166</td>
<td>154</td>
<td>135</td>
<td>179</td>
</tr>
<tr>
<td>Completed</td>
<td>56</td>
<td>52</td>
<td>91</td>
<td>113</td>
<td>92</td>
<td>87</td>
<td>125</td>
</tr>
<tr>
<td>Dropped</td>
<td>39</td>
<td>44</td>
<td>56</td>
<td>53</td>
<td>62</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Rate (%)</td>
<td>41</td>
<td>46</td>
<td>38</td>
<td>32</td>
<td>40</td>
<td>36</td>
<td>30</td>
</tr>
</tbody>
</table>

* The data collected from various faculty members who taught college algebra at TAMIU.

To reduce the class drop rate, innovative method must be implemented into the homework submission and grading process. Unfortunately, the traditional homework system does not seem very effective addressing the class drop rate issue. Although professors and teaching assistants spend great effort grading to homework, and many times students of TAMIU are more interested in homework scores rather than learn from their mistakes. The current homework grading system does not provide sufficient interaction between professors and students. Though the professors have office hours available to answer the students’ questions, but the students may not be utilizing these hours because of their full-time or part-time work schedules or other engagements.
Failure to maintain an open communication activities, the students repeats the similar mistakes in the examinations as they did in the homework. Such failures in exams and homework drive struggling students to drop the class before completion.

**Literature review**

Researchers found a positive correlation exits between homework accomplishments and the class drop rate. Cooper et al.\[7\] conducted a research where 709 Students and their parents, and 82 teachers completed a questionnaire concerning amount of homework assigned by teachers, portion of assignments completed by students, and attitudes about homework. Upon collection of student achievement measures, the authors found weak relations between the amount of homework assigned and student achievement, and positive relations between the amount of homework students completed and achievement, especially at upper grades (6-12). Hoover-Dempsey et al.\[13\] reviewed research on parental involvement in student homework, and found that parents involve themselves in student homework because they believe that they should be involved, believe that their involvement will make a positive difference, and perceive that their children or children's teachers want their involvement. Unfortunately, the first-generation college students fail to get that at TAMU. Leone and Richards\[17\] found that in instructive practice, homework plays a critical, long-term role in the development of students’ achievement motivation. Homework provides students with time and experience to develop positive beliefs about achievement, as well as strategies for coping with mistakes, difficulties, and setbacks. The authors also argued that homework is a vital means by which students can receive the training they need to become mature learners. Bempechat\[5\] obtained similar conclusion regarding the homework assignments and students’ achievements.

Moreover, researchers found that homework and assignments play constructive role in the course performance of all levels of students. Keith and Cool\[16\] tested the influence of ability, time, quality of instruction, motivation, and academic coursework on students' achievement, controlling for relevant background variables. The authors found that the intellectual ability and academic coursework had direct effects on achievement, and same dose the homework. Their results support that the drop rate can be significantly reduced if students can complete their homework correctly and on schedule. Ryan and Hemmes\[29\] studied the effects of the contingency for submission of homework assignments and found that homework submission was not maintained when the only consequences were instructor-provided feedback and expectation of improved quiz performance. Olympia et al.\[23\] examined the effectiveness of self-managed individual and group contingency procedures in improving the completion and accuracy rates of daily mathematics homework assignments. Students who were allowed to select their own performance goals made superior improvements in the number of homework assignments returned compared to students who were given a specified goal by the classroom teacher.

Recently, Schmitz and Perels\[30\] studied aims at enhancing math learning and general self-regulation by supporting daily self-regulated learning during math homework. The authors used standardized diaries as a self-monitoring tool to support self-regulatory behavior. Eren and Henderson\[8\] followed an identification strategy that allowed to largely eliminating unobserved student and teacher traits. The authors examined the effect of homework on math, science, English and history test scores for eighth grade students in the United States and found find that
math homework has a large and statistically meaningful effect on math test scores. PytlikZillig et al.\cite{27} investigated two frequently-used discussion protocols were as part of a program to implement teaching cases in undergraduate that involved synchronous face-to-face (FTF) and asynchronous computer-mediated (CM) discussion taking place outside of class. They found both CM and FTF discussion related to higher cognitive-affective engagement with the cases than the control condition: and the CM discussion condition was associated with higher cognitive-affective engagement than FTF discussion. In contrast, FTF discussion, but not CM discussion, was associated with higher-than-control-condition case analysis ability at the end of the semester. Katz et al.\cite{15} employed self-determination theory as a theoretical framework for investigating the role of parents in the quality of the motivation that students adopt towards homework. The findings highlight the role of type of parents' involvement with their children's homework in the children's motivation toward homework, and of parents' own type of motivation for this task in the quality of their involvement.

According to previous research, the students who stayed in the classroom through the semester, and submitted homework regularly have better grades. Also, the lower is the homework submission, the lower the grads at the end of the semester. Table 3 represents the homework performance data and course grades for 153 students (who completed the course) taking Business Math I and II between 2008 and 2011 [Lin et al.\cite{18}]:. Based on the course grade with homework performance, it is found that students who earned an “A” submitted almost all assigned homework during the semester. On the other hand, if the student submitted only 63% of their homework did not succeed at the end. Another observation states that homework score is also correlated with the final course grade. For example, when a student earned an “A” on the course, his/her homework score was above 90 in average. Similar conclusion can be made for those students who scored “B,” “C,” “D,” and “F.” Many TAMIU students work very hard in their courses, yet a regular class time may not be sufficient to create and interactive environment to address all the problems that students may have for the course. This situation is true for the classes where the student number is greater than 40. Therefore, innovative methods must be devised and implemented to improve the retention and class performance in mathematics, engineering, and physics.

### Table 3. Correlation between homework and grads*

<table>
<thead>
<tr>
<th>Final Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students</td>
<td>39</td>
<td>42</td>
<td>38</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>Homework submission rate (%)</td>
<td>95</td>
<td>88</td>
<td>86</td>
<td>78</td>
<td>63</td>
</tr>
<tr>
<td>Average homework score</td>
<td>92</td>
<td>84</td>
<td>73</td>
<td>64</td>
<td>49</td>
</tr>
</tbody>
</table>

*The data collected from various faculty members who taught Business Math I and II at TAMU.

### Need for web-based application

Many researchers have found that incorporating new technologies to establish great relationships among the professor and students are a part of the interactive teaching. Warschauer and Healey\cite{32} had shown an explosion of interest in using computers for language teaching and learning. The authors provided an overview of current teaching practices and research related to the uses of computers in the language classroom. Millard\cite{22} pointed that in Engineering at
Rensselaer, interactive learning modules (ILMs) are being developed for use in several undergraduate courses. These multimedia materials are created with the Director authoring environment and can be accessed via a standard Web browser. Instructors can use ILMs for in-class demonstrations, students can use them for structured exercises and learners can use them anytime, anywhere via the Internet. Al-Nuaimy et al.\textsuperscript{[2]} stated that teaching and learning in higher education has recently been transformed by the development and affordability of fast microcomputers and the accessibility of the World Wide Web. The potential to utilize the Web to enhance students' learning has been recognized, and to this end a pilot web-based system has been developed as an online interactive resource for the teaching and learning of an undergraduate module on Communications within the Department of Electrical Engineering and Electronics. Rüschoff and Ritter\textsuperscript{[28]} discussed the current state of the art with regard to the use of new technologies in the classrooms. Lu and Boi\textsuperscript{[20]} found that peer review has become commonplace in composition courses and is increasingly employed in the context of telecommunication technology. The potential to utilize the Web to enhance students' learning has been recognized, and to this end a pilot web-based system has been developed as an online interactive resource for the teaching and learning of an undergraduate module on Communications within the Department of Electrical Engineering and Electronics. Rüschoff and Ritter\textsuperscript{[28]} discussed the current state of the art with regard to the use of new technologies in the classrooms. Lu and Boi\textsuperscript{[20]} found that peer review has become commonplace in composition courses and is increasingly employed in the context of telecommunication technology.

According to the previous findings, a need for an interactive application that will serve as the active communication port between professors and the students of TAMIU outside the class period became very crucial. Also, the need to reduce the class drop rate by 50% for early college students and to improve their course performance in mathematics, engineering, and physics became the motivation to develop a web-based homework submission, feedback, and review system. Next sections discuss the proposed application structures, development methodologies, and advancements in the developments.

**Expectations of application**

The application is designed to meet the objectives of MSEIP, which is “to effect long-range improvement science and engineering education at predominantly minority institutions and to increase the flow of underrepresented ethnic minorities, particular minority women, into scientific and technical careers.” To achieve the goal, the following specific objectives are accomplished throughout the three year period from August 2010 to August 2013 [Lin et al.\textsuperscript{[18]}]:

1. Develop a web-based Virtual Teaching Assistant System (ViTAS) to provide a highly interactive learning environment for students to learn knowledge beyond the classroom.
2. Implement the ViTAS into eight target courses including college algebra, foundation of engineering I, business math I and II, introductory statistics, general physics, principal of engineering and related lab courses (Table 4).
3. Provide training and workshops for students and professors to use ViTAS.
4. Expand the functionality and improve the performance of the ViTAS based on the comments and suggestions from students and professors who use the system.
5. Extend the ViTAS application to other curriculums such as general chemistry, biology, and upper level courses at TAMIU.
Table 4. Target courses for ViTAS application [Lin et al.\textsuperscript{[18]}]

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>College Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 1201</td>
<td>Foundation of Engineering</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 1314</td>
<td>College Algebra</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 1324</td>
<td>Business Math I</td>
<td>Freshman</td>
</tr>
<tr>
<td>PHYS 1301</td>
<td>General Physics</td>
<td>Freshman</td>
</tr>
<tr>
<td>MATH 1325</td>
<td>Business Math II</td>
<td>Sophomore</td>
</tr>
<tr>
<td>MATH 1342</td>
<td>Introductory Statics</td>
<td>Sophomore</td>
</tr>
<tr>
<td>ENGR 2305</td>
<td>Principal of Electrical Engineering</td>
<td>Sophomore</td>
</tr>
<tr>
<td>ENGR 2105</td>
<td>Principal of Electrical Engineering Lab</td>
<td>Sophomore</td>
</tr>
</tbody>
</table>

Application creativity

The Virtual Teaching Assistant System (ViTAS) is a web-based homework grading system, which is developed to provide students with an interactive learning environment outside of class periods. The target of the application is to decrease the class drop rate by 50% and further improve the course grade through the interactive learning system. The students are able to submit their homework on-line, engage anonymous review, grading, and discussion with their peers. By implementing this technology, students can learn effectively and enhance the course materials. Since students will be randomly assigned for homework evaluation, in many cases a more advanced peer will be able to help the student with less motivation.

The ViTAS application is encouraged originally by Vygotsky's\textsuperscript{[31]} social cultural theory of mind [Lin et al.\textsuperscript{[18]}]. The theory emphasizes learner interaction and collaboration, and it played an important role in the field of second language acquisition since 1980s. According to Vygotsky\textsuperscript{[31]}, an essential feature of learning is that it creates the area of proximal development, i.e. “learning awakens a variety of internal development processes that are able to operate only when the child is interacting with people in his/her environment and in cooperation with his/her peers.” Aljaafreh and Lantolf\textsuperscript{[1]} studied the corrective feedback and zone proximal development, and found that the beginner and the expert interacting through collaborative learning continuously discover the potential zone proximal development. Due to the arrival of information technology, the interactive learning theory generated lot of rapid applications not only in instruction of language [Jonassen et al.\textsuperscript{[15]}], but also in science and engineering education and career development [Millard\textsuperscript{[22]}, Baillie and Moore\textsuperscript{[4]}]. In the ViTAS application, the professors can be able to help the students to reach their zone proximal development.

The ViTAS design

The initial architecture of ViTAS consists of five application modules: Homework Assignment, Homework Submission, Homework Grading, Homework Discussion, Homework Solution Upload and Feedback, Homework Reports and Administrator [Lin et al.\textsuperscript{[18]}]. Figure 1 describes the functional configuration of the application modules.
The homework assignment module is a web-page for instructors, which allows log-in to the system and uploading the homework assignments for the students. The homework submission module is a web-page that allows the students to log-in to the system through the internet and upload the homework in ViTAS in the electronic formats including MS Word, Excel, PowerPoint, Excel, Text, and Acrobat PDF.

Figure 1. Architecture of the ViTAS application

The homework grading module allows the student to review and evaluate his/her peer homework anonymously. The anonymity is an important principle to allow the student to evaluate his/her peers fairly. The homework discussion module serves as a dialog box where the grader and the homework owner can anonymously discuss the homework grading. The homework solution upload, peer assignments, and feedback module is the place where the professors/instructors posts the standard solution for the homework assignments, assign peer for each students and provide feedback. Based on the posted solution the grader can grade or change the peer’s previous grade if required. The homework report module will allow the professor to agree on peers grading or he/she will have the final grading rights, which will allow students to do the fair grading to their peers. Finally, the administrator module will insert late registered students into the ViTAS system and modify the courses with proper instructor if the initial schedule changes after the initial data insertion. Figure 2 shows the operational flow chart of the ViTAS application where HW stands for homework.

Agile methodology in ViTAS development

In software development process, several methodologies of software development life cycles have been followed by the developers. These are waterfall model, rational unified process, “Vee” process model, spiral model, agile development, etc. Nowadays, the typical software development industries have not been so great while they have to deliver the working software application in time and within the budget. It is widely reported that among 80% of all software development projects fail because of lack of end-user involvement, poor requirement analysis, unrealistic schedules, lack of change management, testing and inflexible and bloated processes [Cohn[5], Martin[21]]. In agile software development process addresses these issues that make
software development processes more successful. Also, in the agile development process, a minimal documentation is required to start the process as users, system analyst, developers, team leader, quality assurance analyst, and database administrator work together as a team.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit HW to ViTAS</td>
<td>Each student is anonymously assigned to grade his peer’s HW</td>
</tr>
<tr>
<td>HW problem discussion</td>
<td>The HW owner reviews his HW being graded</td>
</tr>
<tr>
<td>Each student is anonymously assigned to grade his peer’s HW</td>
<td>Agrees with the grading</td>
</tr>
<tr>
<td>Standard solution is posted by professor in ViTAS</td>
<td>The grader compares the grading with the standard solution</td>
</tr>
<tr>
<td>Make corrections on the previous grading if required</td>
<td>The grader compares the grading with the standard solution</td>
</tr>
<tr>
<td>Report the HW score in ViTAS</td>
<td>Make corrections on the previous grading if required</td>
</tr>
<tr>
<td>End</td>
<td>Report the HW score in ViTAS</td>
</tr>
</tbody>
</table>

Figure 2. Operational flow chart of ViTAS application

Recently, the agile development process got lot of attention to the researchers in the area of information technology. Garcia et al.\textsuperscript{[10]} provided a set of guidelines to develop knowledge-based Process Asset Libraries (PAL) to store software engineering best practices, implemented as a wiki and improves the use of agile processes. Greer\textsuperscript{[12]} addressed a range of research areas including the application of agile methods to safety critical software development, the relationship of agile development with user experience design and how to measure flow in lean software development. Similar research is done by Gary et al.\textsuperscript{[11]} on the basis of agile development process. Procter et al.\textsuperscript{[26]} used a case study of a project to create a Web 2.0-based, Virtual Research Environment (VRE) for researchers to share digital resources in order to reflect on the principles and practices for embedding eResearch applications within user communities using agile development. Ferreira et al.\textsuperscript{[9]} reported in detail on one observational study of a mature Agile/Scrum team in a large organization, and their interactions with the user-experience designers working on the same project. The authors also explained how multi-cultural teams work together in agile environments. Based on the previous research and working experiences in agile environment, the agile methodology is used for the development of ViTAS application.

**Agile development steps**

Based on Ambler\textsuperscript{[3]} and Cohn\textsuperscript{[6]} the agile development process has the following stages in the software development project:
1. The scope of ViTAS
2. Iteration -1: initial planning of ViTAS
3. Iteration 0: user stories for ViTAS
4. Constructive iterations for ViTAS
5. Release iterations
6. Production

Next sections describe the above steps during the development of the ViTAS application.

The scope of ViTAS

The ViTAS is a web-based application, which provides the student and the professors of TAMIU an interactive communication baseline outside of class. The students will upload their homework solutions given by the professor on a particular class such as college algebra, business math I and II, general physics, principal of electrical engineering, etc. [Table 4]. The purpose of this application is to reduce the class drop rate by 50% especially for the freshman and sophomore students. Detail discussion regarding the necessity of ViTAS application is discussed in previous sections.

Iteration -1: initial planning of ViTAS

In the initial planning of the ViTAS application development, few important aspects is considered such as set up the development environment (research laboratory), hire the appropriate personnel (graduate assistants), buy the necessary equipments (computers, servers, printers, etc.), use of software packages (MS Visual Studio 2010, SQL server 2008 R2, MS Team Foundation Server, etc.), and network connections to the servers. The workstations and server connection network is designed and setup to initialize the development process shown in Figure 3. After the work stations are setup, all the necessary tools are installed in the work stations.

![Figure 3. Network setup for ViTAS development environment](image-url)
### Iteration 0: user stories for ViTAS

In agile development, it is most important to accumulate the requirements, prioritize them and construct the iterations to complete the development processes. Therefore, in iteration 0, all experienced users and development team members of ViTAS discussed the design issues and requirements in several meetings. Table 5 shows the stories with their points and priorities that are generated from the iteration 0.

<table>
<thead>
<tr>
<th>Story Number</th>
<th>Title</th>
<th>Owner</th>
<th>Priority</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFS 1</td>
<td>Create a database in SQL server for ViTAS, which will be the data repository of the system</td>
<td>Database Administrator</td>
<td>*****</td>
<td>1</td>
</tr>
<tr>
<td>TFS 2</td>
<td>Create a project for ViTAS development in Visual Studio where the code for ViTAS will be generated</td>
<td>Developer</td>
<td>*****</td>
<td>1</td>
</tr>
<tr>
<td>TFS 3</td>
<td>Install Team Foundation Server and create a source control directory for ViTAS. This will be the code repository and story/task assignments for each team member</td>
<td>Developer</td>
<td>*****</td>
<td>3</td>
</tr>
<tr>
<td>TFS 4</td>
<td>Create a data dictionary for the system.</td>
<td>Developer</td>
<td>****</td>
<td>8</td>
</tr>
<tr>
<td>TFS 5</td>
<td>Create the database schema and the relationship for the ViTAS system</td>
<td>Database Administrator</td>
<td>*****</td>
<td>13</td>
</tr>
<tr>
<td>TFS 6</td>
<td>SSIS packages are required to insert the initial data into the ViTAS table</td>
<td>Database Administrator</td>
<td>*****</td>
<td>20</td>
</tr>
<tr>
<td>TFS 7</td>
<td>Students will be able to view the courses he/she is registered for a particular semester</td>
<td>User</td>
<td>*****</td>
<td>5</td>
</tr>
<tr>
<td>TFS 8</td>
<td>Students will be able to view the uploaded homework assignments assigned by professor based on any course he/she is registered for</td>
<td>User</td>
<td>*****</td>
<td>8</td>
</tr>
<tr>
<td>TFS 9</td>
<td>Student will be assigned the peer's homework to grade anonymously</td>
<td>User</td>
<td>*****</td>
<td>5</td>
</tr>
<tr>
<td>TFS 10</td>
<td>Student will be able to view his/her final grading for each homework of each course</td>
<td>User</td>
<td>*****</td>
<td>3</td>
</tr>
<tr>
<td>TFS 11</td>
<td>Create the login page with the user id and password input form</td>
<td>Developer</td>
<td>*****</td>
<td>8</td>
</tr>
<tr>
<td>TFS 12</td>
<td>Based on the username and password students, instructors, and administrator will be directed to the separate web page</td>
<td>User</td>
<td>*****</td>
<td>8</td>
</tr>
</tbody>
</table>

It is assumed that ***** is the highest priority and * is the lowest priority.

After the stories are generated based on the discussion, the team members pointed them using the number sequence such as 1, 2, 3, 5, 13, 20, 40, 100. This is similar to the A Fibonacci sequence is 1, 2, 3, 5, 8, 13, 21, 34, 45, etc. The agile development teams use a modified version of this which looks like 1, 2, 3, 5, 13, 20, 40, and 100. Cohn\(^6\) suggested this is because the original
sequence proposes mathematical accuracy and real software development projects are. A lot of agile development teams throughout the United States assumed that 1 point is equivalent to 3 to 5 hours of work for a particular stories/task. Therefore, if a story has 5 points, it is estimated to be completed in 15 to 25 hours for a person based on his/her experience level. In the process of the ViTAS development, professors along with two graduate students from MIS department of TAMIU are selected as the development team members. Also, the professors and students are the user-experience design members. Initially, the entire development team generated 26 user stories, but as the development progressed, the more stories are added based on the new requirements.

![ViTAS database relationship diagram](image)

Figure 4. ViTAS database relationship diagram

ViTAS system generated total 40 stories with 342 story points. These are estimated to be completed in 1710 hours to 2736 hours of combined team work. If a team consists of 7 persons and each of them works 8 hours a day, then the ViTAS system will be developed in 31-59 days. In actual case of ViTAS development, one professor and two graduate students are in the development team and the graduate students are allowed to work 20 hours per week while taking full course load. Therefore, the development project of ViTAS application is estimated to be completed in 143 to 228 days (based on 4 working hours per day).

At the end of iteration 0, it is required to finalize the high priority based stories, which need to be completed initially and without which, the system development cannot be initiated. Based on the priority, first six stories are selected to complete first in the first iteration. Also, various tasks are
added to accomplish the stories development, i.e. for TFS 5 the following tasks need to accomplish to complete the stories:

1. Create table for instructors’ data such as name, ID, title, office location, phone number, email address, etc. in ViTAS database.
2. Create table for students’ data such as name, ID, phone number, email address, etc. in ViTAS database.
3. Create course table with course number, course title, section number, etc. in ViTAS database.
4. Create cross reference tables to create relationships between instructor and course, and students and course in ViTAS database.
5. Create table to store the homework assignments and homework grading based on the student and the instructor cross reference tables.

Figure 4 represents the table structure in ViTAS database and their relationship after completion of TFS 5.

**Constructive iterations for ViTAS**

The constructive iteration phase in agile development process follows Just-in-Time technique, which means “the right stories, during the right time, to the right person, and in the exact amount.” The agile development process addresses the issues during development or coding phase that can be fixed right away as the amount of work is not overloaded per iteration and per person. Another important and most popular aspect of agile development is testing, testing, and testing in each step of the constructive iteration phase. After completing the story development session in iteration 0, the constructive iterations are generated based on the priorities of the stories. For example, in Iteration 1 of the ViTAS development consists of story numbers from TFS 1 to TFS 5 [see Table 5] and all iterations have a length of two weeks.

In this phase of ViTAS development, the stories are uploaded to Microsoft Team Foundation Server (TFS) and arranged according to their priority. The stories and their related tasks are assigned through TFS to appropriate personnel and it is easy to keep track of the story and its owner (who worked on the development of the story). Due to tractability, when a bug/defect is found during the testing of ViTAS, each of the team members identifies their role on correcting the code. The agile development process insists the team members to meet daily for 10 to 15 minutes and share their advancements, road-blocks, suggestions regarding the story functionality, bugs, etc. This is another way to bring an enjoyable atmosphere into the development environment. The bugs for the ViTAS are found during the testing of the stories by the experienced users. That is the way the development team and user experience designers work together as a team in an agile environment and the system development progresses smoothly and successfully.

**Release iterations and production**

The ViTAS application is a completely different application that is being promoted to professors and students of TAMU, therefore all the related data required for ViTAS initial release phase is asked from the professor of the eight targeted course presented in Table 4. These data is formatted using Notepad++ and inserted into ViTAS database using the SQL server integration.
packages that is developed in iteration 2-3. In release iteration it is important to test all the permission issues, network issues, and firewall issues, so that when the system is being used by the users it works perfectly. The server that is been setup can handle 75 users at any point in time without overloading it. Also, the web link that is generated to use this application only be available to the users from the TAMIU computer labs. The front end of the system is developed in the ASP.Net platform and Visual Basic.Net language with SQL server at the backend. This system will continue to improve its functionalities as the feedback will be received from the experienced users.

**Overview of ViTAS system**

Based on the instructors and students point of view, the ViTAS system can be divided into two sections (a) system for instructors and (b) system for students. Outline of both system are provided in the following sections.

**System for instructors**

The system for instructors consists of four major functionalities, they are (i) view class rosters, (ii) view homework, (iii) upload homework, and (iv) peer assignment. Figure 5 illustrates the instructors’ view of the ViTAS system. The view class rosters page consists of the list of courses and the details of all student enrollments in all courses that an instructor is teaching.

![Figure 5. ViTAS system for instructors](image)

In view homework page the instructor is able to see the homework assignments he posted for the students (Figure 6). Also, in this page an instructor can check the students’ homework submissions by clicking the view students’ homework button. In this page, the instructors review and finalize the grading for the students for any homework assignment. In the upload homework page, instructors upload the homework assignments and their due date for the students based on the courses he/she is teaching.

Finally, the peer assignment page allows the instructors to upload solution to the homework assignments he/she posted earlier and this functionality is used after the due date of homework assignments. Also, the instructors assign the peer homework solutions uploaded by the students on or before the due date, to each student automatically by clicking the assign peer homework button (Figure 7).
System for students

After authentication to the ViTAS system, a student can see the list of courses he/she is enrolled in a particular semester and three buttons (i) view homework, (ii) upload homework, and (iii) peer grading. Figure 8 illustrates the students’ view of the ViTAS system. In view homework page, the student views the dropdown menu of courses and a table consists of downloadable Link of the homework he/she uploaded based on the course list. Also, the student views the points he/she received all homeworks after the grade has been finalized by the instructor.

The upload solution page (Figure 9) provides the students to download the homework assignment for a course and upload the solution by the due date. After the due date the homework assignment does not appear in the dropdown list. Also, when a student uploads a file for homework assignment, the file is renamed by the ViTAS system automatically using random number, which makes the peer grading anonymous.
Finally, when the instructor assigns the peer homework to the students after the submission due date, the student visits the peer grading page and download the peer homework assignment including the correct solution posted by the instructor (see Figure 10). As the name of the peer solution is a random number (generated by the ViTAS), makes the students remain unaware of their peer. Also, the students can view the maximum points possible for any assignment and grade their peer though this page. The ViTAS system is implemented in spring 2012 semester in a few courses to review its drawback and observe the responses from the instructors and students. Encouraging responses have been received from the instructors and the students who are suing this system. In future, the modification will be made based on the feedback that is gathered throughout the initial implementation phase. Also, this system will be implemented in all STEM courses near future.
Conclusion

The objectives of this research are to present the process of developing a web-based application using agile methodology and the application will serve the minority serving institutions like Texas A&M International University. This application is deployed with a few undergraduate STEM courses mentioned in Table 3 during the spring 2012 semester to observe the students and instructors’ response. Currently, the system provides a platform where the students are able to submit their homework assignments, review them, learn from their peers and communicate with the professors in an effective way. Moreover, this paper discusses the need for the ViTAS application, need for creating great relationship and better communication method between the early college undergraduate students and professors outside the class period. Also, this application will reduce the early college undergraduate student class drop rate by 50% upon proper usage.

This learning method will be measured both qualitatively and quantitatively. The quantitative measures include reduced student drop rate, course grade improvements, the growth of woman in mathematics and engineering majors, and future research. The qualitative measures include students’ enthusiasm of learning mathematics, engineering, and physics courses, assistance of ViTAS on students’ learning motivation and the advantages of ViTAS over traditional grading process such as Blackboard, Angel, etc. In future, this research can be further developed by evaluating the outcome of the student success using this application. Also, more detail discussion of agile experience can be presented through improvement of ViTAS through user experience design aspects.

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