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# IMPLEMENTATION OF A WEB-BASED ADAPTIVE AND INTELLIGENT TUTORING SYSTEM

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**Abstract**

A number of Learning Management Systems (LMS) such as Moodle, WebCT, and Blackboard provide some form of adaptive features. Research works provided evaluations of LMSs to find out how good LMSs support general functions and features as well as adaptation capabilities.Although LMSs provide some advantages, they are limited on the level of adaptive capabilities when considering the learners' diverse knowledge, goals, interests and performances. This paper presents the significance, architecture as well as implementation of a web-based adaptive and intelligent learning system that optimizes individual learning performance by enabling the efficient integration of reusable Learning Objects and Adaptive Hypermedia technologies.

**Keywords:** LMS; Learning Objects; Hypermedia; E-Learning; Adaptive System.

## I.Introduction

According to Brun et al., (2009), the basic principle of an adaptive system is to collect data, both directly and indirectly, to infer abstract user characteristics and make assumptions about how best to change the learning task. As the learner progress in the learning process, a set of information structures are identified that are used to define the most appropriate learning adaptation path. Information structures are used to infer assumptions about knowledge or skills, cognitive abilities, objectives, motivation, learning style, preferences, tasks and abilities In addition, adaptive learning supports dynamic learning patterns that adjust to learners' preferences, goals or cognitive competencies (Brusilovsky, 2003).

On the other hand, Fegurson et al., (2006) states that conventional Adaptive Learning Systems deal directly with knowledge gain rather than the acquisition of learning skills. However, there are a number of learning environments explicitly support cognitive development within a domain. They deal with such skills as monitoring, regulation, reflection, regulation and evaluation with domains such as sciences and problem solving (Zimmerman, 2008).

Graf (2007) provides an evaluation of the LMSs to find out how good LMSs support general functions and features as well as adaptation capabilities.Although LMSs provide some advantages, they are limited on the level of adaptive capabilities when considering the learners' diverse knowledge, goals, interests and performances. Thus, the "one-size-fits-all" service provided by many existing LMSs cannot deliver personalized instructions to diverse learners (Jeon and Su, 2007). As indicated by Jeon and Su (2007), an adaptive LMS should have the following features. First, it should be built on self-contained and reusable Learning Objects (LOs). Each LO should contain content, practice, and assessment items so that a learner can learn from the content items, practice on what he/she learned and be assessed of what he/she actually learned (SCORM, 2004). The reusability of LOs is important because they can be time-consuming and expensive to develop. The system must be capable of delivering the right content to a learner at the right time in the most appropriate way in order to provide personalized instruction. The system must be able to autonomously change (update) its behavior to satisfy the different needs of learners. Although adaptability can be realized in a variety of ways, three major adaptabilities need to be considered: in content selection, in sequencing and navigation, and in content presentation (Brusilovsky and Maybury, 2002). An adaptive system must be able to accommodate uncertainties existing in the data provided by learners or collected by the system (Tao et al., 2013). Adaptive Hypermedia System apply different forms of user models to adapt the content and links to hypermedia pages to the user (Brusilovsky, 1996). For example, most adaptive e-learning systems such as ELM-ART (Weber and Brusilovsky, 2001), MLTutor (Smith and Blandford, 2002), and SQLT-Web (Mitrovic, 2003) make use of learners' profiles or performance data to achieve different forms of adaptability (Brusilovsky et al., 2004). The profile data are typically provided by learners at the time of their registration, and the performance data are collected by the system based on the learners' interactions with the system and assessment results. Unfortunately, these data may be incomplete, inaccurate, and/or contradictory. For example, a learner may not be able to provide the system with a complete set of profile data (e.g., not able to specify the preferred learning style). Even if he/she provides a piece of information, it may not be accurate. Also, some profile data may contradict with the performance data (e.g., a learner may specify that he/she has certain prior knowledge on a subject which contradicts with his/her actual performance). We shall call the above problems collectively as “the data uncertainty problem” (Jeon and Su, 2007).

**II. Related Works**

Adaptive Leaning Objects are design and implemented following the principles and technologies of Intelligent Tutoring Systems (ITS) (Manouselis, 2011).Intelligent tutoring systems (ITSs) are computer programs that are designed to incorporate artificial intelligence (AI) techniques in order to provide tutors which know what they teach, who they teach and how to teach it (Wenger, 2014). The design and development of such tutors lie at the intersection of computer science, cognitive psychology and educational research (H. S. Nwana 1990). Research and practical needs are the two motivating factors for building ITSs. One of the main advantages of ITSs is the possibility for providing one-to one tutoring. It is agreed that individual tuition, tailored to the needs of the student, is the most effective form of educational interaction. Some desirable characteristics of ITSs are:

- Reports of student progress for teachers
- Provide immediate and motivational feedback to the students
- Management tools for entering data into the database and monitoring the progress of the students
- System performance requirements including response time and accuracy of responses
- Authentication of user and retrieval of previous session information
- Logging all user activity including the time spent on lessons and all attempts at answering the questions

Adaptive and intelligent web based educational systems provide an alternative to the traditional “just put it on the web” approach in the development of educational courseware. These educational systems tend to be more adaptive by building a model of the goals, preferences and knowledge of each individual student and using this model throughout the interaction with the student in order to adapt to the needs of that student. They also attempt to be more intelligent by incorporating and performing some activities traditionally executed by a human teacher such as coaching students or diagnosing their misconceptions. The first pioneer intelligent and adaptive web based educational systems were developed in 1995-1996. An interest to provide distance education over the web has been a strong driving force behind these research efforts (Brusilovsky and Peylo 2003).

Adaptive and intelligent systems are not synonymous. Adaptive systems attempt to be different for different students and groups of students by taking into account information accumulated in the individual or group student models. Intelligent systems apply techniques from the field of Artificial Intelligence (AI) to provide broader and better support for the users of web based educational systems. Majority of the existing systems fall in only one of the categories. Systems like German tutor and SQL-Tutor are non-adaptive. They will provide the same diagnosis in response to the same solution to a problem regardless of the students' past experience with the system. Existing systems like AHA and WebCOBALT use efficient but very simple techniques that can hardly be considered intelligent. The reason for focusing on both adaptive and intelligent systems is both groups are of interest for AI in education community.

Findings indicated that use of an intelligent tutoring system for the accounting cycle in a 50 minute homework session contributed to an improvement in test performance of approximately 27 percentage points in comparison to students using textbook and course notes to complete the same homework improved their test performance by about 8 percentage points.

Part of the challenge in creating an AI tutor is finding an appropriate balance between giving and withholding assistance. Showing students how to solve a problem (giving assistance) can be more effective in some cases but requiring students to solve problem on their own (withholding assistance) can be equally effective in other cases. Because an AI tutor can be designed to give or withhold assistance at various times, its impact on student learning is an empirical question requiring assessment. Artificially intelligent tutors respond dynamically to the individual learning needs of each student. That is, an AI tutor does not employ a set of instructions, guides or problems that are pre-programmed to anticipate particular student responses. Instead, an intelligent tutor constructs response in real-time using its own ability to understand the problem and assess student analyses. For example, an AI tutor can construct step-by-step feedback and hints that are tailored to the specific analyses and difficulties evident I each individual student's responses much as human tutor does. This dynamic feature, which is unique among educational computing technologies, provides many potential benefits over pre-programmed instructions and guides. Early ITS development efforts began to explore computational and communication issues related to getting a computer to teach like a human. Examples of ITSs developed during the late 1970s and early 1980s are WEST (game playing), SOPHIE (electronic trouble shooting), GUIDON (medical diagnosis), WHY (geography), STEAMER (power plant theory of operation), Quest(physics problem solving), EXCHECK (mathematical proofs) and BUGGY (arithmetic problem solving).In recent years, the focus of ITS research has shifted from development of systems dedicated to a particular subject to the development of ITS authoring tools accessible to non-programmers (Hsieh 2001).

## III. Methodology

The system architecture and flow chart is shown in fig1 and 2 respectively. As proposed by H. S. Nwana (1990); Noguera et al., (2017), the system consists of student model, Domain model which contains learning objects, Tutorial model which contains hypermedia links and the interface. The learning object concept makes it possible for students to learn exactly what they need, when and where they need it. Learning paths provide students with a highly adaptive, goal-oriented learning environment. A sequencing algorithm aligns learning objects to a learning path based on individual performance. The assessment and testing tools build into the learning objects allows for each student to initiate their learning based on their capabilities and adapt their learning to their individual needs, tracking learning success, and achieve the desired mastery of a skill when they reach the learning path's goal.

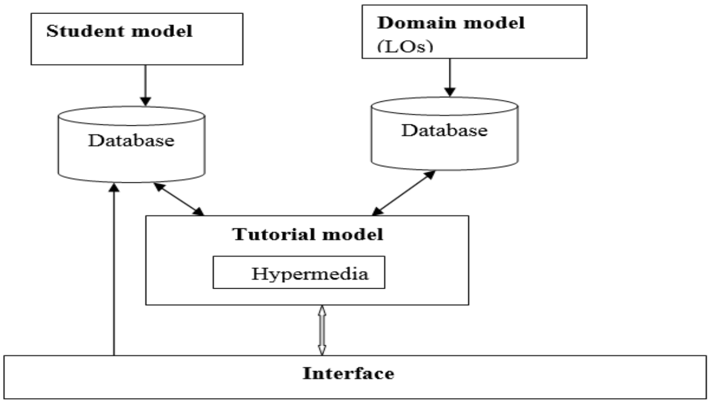


**Figure-1. System design architecture.**

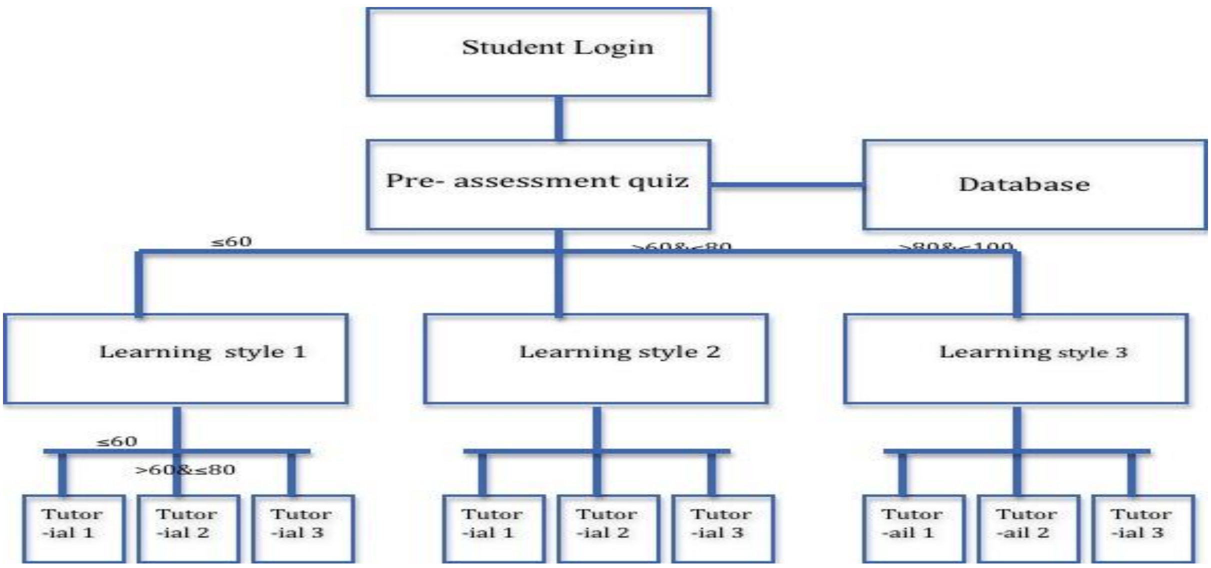


**Fig 2: The flow chart.**

## IV. System Implementation

The purpose of this project is to build an intelligent and adaptive web based tutorial system that will present material in an interactive manner to the student. In this system, the lessons are guided by the actual skill set of the student taking the course. The system evaluates the student's level through examination and depending on the actual level of the student, the student will be guided to the appropriate tutorial. The interface of the built system is shown in Figure 3.

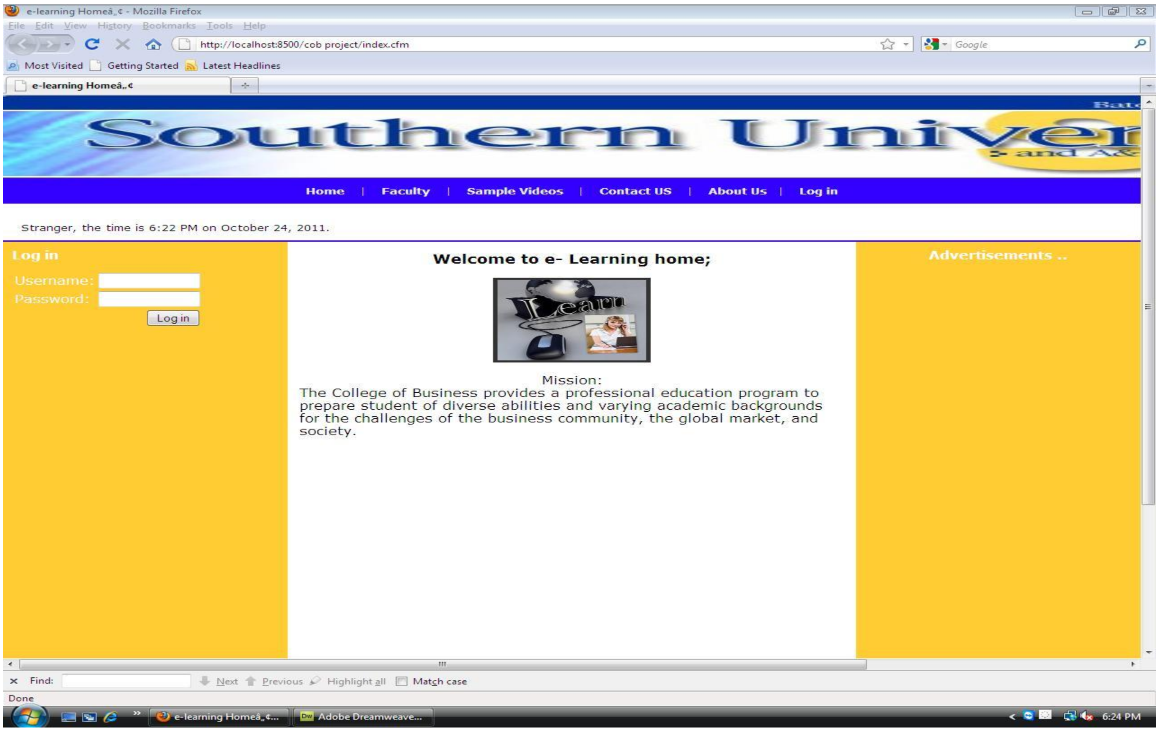


**Figure 3. Home page of the web system.**

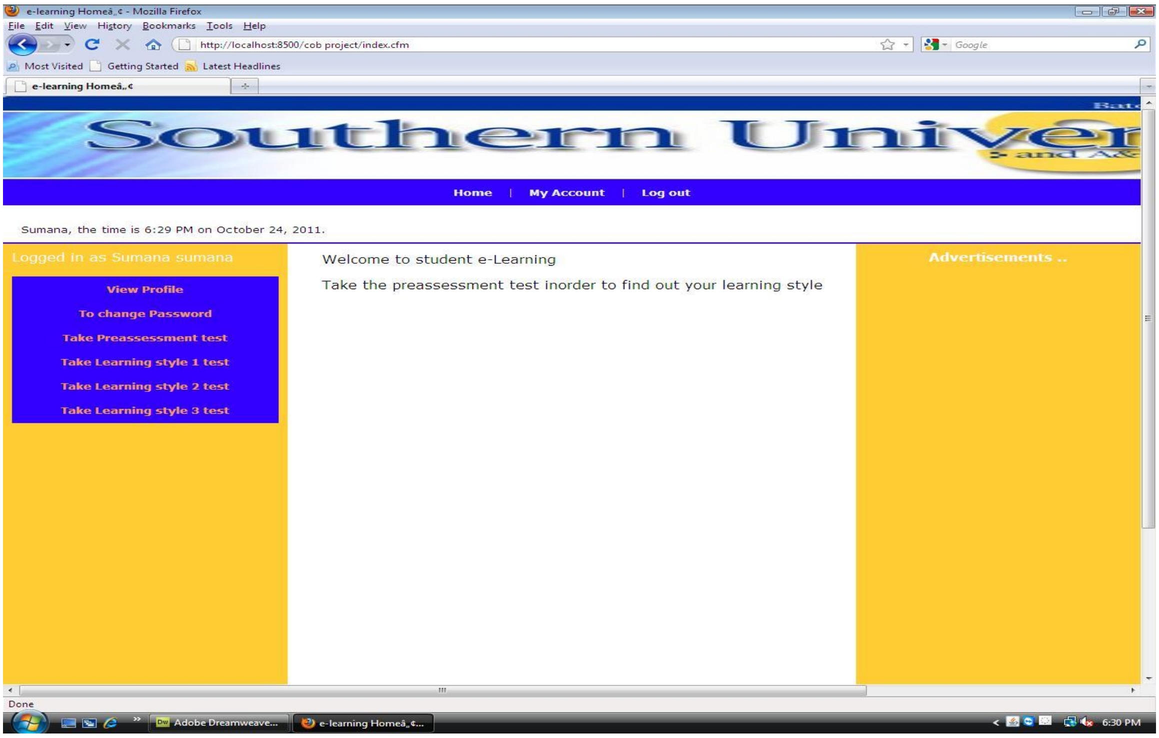


**Figure 4. Student view after login.**

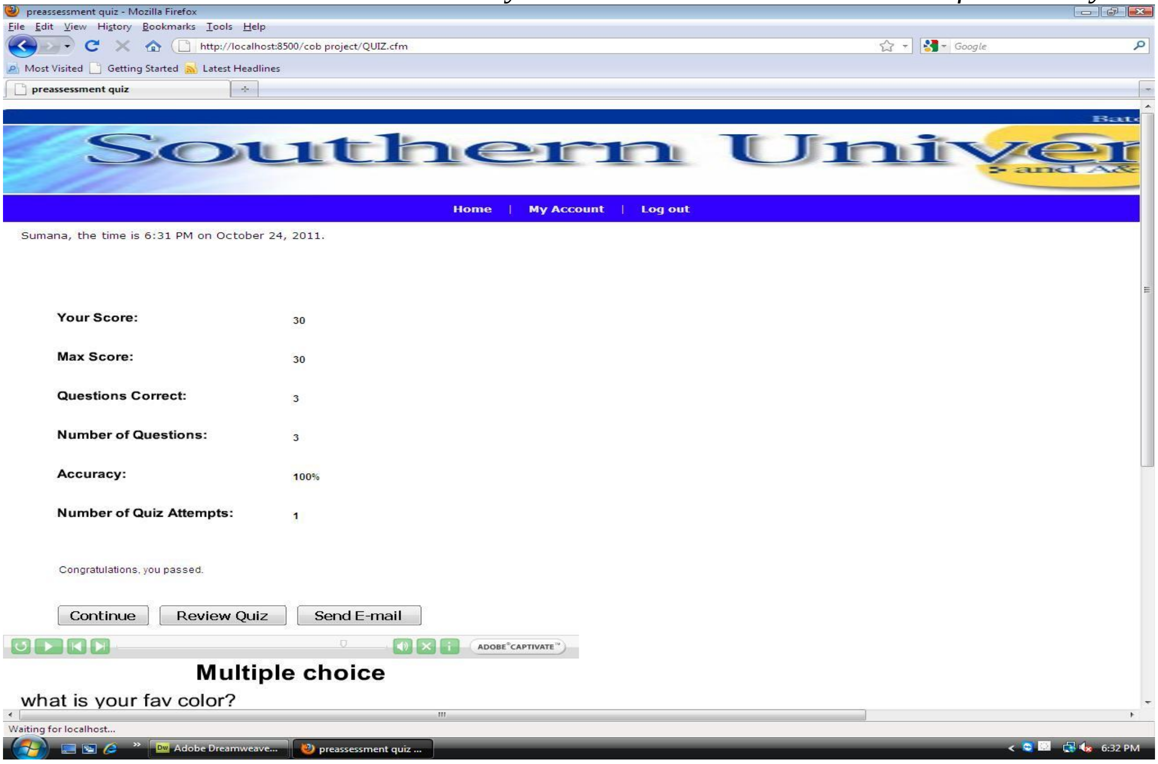


**Figure 5. Score display at the end of the pre-assessment quiz.**

Students, faculty and administrator can login using the username and password. Students and faculty need to first register in order to be able to login to the system as shown in figure 6. After login, the faculty will be able to access the list of courses, student list from the database. The faculty view and student view after login are shown in Figure 3.

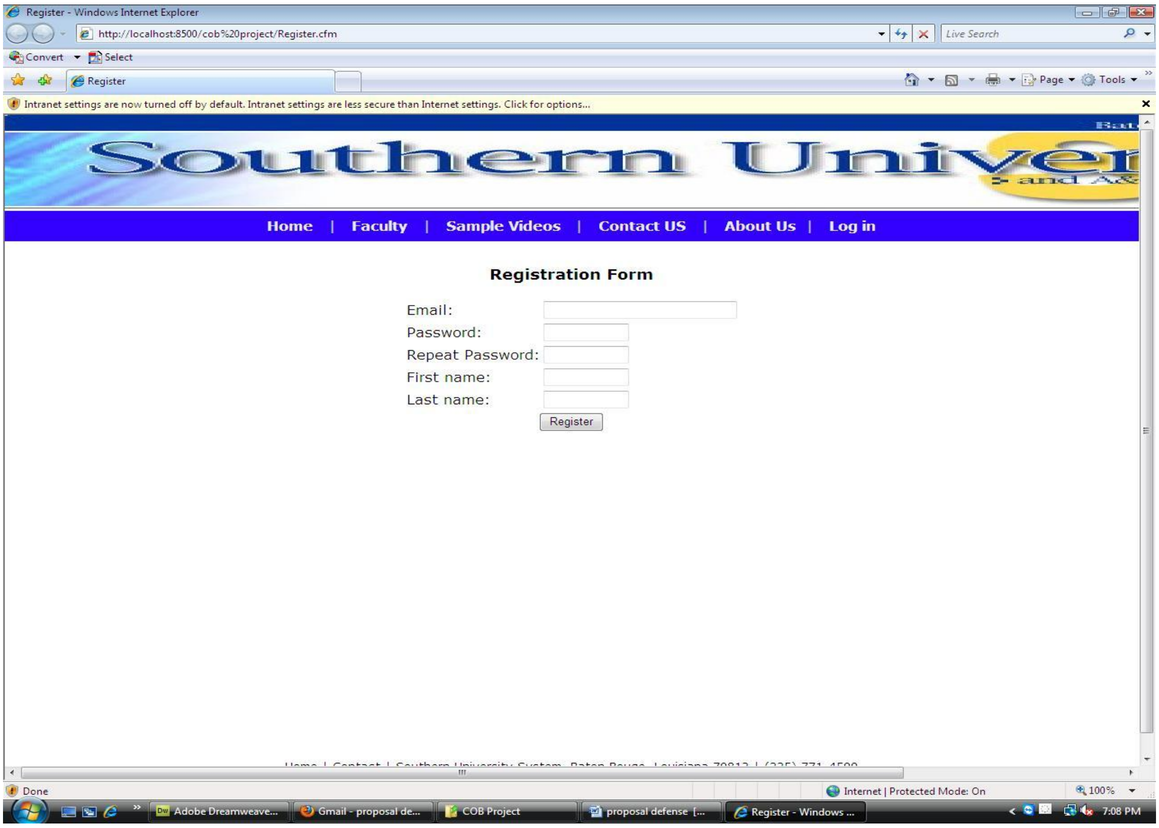


**Figure 6. Registration form for faculty and students.**

## V. Discussion

The built system initially categorizes the students into 3 learning styles depending on their performance in the pre-assessment test. In each learning style, the system presents the student with a quiz in order to determine which tutorial the student should be directed to. Depending on the quiz results, the system redirects the student to the appropriate tutorial. Hence the system fulfills its set goals. This project is about building an intelligent and adaptive web based tutorial system. This project is aimed at helping the students and faculty with their courses. The faculty can use this system to build different tutorials related to their course. This system helps the students in taking the tutorials online at their own convenient time and place and helps them in learning the materials better.

## VI. Conclusion

In any software/tool development, Maintainability will always be a process and performing this task usually comes with heavy cost (Ayeni&Misra 2014). Maintenance prolongs the life span of the software. Future research works tends to show a detailed maintainability model. The tutorials can be made interesting by incorporating graphics and audio clips**.** Intelligent user interface can be built into the system that provides an enjoyable experience through interactive game like and entertaining lessons **.**Features such as class rostering, grade analysis and statistics and generating progress reports can be incorporated into the system.

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