Adaptive Learning Methodologies to Support Reforms in Continuous Formative Evaluation

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***Abstract*—This paper presents the extensions of Amrita Learning, a web-based, multimedia-enabled, Adaptive Assessment and Learning System for schools to facilitate Continuous and Comprehensive Evaluation (CCE). Continuous Evaluation refers to the formative assessment from the beginning of instruction and periodically during instruction and is closely interwoven with learning.**

Amrita Learning's CCE extension supports adaptive assessments directly mapped to CBSE curriculum, monitors proper implementation of CCE and automates, enforces, and gathers usage and performance statistics. Being an adaptive system, it already supports self-paced learning, constructivist, mixed presentation, mastery, and spiral learning.

The proposed competency model has been developed and is being pilot tested at schools in India. Initial results of the study are discussed in this paper.

Keywords- Adaptive Learning; Assessment; intelligent tutoring; Simulation; Continuous and Comprehensive Evaluation; CCE; Interactive Animation; Formative; Summative;

I. INTRODUCTION

In 2009, India's Central Board of Secondary Education (CBSE) made a bold and ambitious move to reform and the educational system to higher standards based on well tested research principles. CBSE introduced the Continuous and Comprehensive Evaluation for Class 9 and 10 and made optional the Class 10 common Board Exams.

In previous years, summative end of term examinations were the main mode of assessments. However, an overemphasis on the summative assessment had lead to unhealthy competition, labeling, and negativity.

Since then CBSE has mandated continuous formative assessments with term end summative assessments. Holistic approaches to the development of the students which include both stochastic and non-stochastic are included. The importance of nurturing emotional, value-based, and social IQ is recognized with emphasizes on both stochastic and non-stochastic areas.

However, this move has resulted in increased effort to administrators, instructors, and schools to monitor, manage, ensure proper implementation, and evaluate the success of CCE. The availability of a well tested, curriculum-mapped, online system, which is scalable to thousands of concurrent users, makes this task more manageable while providing administrators with information at their finger tips.

There is a need for a system that can provide a common baseline for formative assessments and direct reporting of usage and performance statistics to the student, the school and to the board. It is valuable to have a system assists schools implement CCE and monitor the implementation of these reforms.

II. AMRITA LEARNING - ADAPTIVE SOLUTION

Amrita Learning emulates a one-on-one motivating teacher who understands a student's knowledge level and learning speed, effectively responds to a student's needs and provides feedback to the class teacher and the student [6].

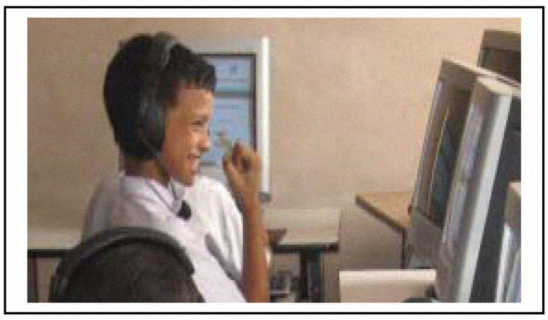

Figure 1: Motivating and Child Friendly

Amrita Learning supports a web-based adaptive learning methodology with spiraling of concepts, progression based on mastery of concepts, adaptive presentation, sequencing and feedback based on student profiling, and supports various types of content including flash interactive animations, simulations, videos, and XML and text files [6].

It uses intelligent class monitoring to identify the students who have learning records that are different from those of their peers [1]. These students may be different from others in many ways. They could be progressing too fast, or too slow, or simply need different types of tutoring. These students will get individual attention from the software.

A. Adaptive Assessment

Adapting the assessment to student is an interesting and new direction for research [4, 5]. The majority of the adaptive assessment models are based on 'item response theory' (IRT), a mathematical model to create adaptive tests.

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The advantages of adaptive assessment include more accurate assessment of knowledge level, shorter duration of assessments, working at a level that is neither too easy nor too difficult [8].

Amrita Learning maintains a student model based on student's prior preferences, knowledge, skills, and pace of learning. Based on the student model, questions from various sub areas are presented to the students. Within each sub area, adjustments are continuously made based on accuracy and speed of response. Assessment ends when the right level has been found for every sub area. The time required for assessment is directly proportional to the deviation in expected learning level from the start of the test, i.e. it takes more time for the advanced and the weaker student and less for the student performing at the grade level.

- Identify skills individual students have mastered
- Diagnose instructional needs
- Monitor academic growth over time
- Make data-driven decisions at the classroom, school, and district levels
- Place students into appropriate instructional programs.

B. Adaptive Learning

With Amrita Learning, for every distinct sub-area, the students progress at their own pace and can either advance to topics ahead of their grade level, learn at the grade level, or learn remedial pre-requisite materials where mastery is needed for effective learning of current level. For example, a student could be at grade level in geometry, above grade level in multiplication and below grade level in word problems involving multiplication. Additional time and emphasis is automatically provided to the learner's lower level.

Studies have shown that adaptive presentation increases student performance [3]. Amrita Learning adapts

- the content by selecting the format or content
- order of content
- look and feel of screens and navigation flow
- Feed-back (thinking clues, help, step-by-step hints, tutorials, pre-requisite) etc.
- Adapting the skill area to present based on performance in various skill areas.

The scope of the Adaptive Assessment curriculum was modified to any subset or skill area of the content that mapped to the CCE curriculum and the algorithms were adjusted accordingly.

III. System Support of Remedial Intervention & Learning

Amrita Learning allows dynamic sequencing and presentation of syllabus content which adjusts to the individual student. When the student experiences repeated difficulties with new topic, the topic is set aside for later presentation. Again, the goal is to challenge the student without frustrating him, and thereby to keep him engaged in the learning. (Figure 2)

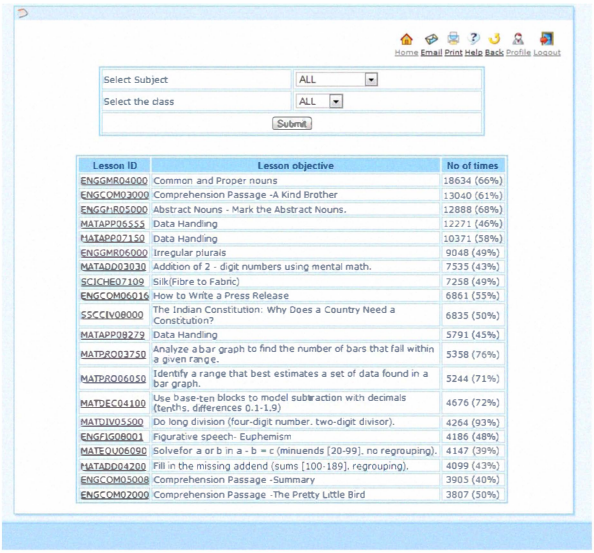

Figure 2 Questions answered incorrectly by most students

The proportion of instruction across topics is adjusted for the student so that areas that need improvement receive more questions, thereby reducing the gap between the student's areas of improvement and strength.

Tutorial intervention guides individual student learning. When the student encounters difficulties the system employs various instructional strategies, including sequential practice within the area of difficulty, presentation of brief tutorials, and/or review of prerequisite material.

Amrita Learning supports pre-requisites for concepts; when students are unable to master a concept after multiple attempts, it may decide to a review of the pre-requisites. In our own judgment the automatic provision for work on prerequisites is one of the most powerful and sophisticated features that can be used in a computer-based learning.

By periodically checking the student's recollection of previously mastered material, the system assures the student's firm basis for further learning.

IV. CCE Assessment Module of Amrita Learning

Amrita Learning's extension to support intelligent CCE is to automate, enforce, and gather usage and performance statistics. Being an adaptive system, it already supports self-paced learning, constructivist, mixed presentation, and mastery and spiral learning. Other good quality learning methodologies supported include experimental learning, activity-based, targeted help and hints when errors.

Students may take the formative assessments and reattempt at their own pace, assessments may be designed to support spiral learning (multiple parallel concepts) and though mistakes are scored as incorrect, guidance is provided with hints and help and students are encouraged to try again so that they have a chance to learn from their mistakes.

A computer based adaptive assessment system can support both formative and summative assessments. The purposes of the CCE extension include:

- To develop adaptive assessment but implemented to support both traditional and adaptive modes.
- To measure student achievement of academic standards;
- To measure each student's growth over time along the assessment scale;
- To provide schools with timely information useful for instructional program improvement.
- To provide a common secure framework to for administering parts of Formative and Summative Assessments.

V. CCE Formative Assessment Module

Continuous formative evaluations are gaining increased focus and attentions – these tests that are given throughout the year – are a necessary tool in the current educational environment. Formative assessments provide educators with insight into student performance, inform instruction needs, and provide administrators with valuable reporting data. For educators and administrators to receive the highest quality data from assessments, the assessments must be scientifically based. Only then can educators and administrators gain an accurate picture of student achievement with actionable results.

Designed to provide educators with a reliable measure of student progress, these are built from the ground up to address the challenges that education professionals encounter.

- Formative Assessments consist of one or more of methods of evaluation including class work, homework, oral questions, quizzes, projects, assignments, and tests. It is diagnostic and remedial and carried out throughout the year.
- The formative assessment may be attempted multiple times by the students until mastery is achieved, up of the maximum number of attempts allowed.

Many researchers have addressed effectiveness of adaptive learning based by student models [1, 2]. Amrita Learning uses the student model and performance, to determine one or more action to be taken during an incorrect response.

It is recognized that self-assessment tests can be used for instructional purposes, when item correction is shown within some feedback. Possible interventions for learning are step by step help, a similar example, tutorial on concepts, pre-requisite skills and so on. The formative assessment may be attempted multiple times by the students until mastery is achieved, up of the maximum number of attempts are allowed.

Based on the student profile, the system will determine one or more action to be taken during an incorrect response. Studies have shown that self-assessment tests can be used for instructional purposes, when item correction is shown with appropriate feedback [7].

Possible interventions for learning include step by step help (Figure 3), a similar example, and tutorial on concepts or stepping back to remind them of pre-requisite skills and so on.

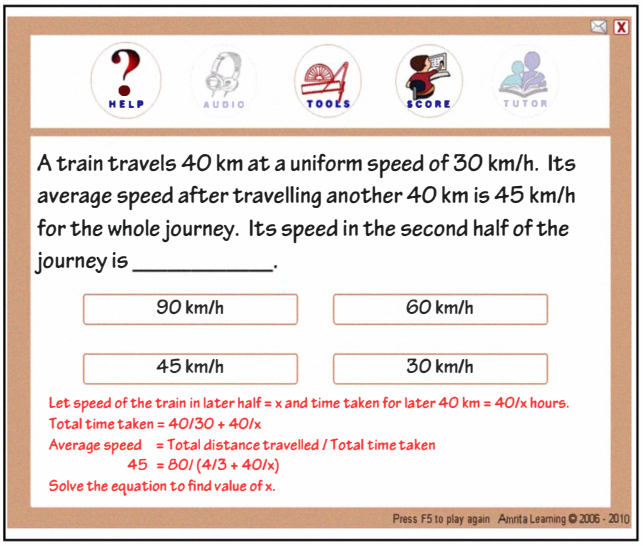

Figure 3. Incorrect response triggered HELP

VII. Multimedia Enabled, SCORM Compliant Question Bank:

A wide variety of Multiple Choice Questions are included to test higher order objectives like application, analysis, synthesis, and reevaluation. Parallel question banks are supported for student practice, formative assessments, and summative assessments. These assessments must only become active in periods determined by the school administrators.

Besides the Class and Subject, the organization is based on the learning point or objectives shown in the table. Each learning objective can have a set of questions and each question may have multiple attributes.

Amrita Learning content is designed to build the higher order thinking skills (HOTS) of students. Higher Order Thinking Skills include inference, compare, and contrast, applications, problem solving, classification, interpretations, conclusions, judgment, ranking, and ordering.

VIII. Reporting Module

Students get detailed reports which pinpoint the areas of strengths and the areas that need improvement. Teachers can use these to provide appropriate instruction to the students. Features include:

- Percentile ranking for a student based on students in school and across students in all the schools using the system.
- Help in diagnosing student's learning difficulties and implement effective methods of teaching the students thus enriching the instructional process in schools.
- Feedback on areas of strengths and weakness for various groups (by school, economic background etc.), thus providing feedback to the curriculum that is taught and influencing curriculum update and development.
- For every student, the time spent, the sessions, score, current level, and so on are stored in the system.

A. *Teacher Reports*

Reports include areas of strengths and weakness for various groups (by school, economic background etc.), thus providing feedback to the curriculum that is taught and thus influencing curriculum update and development.

For every student, the time spent, the sessions, score, current level, and so on are stored in the system. The types of reports for teachers include:

- Class performance reports (Figure 4)
- Attendance and usage analysis
- Consolidated report for a particular period.
- Assignment reports
- Detailed student logs

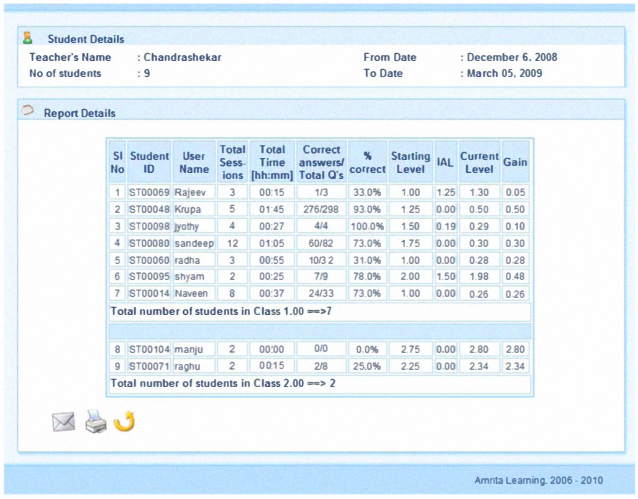

Figure 4. Sample Teacher Report for a class shows number of sessions, time taken and performance of each student

B. *Student Reports*

- Data about every student's performance is continuously recorded and updated. (Figure 5)
- Such data is made available in the form of text and graphical reports.

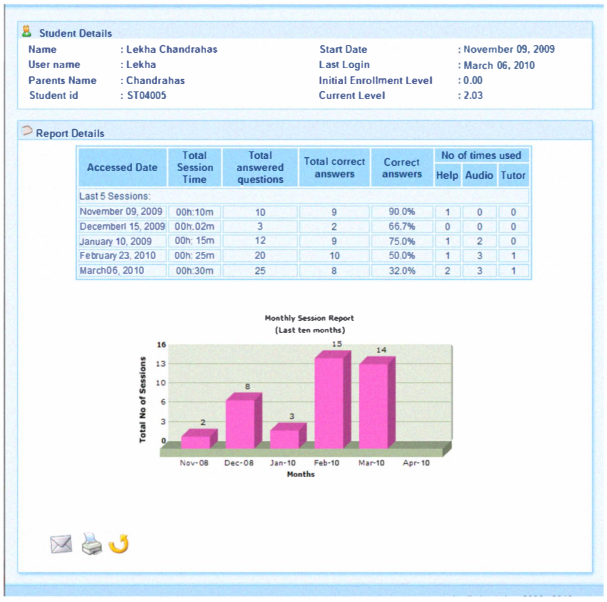

Figure 5. Sample Student Session Report

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IX. PILOT TRIALS

Pilot trials in three schools were conducted for three schools in smaller cities, Kollam, Mangalore, and Cochin over a four month period. Students used Mathematics formative assessment and learning modules every week. Students at the Mangalore School had more number of computers and hence we able to use the system twice a week, while the students at Cochin and Kollam used it once a week.

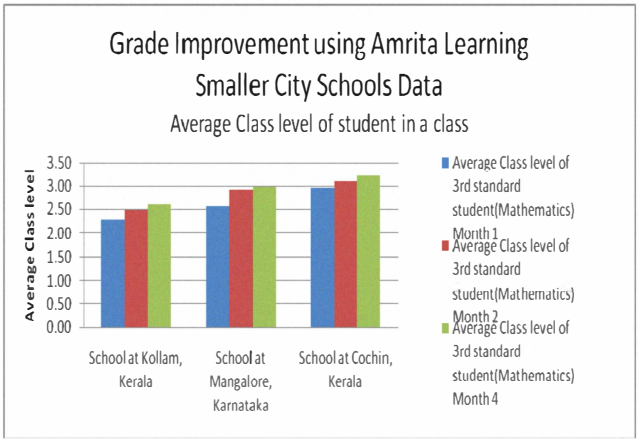

Figure 6. Results of average grade improvement in three small city schools

The average initial assessed level of the students is shown in the chart and all showed an increase in grade level. (Figure 6)

The average grade level improvement was the highest in the school in Mangalore. This may be due to the fact that the students in the Mangalore school used the system much more than the students in the Cochin or the Kollam schools.

X. CONCLUSIONS AND FUTURE WORK

In this paper, we have explained the enhancements to Amrita Learning to support Continuous and Comprehensive Evaluation reforms.

The main design considerations of our research work that were discussed in the paper are:

- For large scale implementation of Adaptive assessment, it is important to provide an assessment that directly supports classroom curriculum.
- A tool to support formative assessment in an adaptive manner may benefit users from diverse backgrounds and skills.
- Extensive feedback enhances the learning process.

Future plans include grouping students by ability so as to further aid the teacher in intervention. A complete teacher authoring module where a teacher can add content and define the adaptive behavior and rules is being developed.

Amrita Learning has been tested with about 300 concurrent users. Architecture changes are being made to scale it and allow many thousands of concurrent users.

XI. ACKNOWLEDGEMENT

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