Real-Time Skill Assessment Data Mining Model to enhance students' performance

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***Abstract*—**High quality universities exhibit an excellent record of academic achievements, highly influenced by student's performance. Thus, the need for a web-based model to monitor, analyse and predict student progress and performance which could bring the benefits and impacts to students, educators and academic institutions. To ensure the success of such a formative assessment model and to improve student learning, the following strategies are used: 1) providing feedback to students to move learning forward and suggesting interventions measures (give supplementary work, organize tutoring sessions, etc..) for teachers to help students reaching their goals., 2) activating students as owners of their learning to improve performance, 3) and initiating an iterative self-assessment to identify criteria for success such as setting goals and work towards expected standards. According to Harlen and James [1] formative assessment is directed towards promoting learning by taking into account the progress of each individual, the effort put in and other aspects of learning which may be unspecified in the curriculum; and by identifying several instances of certain skills and providing diagnostic information as feedback to students as well as to teachers. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt, rather than simply a test score or other measurement of how far a student is falling short of the expected standard. Nicol and Macfarlane-Dick [2] list some principles of good feedback practice: It clarifies what good performance is, it facilitates the development of self-assessment in learning, it provides high quality information to students about their learning, It encourages positive motivational beliefs and self-esteem, it provides opportunities to close the gap between current and desired performance, and It provides information to teachers that can be used to help shape teaching. The aims of this study are twofold: first, it allows students to monitor their progress through an online real time system which predict their performance in the next period of time and set future learning targets using data mining methods. Moreover, it offers a real time progress feedback that allows them to proceed through the production of work that aims to achieve those targets; simultaneously teachers can observe the performance of the whole class and intervene accordingly; the second purpose is to promote self-assessment to enhance education by evaluating student assessed value versus the real accomplishment. This will motivate students to be active in their own learning and to understand their strengths and weaknesses.

***Keywords*—**Educational Data mining, formative assessment.

I. Introduction

Assessment is defined as measurement of the learner's achievement and progress in a learning process [3, 4]. In an often-cited article describing how formative assessment improves achievement, Sadler [5] concludes that it hinges on developing students' capacity to monitor the quality of their own work during production.

Two major forms of assessment exist: formative and summative assessments [6, 7]. Summative assessment measures what students have learned at the end of a course, or after some defined period [8]. It can also refer to certifying that the required levels of competence have been achieved [6]. In general, summative assessment includes scoring for the purposes of awarding a grade or other forms of accreditation. Oosterhof *et al.* [7] research on online assessment literature endorses that summative assessment is considered suitable for certifying a learner's final achievements.

Formative assessment is commonly applied in the classroom as a source of ongoing feedback with the aim to improve teaching and learning [8]. It can also be referred to as assessment for learning that occurs during the course of instruction with the aim to support learning [7]. Formative assessment activities are embedded within instructions to monitor learning and assess learners understanding for the purposes of modifying instruction and informing further learning through ongoing and timely feedback until the desired level of knowledge has been achieved. Black *et al.* [9] noted that practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited.

In the classroom the formal assessment is done through assignments, tests, quizzes, performances, projects, and surveys; or informally through questioning and dialogue, observing, and note taking. In any of these instances, teachers and students may or may not be engaged in formative assessment: the determining factor is not the type of assessment they use, but rather how they use the information to create an authentic learning environments which can influence learner engagement. Unless all members of an educational environment (teachers, students etc.) come to understand their strengths and weaknesses, and how they might deal with them, they will not make progress in enhancing learning and teaching performance. "Formative assessment, therefore, is essentially feedback [10] both to the teachers and to the pupil about present understanding and skill development in order to determine the way forward." [1]

The objective of this research is to use formative assessment to increase students' responsibility for the setting of their learning targets and also for the monitoring or tracking of those targets. This research also focuses on how educational

data mining techniques can be used to design an early warning system to improve students' achievement and minimize the drop rate.

II. Real-Time Skill Assessment (RTSA) Model

The determination of developing a formative assessment model is to aggregate strategies for helping students motivate themselves. The real time skill assessment (RTSA) model is an iterative framework that provides teachers a possibility for enriching student motivation and make them self-aware of their knowledge; and helps in developing a culture of using the model's outcome data to improve the drop rates [9] by focusing on less mastered skills. The proposed model represents a diverse array of interventions with the following characteristics: the use of classroom discussions, classroom tasks, and homework to determine the current state of student learning and understanding of a specific; the provision of descriptive feedback, with guidance on how to improve, during the learning; and the development of student self- and peer-assessment skills.

Diagrammatically, the model looks like this:

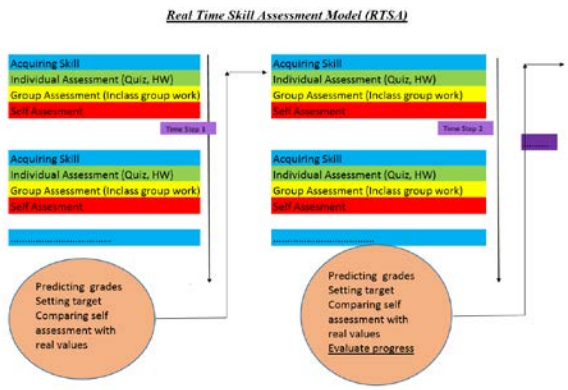

Figure 1. RTSA Model.

This model proposes some techniques to be used in the classroom to collect evidence of student learning, and to provide information needed to adjust teaching and learning while they are still happening:

1- Acquiring skills: classroom and questions dialog are unmeasurable but engage students and expands their learning. Asking better questions affords students an opportunity for deeper thinking and provides teachers with significant insight into the degree and depth of student understanding.

2- Constructive quizzes: Periodic quizzes can be used during the formative assessment process to monitor student learning and adjust instruction during a lesson. Constructive quizzes will not only furnish teachers with feedback on their students, but they serve to help students evaluate their own learning. The teacher should use the results of these quizzes to adjust instruction immediately based on student outcomes. Constructive quizzes are a good way to add movement in the classroom and allow teachers to determine the depth of student learning to inform their instructional decisions.

3- Group Assessment such as Think-Pair-Share [11] and Four Corners are quick strategies that can be used effectively in RTSA model for gauging student understanding. These activities ensure that all students are interacting with the information. Students can discuss the solution method. The teacher can listen to student discussions and determine who has information who does not.

4- Visual representation of the student self- evaluation skill. This quick way of assessing student depth of understanding regarding a specific skill allows the teacher to adjust instruction immediately to address student needs and allows student to learn how to self-assess his knowledge.

III. Data Mining Methods

The developed model predicts student's grades and factors affecting their grades. Using KNN algorithm we detect students at risk or most likely to fail the course. Such students are given real time feedback using association rules [12]. A web based application system implements graphical representation (Visualization) of the collected statistical data and offer students and professors update on the student's and the class's performance.

In this study we use two kinds of data sets, the first data set is populated with student's grades and these are collected every 2-3 weeks, they predict the student's final grade based on this 2-3 weeks of data. The second data set is categorical and has very valuable routine information about a student. This data set is a result of a questionnaire which is filled by all the students in a course. The goal of this is to find out about the student's daily routine, family and educational background and interests. This data is mined along with the grade data collected every 2-3 weeks. Together they predict student's grade and possible factors for his predicted grade. Based on this outcome an Iterative Intervention Algorithm gives each student's targets to be achieved and suggest some improvements in grades as well as in student's routine for upcoming 2-3 week session. This information about the student is private and help the professor/instructor to understand more clearly the student's needs in coping with the course and take appropriate actions to assist the student.

This study uses [13] Combination of Multiple Classifiers (CMC) or the Ensemble approach to boost the accuracy of the results. All students has to belong to one of the four classes. Which will be determined by four or more classifiers working on two different datasets and cast a vote to one of the four classes.

The data mining implementation steps are as follow:1) classify students, and focus on the top performing and underperforming classes, 2) perform rule mining to obtain the set of factors responsible for a student's poor performance, 3) provide the information gained from the above two steps in an intuitive way, 4) predict final grade/factors of the student by using classification algorithm, 5)set up targets for the students next session, 5) visualize data on a web application and 6) evaluate the student self-assessment effectiveness.

In a pilot study developed at University of Houston, many students finds that formative feedback enabled them to identify their strengths and weaknesses, revise their work, and continuously refine their understanding by reviewing feedback, which supports them towards engaged and self-regulated learning (Crisp & Ward,2008). First, we implemented Bayes classifier along with K-Nearest Neighbours and predicted grades based on the collected data and classified students in four classes:1) top performing (85-100), 2)at risk (60-85),3) endangered (45-60), and 4) fail (<45). Second, we recommended descriptive feedback such as do supplementary work, or attend more classes, or suggest immediate teacher interventions to raise the student's self-esteem.

Figure 2. Class Performance

Figure 2 evaluates student class performance based on his/her grades of attendance(att), homework (hw), class projects(cp), quizzes (qz) and predict the final exam (FE). Moreover the student can locate his performance in regards to all class members.

Figure 3. Student at Risk.

Figure 3 is an example of a student at risk and the suggested improvement needed to move to the upper level target. The effectiveness of feedback has a number of characteristics such as providing learners with diverse opportunities for dynamic and meaningful interactions with other (particularly the teacher and peers). Besides, embedding of formative assessment within courses fostered a sense of an interactive and collaborative learning communities. Therefore, setting a self -assessment cycle is a way to assess what students knows and value what they assess, while still keeping assessment manageable, valuable, and do-able [14].

Table 1. RTSA results**.**

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Students classifications	Target	Self-assessment accuracy in percentage	Improvement in percentage
At Risk	Top	50	10
Endangered	At Risk	81	16
Top	Top	48	15
Fail	Endangered	86	13

For instance, the table above shows the students classification class, the target for the next time period, the self-assessment accuracy after comparing the assessed value with the real performance and the improvement reflects how well the student succeeded in evaluating his knowledge, the low percentage proves the lack of experience so RTSA will be a good model to train students so that they can locate their weakness and improve it or at least seeks help.

RTSA model succeeded in including all activities undertaken by students that provide information to be used as feedback to modify teaching and learning activities. However, any new model used should have learning outcomes and an assessment plan. The next section discusses the usefulness of self-assessment to enhance education.

IV. Evaluation Techniques

Student learning information collected during the first iteration of the model is valuable in making corrections and changes [15]. However , evaluating the accuracy of the self-ass cycle with considerations for assessing skill knowledge process, as the student "learns how to self-assess his/her knowledge", is useful to enhance education by improving the knowledge of low performing students through adopting adequate interventions to help student succeed (as tutoring sessions, video tutorials etc.) The iterative approach to self-assessment is that the student eventually gets good at it. But what constitutes "goodness?" "Good" would be defined as accuracy in measuring the self- assessment of how well the student knows the subject versus his/real grade in the exam. The trick is expressing those assessments in such a way as to make them measurable. Tracking these metrics in each time cycle will give the student the ability to measure improvements

in self-ass, but also guide decision making on what type of interventions is needed to enhance learning [16].

To analyse the self-assessment effectiveness we use the model of iterative processes for the assessment-correction cycles [17]. In this model A_0 is the value of the initial assessment, A_1 is the value of assessment in one iteration, A_2 is the value of assessment in one iteration, p_i is the probability of the i^{th} entrance in the correction cycle. We assume that p_i is decreasing with every new cycle and use the following approximation.

$$p_i = p_1 * e^{-(i-1)*\propto} \qquad (i = 1, \dots n) \qquad (1)$$

Where $\propto$ is the coefficient which specifies the decrease in the probability of entering the iteration cycle. If one has gathered statistics for p1 and p2 then the effectiveness of the iterative assessment is evaluated with the following formula.

$$A = A_1 + p_1 * \frac{A_1 + A_2}{1 - \sqrt{p_1 * p_2}} \qquad (2)$$

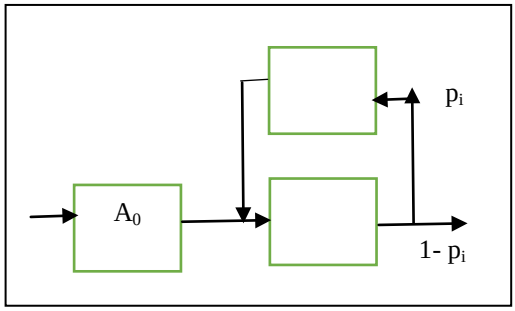

Figure 4. Model of the iterative assessment-correction cycles

Self-assessment is used to evaluate the effectiveness learning and instructional activities and demonstrate professional development. Self-assessment of learning within an active learning paradigm was conducted over a semester. The assessment correction (A) was blended with qualitative data collection and analysis methods. (A) was an effective self-assessment formula and provided proof of the good model design and delivery strategies to meet student learning goals and teach them to self-assess their knowledge. In fact, the self-assessment reduces considerably the value of A_1.

V. Conclusion

The RTSA model starts by providing students with a clear and understandable vision of the learning target. It offers regular descriptive feedback and teach students to self-assess and set goals [18]. The model helps students to identify and communicate the learning and performance goals; to self-assess current levels of understanding; and to provide the student with strategies and skills to reach the goal.

The implementation of this model indicates that online formative assessment can engage learners in meaningful learning experiences through the creation of learning environments that support active engagement of learners [19]. Engagement is instrumental to meaningful learning. By addressing the fundamental issues discussed in the preceding section, RTSA is as an innovative strategy facilitating formative and immediate feedback, engagement with critical learning processes, and promoting equitable education [20]. Our findings suggest that real time formative assessment can provide a means to align assessment with teaching and learning, and inevitably change how learning and assessment occur.

Self - assessment of learning is necessary to document student accomplishment and recognize growth of graduation rate. Further empirical research about real time formative assessment will require a systematic and rigorous approach in order to achieve more useful findings that can inform effective practices. One way forward would be to conduct the research throughout different department within various courses grounded within congruent theoretical perspectives, making those perspectives explicit along with the teacher's beliefs as well as uncovering important professional development and organizational characteristics and factors. There is also need to foster assessment strategies shared understanding among students about what is valued in assessment and their roles within this process in order to achieve desirable educational outcomes [22].

This study recommends that the main key components of real time formative assessment is to provide opportunities for students to express their understandings should be incorporated in any teaching strategy. "Whatever the procedures by which the assessment message is generated, it would be a mistake to regard the student as the passive recipient of a call to action." [9]

Future work can focus on the different types of interventions to be used to enhance student performance is by designing lessons to focus on one learning target, teach students focused revision and engage students in self-reflection, and let them keep track of and share their learning [21]. A future formative assessment research may also address teacher's information needs, helping to answer questions critical to good instruction: who is and is not understanding the lesson? What are this student's strengths and needs? What misconceptions do I need to address? What feedback should I give students? What adjustments should I make to instruction? How should I group students? What differentiation do I need to prepare?

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