ALGEBRA – THE MATHS TEACHER EDUCATIONAL GAME

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INTRODUCTION

In Sri Lankan school curriculum Mathematics is one of the core subjects taught from year one to year 11. In *GCE (O/L)* passing mathematics is essential to pass the exam. Yet, students consider mathematics as one of the most difficult subjects in the curricula. This is clearly evident when term results for mathematics are analyzed because majority of marks obtained falls in the 1st percentile compared to other three percentiles. *GCE (O/L)* results prove this argument further. Table 1 indicates the Passing/Failure rate in mathematics for several consecutive years.

Table 1. *GCE (O/L)* Mathematics answer sheet Analysis

Year	2009	2010	2011	2012	2013
Pass (A+B+C+S) %	50.8	60.37	55.33	52.18	51.44
Weak %	**49.2**	**39.63**	**44.67**	**47.82**	**48.56**

Source: *GCE (O/L) Evaluation Report for 32 Mathematics* (*Relevant Year*) published by *Research and Development Branch, National Evaluation and Testing Service, Department of Exam, Sri Lanka.*

It was widely discussed that this low performance (approximately 45% weak) is due to the fact that students have not internalized the theories and basic mathematics concepts in their primary education. The teachers play a vital role to resolve this issue in classrooms but most of the children struggle with answering mathematical problems. One commonly believed fact is that the time allocated for the mathematics subject at school time table is insufficient to cover the given syllabus. Then the teachers are compelled to teach in an accelerated speed at the expense of quality and pace of teaching. As a result, slow learners and weak students are negatively affected.

At present, apart from traditional learning modes/materials, there are lots of other supporting material on the web such as tutorials, virtual class rooms, MOOCS, video lectures etc. All these are for passive learning and do not consider the level of knowledge of the learner. Since almost all these are in English language the language barrier becomes a hindrance for utilizing these materials effectively. In addition some of the tailor made software tools for learning becomes difficult for usage due to technical and licensing limitations.

At present computer has become a household item and young children are so keen on playing computer games. By considering all these facts this paper proposes to develop a software tool in the form of a game to teach mathematics.

METHODOLOGY

Algebra - The Maths Teacher Educational Game will be a personalized and an intelligent educational game for *GCE (O/L)* students. Students can use the Maths Teacher game to learn algebraic concepts in GCE (O/L) syllabus in the form of an intelligent game. The game can be played in two modes namely *Learning* mode and the *Challenging* mode. Mathematical

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objects in the game are designed considering the Sri Lankan education standards, Bloom's Revised Taxonomy and theories of child psychology with an additional Sinhala interface. Questions at each level will be selected through Game engine considering both user game adjustment (*user rating value*) and player performance (*Core rated value*) along with the stages of the Bloom's Taxonomy.

Core rated value	Level	Resemble grade

Initially the user has to register with the system and can select a user rating value. This value reflects the player's own judgment about his/her level of performance in mathematics. The game environment will be automatically adjusted according to the player performances and current rating. The *jMonkey* game engine will be used for system development to harness the power of java to generate a platform independent output. The overall design of the system is given in figure 1.

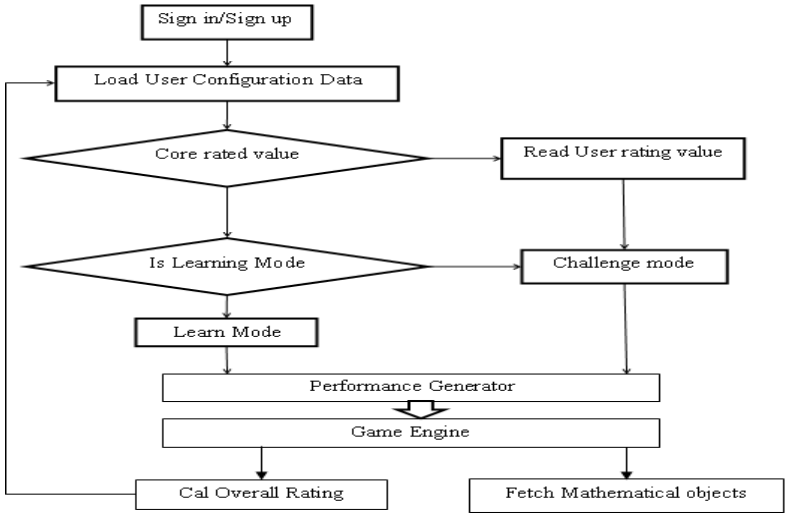

Figure 1. Overall system design

FRONT END OF THE SYSTEM

The game is operated in two layers, i.e., front end layer and the back end layer. The front end layer handles screen play and fetches final results such as the answer given for each question; time consumed per each question etc, and feed them to the back end layer. The front end is designed using *jMonkey* game engine and 3D arts, entities, scenes and textures are designed using *Blender interface*. The front end contains all user screens, interfaces and game environment. The main task of the front end is to make screen play as a game for the set of questions generated by the back end. After completing an activity a summary report will be generated. Soon after finishing each session front end will send list of activity responses, session summary and core rated value or user rated value to the back end and wait for next session or activity.

Game Engine -BACK END

The Back end is the heart of the learning system where all the processing takes place. It is triggered by front end data and at the back end these data are being analyzed by performance generator and game engine to fetch next task. If the user is a new user then the performance level of the user and the corresponding stage of the Blooms taxonomy have to be acquired before starting the game. The main module is categorized into 5 levels namely, Level0, Level1, Level2, Level3 and Level4 to resemble the activity *remembering* of all grades, up to grade 3, 6, 9 and 11 respectively. The Level will be selected considering the user rating values or core rated value of the user. Initially user rating value is set to 0 and core rated value is basically based on the criteria given in Table2.

Table 2. Game level layout

0	0	All grade Uses Remembering
1 - 25	1	grade ≤ 3
26 - 50	2	grade ≤ 6
51 - 75	3	grade ≤ 9
76 - 100	4	grade ≤ 11

PLAYING THE GAME

If a player is in the *Learning* mode the lessons are fetched by game engine based on the user level. Previous activity responses and current rate of performance will be considered to offer next lesson task i.e. if user has low performance in a particular category next lesson will include more on the same category. If a user has answered correctly for all the questions in a particular level then that is considered as the best performance for that level and the next lesson questions will be from Bloom's upper stage. Once a level is completed the system calculates the core rate value for each user.

In the *Challenge* mode the game engine initially finds the user level and the stage in the Bloom's taxonomy. For each level initially, five (05) questions will be randomly selected from the question bank. For each level, the first criteria for performance generation is the number of correct answers given and the second criteria is the average time taken to give an answer. Time band is divided into 5 groups, 0-25, 26-50, 51-75, 76-100 or more as a percentage. For each question the allocated time limit is inbuilt and shown to the user. When the time limit is approaching the user is alarmed. If all the questions in a particular level is completed within the given time period the core rated value of the user is increased and allowed to go to next stage of the Bloom's taxonomy. In the same manner if there are less than two correct answers in a particular level the core rated value is decreased. Yet, the stage in the Bloom's taxonomy is not decreased but the user will be given another two levels that comprise of questions where the user answers are wrong. The purpose of doing this is to make him thorough in the weak areas before moving to the next stage in the Bloom's taxonomy. The game playing cycle is given in Figure 2.

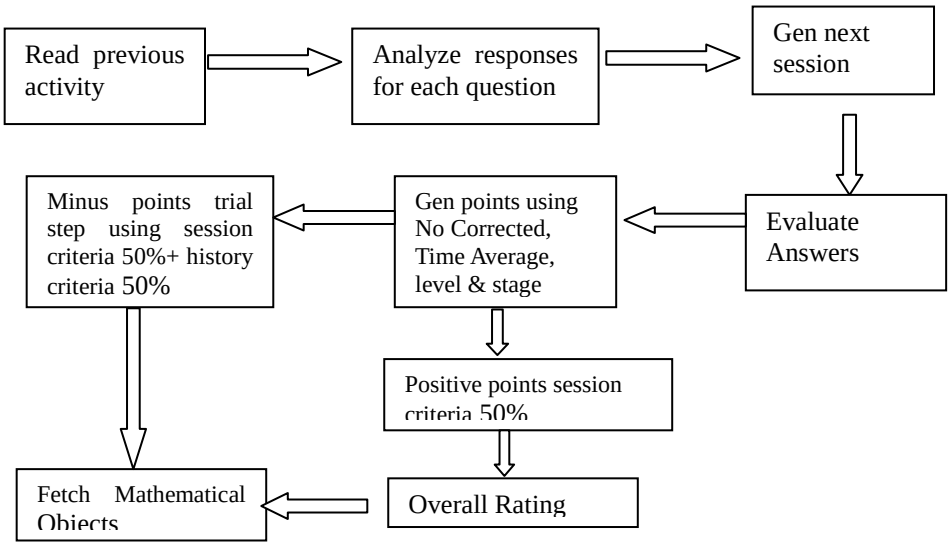

Figure 2. Working cycle of a Game

The game engine will consist of a rule based comprising of game playing rules, level offering criteria (as shown in table 2), rules for generating the core rated values, rules for getting feedback and question selection criteria are stored in the knowledgebase. Table 3 shows the criteria for calculating the core rated values. Hence the game will provide a personalized and intelligent learning environment.

Table 2. Level Acquisition based on Bloom's Revised Taxonomy

bStage	Bloom's Stages	Level 0	Level 1	Level 2	Level 3	Level 4
1	Remembering	Uses Remembering, No points granted.	01-05	26-30	51-55	76-80
2	Understanding		06-10	31-35	56-60	81-85
3	Applying		11-15	36-40	61-65	86-90
4	Analyzing		16-20	41-45	66-70	91-95
5	Evaluation & Creating		21-25	46-50	71-75	96-100

RESULTS AND DISCUSSION

All the events played are stored for report generation. The reports will comprise of performance statistics presented in different formats with icons for capturing more attention. Since O/L students are mature enough to identify and address their own weaknesses the report generated will give them a good insight to identify the areas that they need to pay more attention.

The entire learning process is designed as a game to maintain the motivation of the users. Though there are many mathematical games on the web the advantage in this game is that the user is taken in a learning process according to the knowledge level of the user. Designing of the questions according to Bloom's taxonomy is a very systematic approach in guiding a learner to attain higher level skills such as application and synthesis. Finally the user can get an insight on his level of knowledge by the report generated. The additional Sinhala interface definitely will be an added advantage in the local context.

CONCLUSIONS/RECOMMENDATIONS

The *Maths Teacher* game provides the users with a novel experience for learning algebraic concepts in O/L mathematics in a user friendly environment with a carefully guided learning process for achieving higher knowledge level capabilities. The report on performance can be used to get an insight into the level of performance of the user. The system can be further improved in two obvious ways. The first improvement can be to develop a mobile app to enable accessing at anytime/anywhere. Secondly the web application can be enhanced for multiplayer facility to connect all into a single game environment which will lead player's morale high as well as high interactivity. Though the game is developed as a prototype system to learn algebra in O/L mathematics curricula the framework can be easily extended to a full fledge learning system that covers the whole GCE (O/L) syllabus.

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