Agent Based Approach of Item Response Theory

By

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Abstract

The North Central Province, the largest province in Sri Lanka, has encountered with various problems related to the educational field. Gaining poor results in Mathematics in national level exams, especially in the Ordinary level, is one of them. Although the knowledge of Mathematics is very important to the implementation of every stream of subjects. Statistical data of the Department of Examinations reveal that more than fifty percent of candidates who sat for the Ordinary level got poorer (W) grade in Mathematics. According to the survey conducted by the author, it reveals that the poor knowledge of Primary Mathematical Concepts is one of main reasons for this situation. Introducing Agent based computer solutions is one of the remedies for this. In order to introduce such a system, it is necessary to make psychosomatic measurements of the students. *Item Response Theory (IRT)* is a commonly used for such measurements. To adopt *Item Response Theory* into *Agent programming*, it is necessary to introduce a new model with *Item Response theory*. In this paper, it shows how to introduce such model with *Item Response Theory* & use to develop Agent based algorithm on modified *Item Response theory*.

Initial Survey

In this research, it is essential to collect data of primary students' Mathematics knowledge relevant to subject areas. In order to collect such information, the author conducted several surveys in schools selected in the North Central Province of Sri Lanka.

G.C.E. (O.L.) Examinations 2005 - 2011

Percentage of School Candidates (1 "Attempt) Qualified for G.C.E. (A.L.) by Province and Year
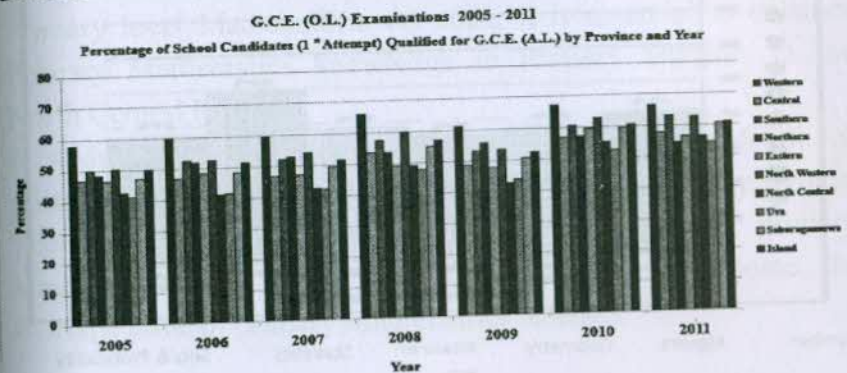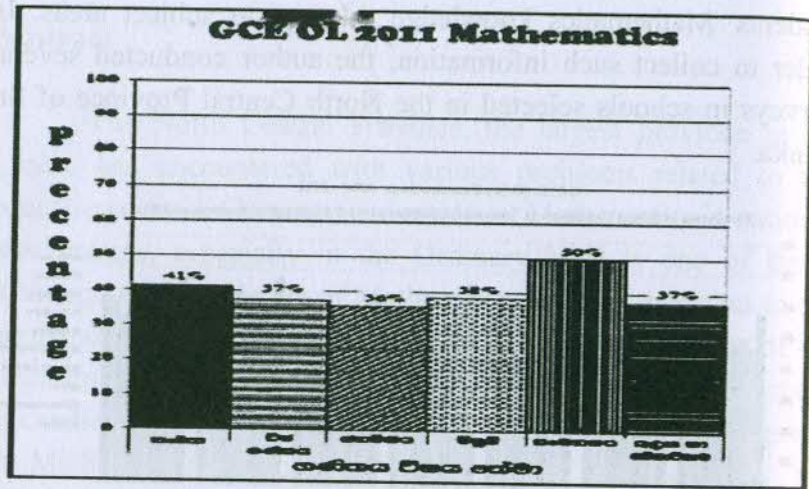
Table 01

At first, initially, the author conducted a survey covering all subject topics in Primary Mathematics in selected schools in the North Central Province. Afterwards, the second survey was conducted by selecting lower graded topics in the previous survey.

Data Collection and Pre-processing

Table 01 shows that students of the North Central Province got lower results in Ordinary Level Examination compared to other provinces.
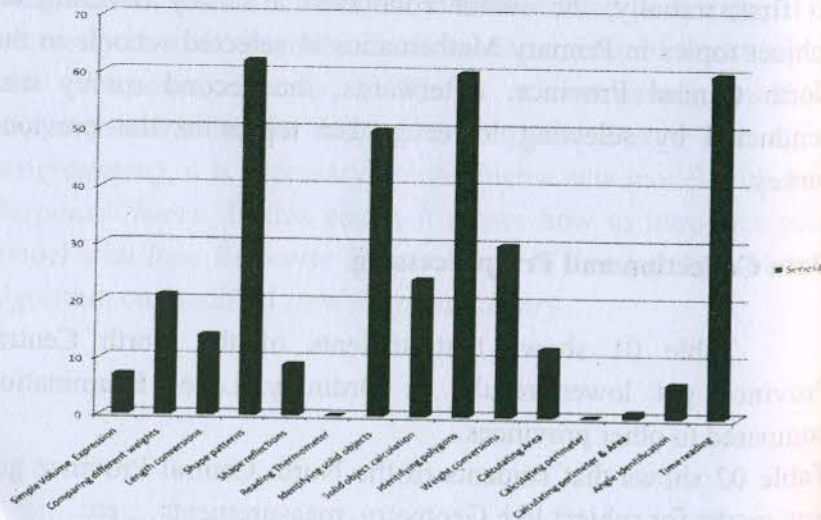
Table 02 shows that students of the North Central Province got low marks for subject like Geometry, measurements... etc.

Table 03 shows the same subject areas that are in primary level students' scores in the survey conducted by the Author.

GCE OL 2011 Mathematics

| Number | Algebra | Geometry | Measurements | Statistics | Sets & Probability |

Table 02

Results of Surveys & Conclusion

It is clear that weaker Mathematics topics for students in Ordinary Level Examination & those in Primary Level Mathematics are almost similar. Therefore, this research reveals that results for the lower grade in Mathematics especially in the North Central Province is a root cause of the lower knowledge in Primary level Mathematics. As such, it is essential to enhance Primary Mathematics knowledge in Primary Students in the North Central Province.

In addition, it is understood that there is a severe dearth of primary Mathematics teachers in the North Central province. Therefore, introducing Agent based system for primary Mathematics may be a great contribution to overcome the shortage issue of primary Mathematics teachers.
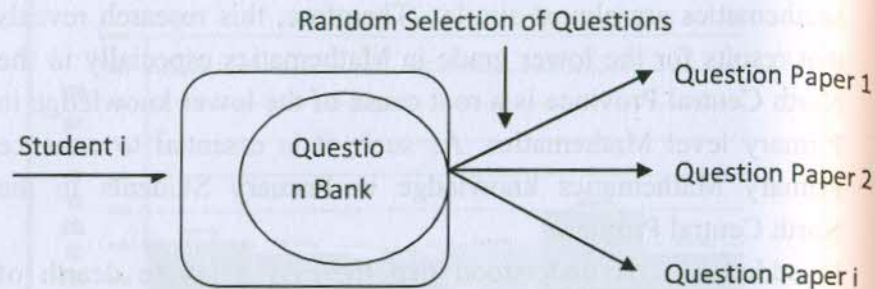
Testing Types

There are two types of testing.

1) **Conventional Testing** - In this case, all students are facing to the same question paper (Q_1 to Q_i) and correct answers are same.
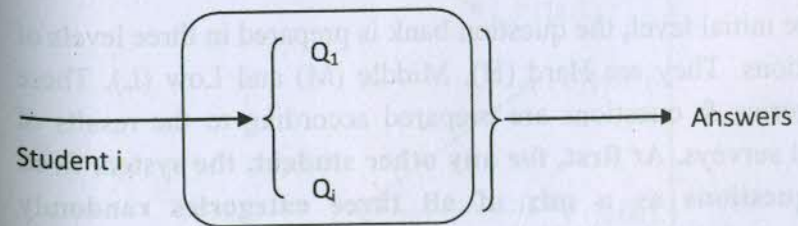
2) Adaptive Testing

2) **Adaptive Testing** - In this case, all students are facing to the different question paper (Question bank should be prepared).

Random Selection of Questions

This can be done with a computer System. Such system is called Computer based Adaptive Testing (CAT).In developing Agent based system with IRT; Computer based Adaptive testing method is used.

IRT Model

In this paper, agented based system is proposed to develop basic mathematical knowledge of primary level students. Before developing such a system, it is essential to develop model of the system. A brief description of the system is as follows.

At the initial level, the question bank is prepared in three levels of questions. They are Hard (H), Middle (M) and Low (L). These categories & questions are prepared according to the results of initial surveys. **At first, for any other student, the system fired 09 questions as a mix of all three categories randomly selected**. A student belongs to H the probability of answering question q1 correctly given by P $(^c_1q/H)$.

As the difficulty of each question is previously calculated, probability of P $(^c_1q/H)$, P $(^c_1q/M)$, P $(^c_1q/L)$, can be calculated. This is shown by following Tree Diagram. Then, we can categorize the student who has faced to the initial test, belongs to which group i.e. Hard (H), Middle (M) and Low (L) by the final conditional probability of each student. Then, the system presents relevant lessons to the student according to students' level.
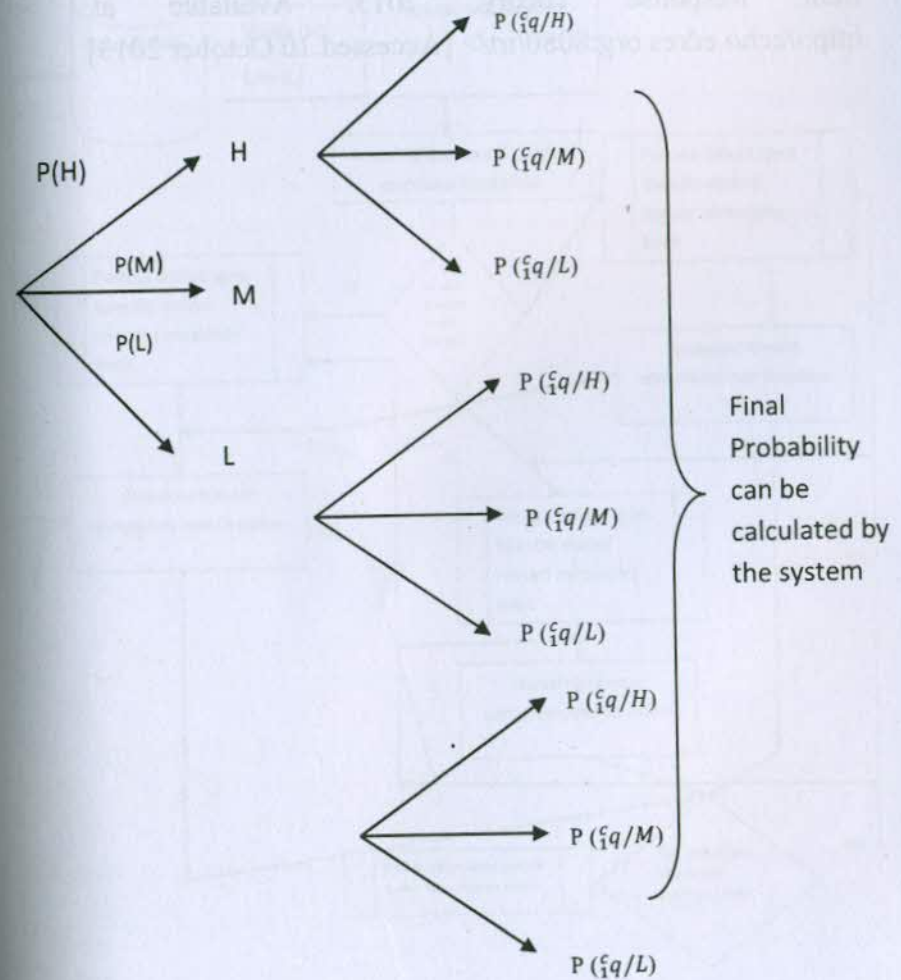
References

Chong Ho Yu, a Simple Guide to the Item Response Theory (IRT) and Rasch Modeling: (http://www.creative-wisdom.com), December 10, 2010.

Department of Examination, 2011. Statistical handbook, 2008 – 2010,Depatment of Examination, Colombo: Department of Examination.

Item Response Theory, 2013. Available at: < http://echo.edres.org:8080/irt/> [Accessed 10 October 2013].

Annex 01

System Implementation

Flow chart

Start

Input student's name & grade

An Agent development for each Student

Question Bank

Hard (H)

Middle (M)

Low (L)

Produce initial questions

Answering Questions & Calculate conditional Probabilities

Previous defined agent takes the student relevant competency levels

Previous defined agent takes the student relevant competency levels

H

For which group the student belongs?

L

Answering relevant competency level Questions

M

Answering relevant competency level Questions

Previous defined agent takes the student relevant competency levels

Answering relevant competency level Questions

Previous defined agent takes the student next competency levels

Does student come into relevant competency levels?

No