

# Personalized Adaptive E-Learning System - Mitigate the Risk of Rashomon Effect Occurrence in Higher Education

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**Abstract** - Personalized adaptive E-learning system means a learning system which is based on learner's feedback, his or her multiple intelligence and learning style. In traditional higher education when conducting lectures there is a risk of Rashomon effect occurrence. Rashomon effect can be simply defined as a how a group of people react to the same incident in a different way. In education that definition can be turned into how group of people react to same lecture material in a different way. The problem is how to mitigate occurrence of this risk. The researcher's proposed solution is an adaptive learning system which is mainly focused on mitigating the risks of Rashomon effect in learning process and improve learners' success of learning based on personalization information like learning style, cognitive style or learning achievements. This innovative adaptive learning method is proposed based on considering two major sources of personalization information which are; learning behaviour and personal learning style. To find out the significant learning styles of the learner, an assigned test - The VARK (Visual, Aural, Read/Write, Kinesthetic) Questionnaire employ. When adjusting the learning materials have to consider learning behaviour of the learners, the interactions and learning results of learners have to recorded and analyse using machine learning techniques. And also use Bayesian modelling to model a student's ability. Based on these information researcher propose as solution by developing an adaptive e-learning system.

**Keywords** - Personalization, Adaptive E- Learning, Bayesian modelling

## I. INTRODUCTION

The purpose of this project is to mitigate the risk of Rashomon effect occurrence in higher education/traditional lecturing education environment. Captured this effect occurrence by observing traditional learning environment and also the Learning Management System failed to reduce the impact of Rashomon effect in learning - teaching process. As a solution purposing a personalized Adaptive e-learning.

### A. Rashomon Effect

The Rashomon effect occurs when the same event is given contradictory interpretations by different individuals involved in that sense Rashomon effect can be simply defined as a how a group of people react to the same incident in a different way.[5]

### B. Adaptive Learning

"An adaptive e-learning system is an (210 Dessislava Vassileva) interactive system that personalizes and adapts e-learning content, pedagogical models, and interactions between participants in the environment to meet the individual needs and preferences of users if and when they arise". In simple words Adaptive learning is a method of education that makes use of computers to interactively presents teaching materials according to the ability or needs of the learner. Benefits of Adaptive learning can conclude as; Exercises match the ability of the learner, Learners feels competent, Learners does not get frustrated, higher motivation.

Some educational researchers have developed methods, tools and environments for computer-assisted learning and several researchers have already found the importance of adaptive learning than traditional forms of education or in computer-assisted education. Also various personalization techniques have been proposed for developing web-based e-learning systems [4].

When considering the effect of adaptive learning most researchers often pay attention to the impact of a single type of personalization, such as learning performance (including learner's profile and learning portfolio), learning style, cognitive style of individual students, on the determination of difficulty levels, learning paths or presentation styles of subject materials [1].

An adaptive e-Learning system gives the learner to select learning materials or contents according his or her interest. In traditional education system, the lecturer can control these facts based on what they see of their learners' reaction and behaviour. In e-learning it should be adapted to one's personal learning style. Traditional education systems provide the same modules to all learners and conducting lecture series the lecturer present one theory and give works, assignments to do but still each learner understand it differently and give different outputs as answers, in this scenario the learner couldn't find what is the correct definition, materials, course works to be followed.

Considering e-learning systems they should be capable of adapting the content of courses to the individual characteristics of learners. Adaptive e-learning systems try to win this challenge by changing the presentation of material to suit each and every individual learner. They collect information about learner's goals and knowledge in order to adapt the education needs to that particular learner. An e-learning system must be based on learner's learning style which makes e-learning more effective and efficient. One of the most important characteristics of an e-learning system is personalization, learners with different skills use the system. An adaptive e-learning system identifies the learner's learning styles through an initial assessment test. The test's score will be used by the system to provide learner a presentation of learning materials according to their knowledge level. This is the first input of the user in the system and with some basic information that they provide for the creation of profile.

## II. PROBLEM DEFINITION

Sri Lankan higher education still uses the traditional lecturing method to deliver courses and use Learning Management Systems (LMS) to give assignments and lecture notes. Observations prove the fact that existing method causes Rashomon effect in both side of lecturer and student during the learning process. Even providing same learning materials and delivering same instructional conditions to all learners may lead to this effect and reduction in learning performance without considering their different background characteristics, prior knowledge, experiences, learning behaviour and personal learning styles.

## III. LITERATURE REVIEW

Yassine Zaoui Seghroucheni, Mohammed Al Achhab and Badr Eddine El Mohajir done research on "Implementation of an Adaptive Learning System that Include Correction of Learning Path Based on the Differentiated Pedagogy and the Bayesian Network" and the researchers mentioned an architecture of an adaptive learning system. As mentioned in the research paper Adaptive learning system is basically composed of Domain model, Learner model and the adaptive model. The adaptation model developed through thier paper takes into account the following parameters developed by the authors of [2];

Learner model:

The learner model used is based on the Felder-Silverman learning styles, and the prerequisites of each learner.

Domain Model:

The domain model is composed of the learning objects which are designed according to the SCORM Standards, a multiple versions of the same learning object and finally the Content metadata as defined by IEEE Learning object Metadata.

Instruction Model:

The instruction model is the pedagogical model responsible for designing the learning object included in the domain object.

Adaptability model:

The adaptation model is the one generating learning objects according to the characteristics of learners (prerequisite, learning styles) and the learning objects that match them.

Evaluation:

The evaluation is the critical part in this adaptive learning system as it remains the only way to correct learning paths if it appears that the generated learning path is not the leading one.

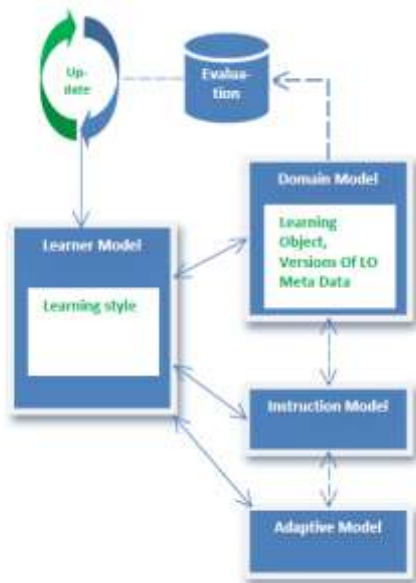
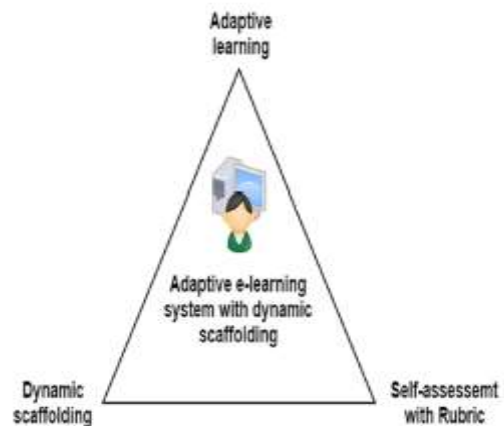


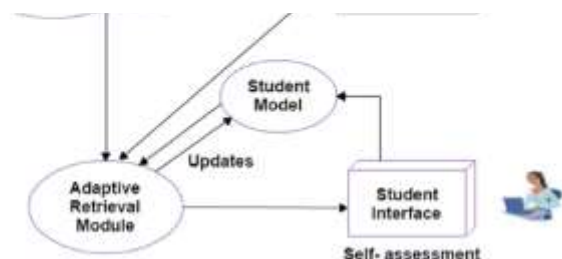
Figure 1: Architecture of an adaptive learning system

Chun-Hui Wu, You-Shyang Chen, Ta-Cheng Chen’s study provides a theoretical framework for building an adaptive learning system and they developed an adaptive e-learning system with dynamic scaffolding for learning by integrating online rubrics to assess students’ capabilities and then provide suitable learning materials to them. The theoretical underpinning of the developed system includes dynamic scaffolding, adaptive learning, and self-assessment with rubrics (Figure 2).



This adaptive e-learning system presents an architecture consisting of five major components: Domain knowledge, Student model, Learning object repository, Adaptive retrieval module, and Student interface (Figure 3). The lines in Figure 3 represent a logical connection among the linked models.

Figure 3: The Theoretical foundation for adaptive e-learning system with dynamic scaffolding



Compared with e-learning, adaptive e-learning systems are more personalized and

Compared with e-learning, adaptive e-learning systems are more personalized and stress the adaptation of learning content and the presentation of this content [7]. The implementation of adaptive e-learning systems require assessing individual differences for all students. In other words, these systems are capable of measuring learner difference and account for this while creating the learning path. Continuous assessments like collecting students' data, insert into adaptive learning systems during the learning process helps deliver suitable learning instruction to each student. These five components in the developed system are described as follows;

1. Domain knowledge: Storing learning content that is to be taught in specific academic courses.
2. Student model: Storing information and data about students. This component determines the student's skill/competence level.
3. Learning object repository: Storage of learning objects. It allows students to retrieve learning materials based on their own objectives.
4. Adaptive retrieval module: The adaption technique allows students select suitable required materials in accordance with their own learning goal and individual learning capabilities.
5. Student interface: Providing learning materials and information. In addition, a self-assessment test using rubrics is conducted during the learning process.[8]

Rubrics can be a powerful self-assessment tool. Under the right conditions, student self-assessment can offer accurate, useful information to improve learning. In this study, the developed system uses feedback from students' self-assessments to guide revision.

As for the delivery mode have find that while infrastructure outreach is low and connectivity erratic one should provide alternative means for education delivery, especially for self studying students [9].

A Bayesian model is a statistical model made of the pair prior x likelihood = posterior x marginal. Bayes' theorem is somewhat secondary to the concept of a prior and one where inference is based on using Bayes theorem to obtain a posterior distribution for a quantity or quantities of interest form some model such as parameter values based on some prior distribution for the relevant unknown parameters and the likelihood from the model i.e. from a distributional model of some form,  $f(X_i | \theta)$  and a prior  $p(\theta)$ , someone might seek to obtain the posterior  $p(\theta | X)$ . Using this theory the performance of the student/ learner is going to measure and model.

A way to model a learner is to use the logistic function:

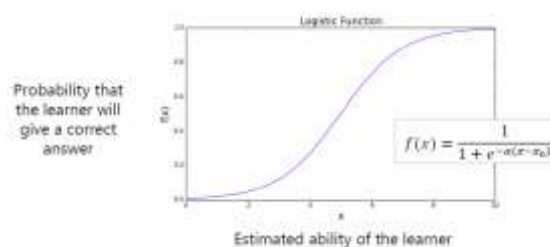


Figure 4: A Model of Ability and Performance

"Difficulty" of the task can be modeled by the parameter  $a$  and  $x_0$

Figure 5: A Model of Ability and Performance

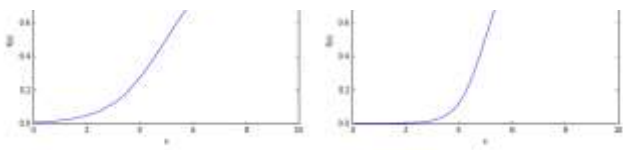
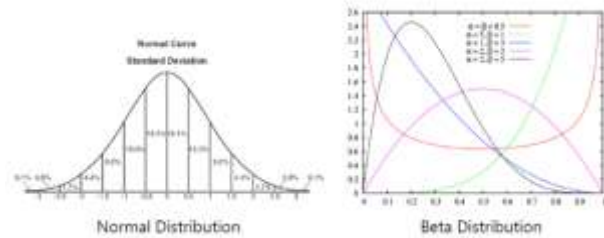


Figure 6.1: Modelling the Process of Answering a Question



One step further is to mathematically describe how the learner generates the answer to a question

Figure 6: Modelling the Process of Answering a Question

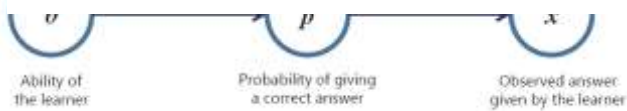
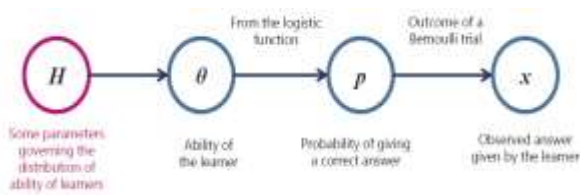


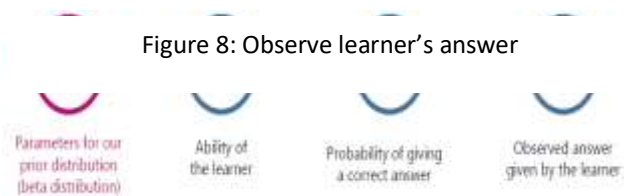
Figure 7: Examples of Prior Distribution

To model the “prior” belief of the ability of a general learner, can add one more step at the beginning.

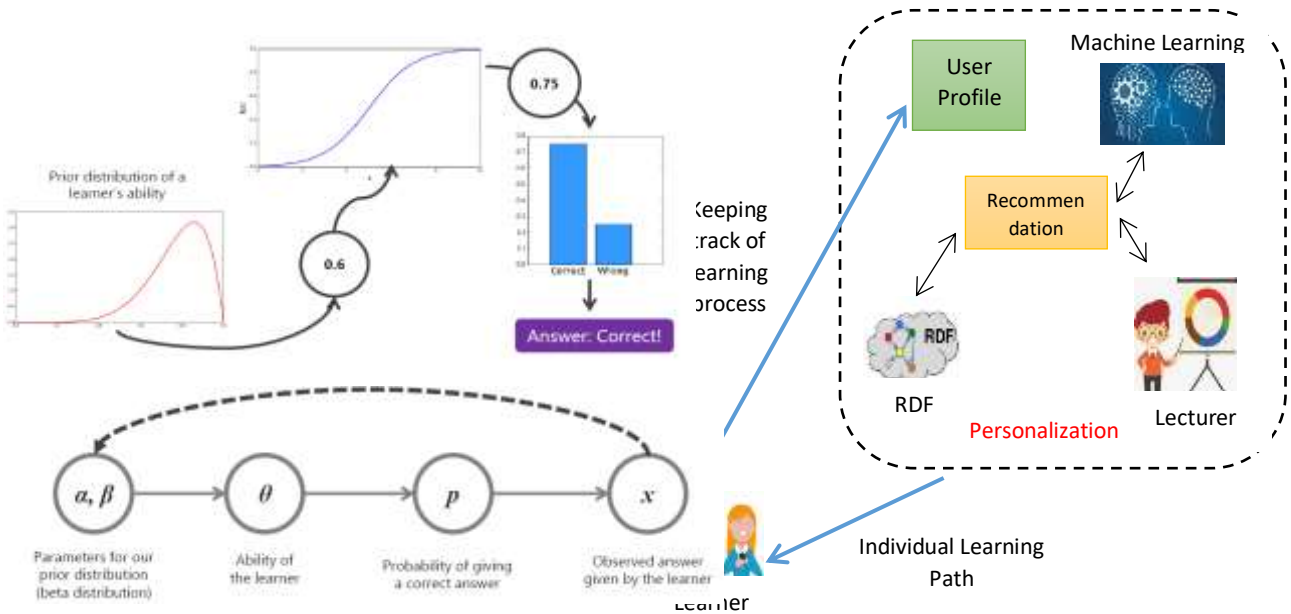


Enters to the Bayesian Modelling - Learner’s answers observed are obtained from a generative process

Figure 8: Observe learner’s answer



Bayesian Modelling will work in application like follows;



With this model, can update “belief” of the learner’s ability when observing the answers given by the learner.

Figure 9: Proposed Adaptive e-learning system architecture

## V. METHODOLOGY

### A. Architecture

### B. Technology

For the implementation of machine learning module use Python, XML RDF (Resource Description Framework) database to do set processing and graph processing, Web page design and proposed chatbot create using C#, Java Script and use Node.JS for back end programming. In additionally MySQL and MongoDB will use to build database of the web site.

### C. Approach

Above mentioned technologies can be used to develop a web based adaptive e-learning system which provide personalized learning course modules, tests, quizzes and assignments.

#### D. Development

After the learner logs to the system, an initial Test is proposed to learner in order to estimate the level of his or her knowledge. Based on that, the system may propose some Links for extra studying, some tutors to watch, or even some extra tests. After this initial phase, let's assume that learner chooses Topic 1 and takes a Test T1. He scores 20. From the score achieved (assuming that 30 or 40 is a edge point of performance that needs to be achieved), now can identify that learner needs extra support and help on Topic 1. So now should consider about recommendations.

The recommendation can be based

- 1) on what actions similar learners followed as actions and appear to have helped them in succeeding in their tests
- 2) on what the specific topic that a learner did poorly in is about (for example Topic 1 depends on understanding and mastering two subtopics 1.1 and 1.2 which are mandatory for answering questions on Topic 1)
- 3) a combination of (i) and (ii)

So learner visits page P1 and page P2 associated with Topic 1, and speaks to a lecturer or both. After that, learner takes Test T2 in Topic 1. Learner achieves a score of 50. Learner managed to improve the score in Topic 1 (which is the target). Can clearly identify that something that has happened between taking tests T1 and T2 has led learner to improve his or her performance. This could be the result of the recommendation made by the system like mentioned above 1) and 2) or learner engaging with other learners or following suggestions for additional study and tests by the lecturer. So that it is evident that it would be helpful to them, if the system is able to provide some useful hints of what previous learners have done (tests taken, tutorials watched, lecturers they spoke) and how they performed when they interacted with the system.

The Machine Learning part will provide the system a pool of possible questions, lecturers and links to be followed by a learner based on the interactions that previous learners of the system have had. These suggestions will be per Topic.

#### VI. DESIGN

The following Work Breakdown Structure (WBS) shows what are the key deliverable and sections to be developed.

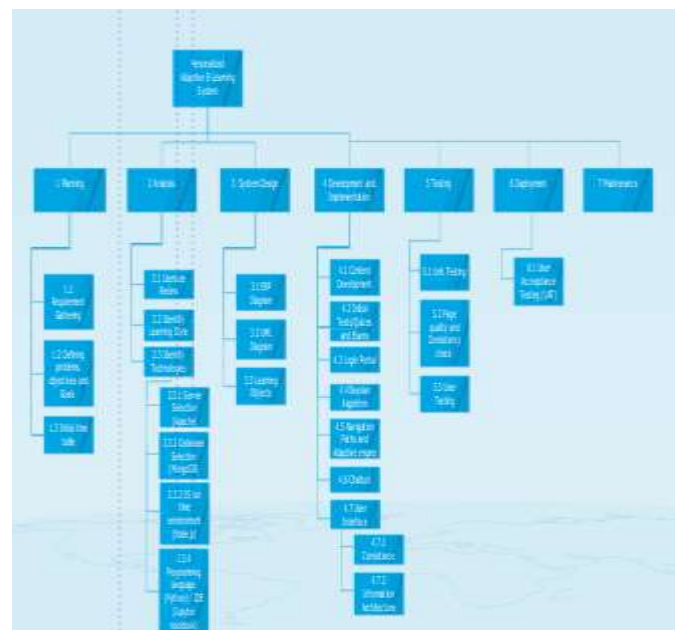


Figure 10 : Work Breakdown Structure

#### VII. CONCLUSION

According to the literature review and gathered data, using Bayesian modeling is the optimal solution for sum up the adaptation process of students who enrolled to the E-learning system. And through getting know about learning styles the students can identify themselves, about their status and with help of the solution they can improve for the expected level, learn efficiently and mitigate the risk occurrence of Rashomon effect.

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