Enhancing Personalized Learning of students through Deep Learning in an Adaptive Learning Environment.

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# Introduction

## Introduction to E-learning

Education is one of the fundamental pillars in a society that drives intellectual growth and uplifts social standards. According to United Nations, Universal Declaration of Human Rights, Article 26, ‘Everyone has a right to education’ (UN General Assembly, 1948) . eginning of the last century education structured focusing on knowledge and skills without considering the learners expectations and leaners abilities. Hence ‘one size fits all’ education system faced challenges to cater individual student requirements. With the development of the technology personalized teaching and learning frameworks immerged to fill this gap. Some of the developed systems to fill personalized learning gap are Learning Management Systems (LMS), Adaptive Hypermedia Systems (AHS), and Intelligent Tutoring Systems (ITS). Furthermore, in recent years have appeared the Learning Style Based Adaptive Educational Systems (LSAES) (Katsaris and Vidakis, 2021)

|  |  |
| --- | --- |
| E-learning systems | Characteristics |
| Learning Management Systems | LMS delivers content and help administrative tasks |
| Adaptive Hypermedia Systems | Provide content based on user goal and performance |
| Learning Style Based Adaptive Educational Systems | Personalize the learning experience based on learning style (visual, auditory, reading/writing, and kinesthetic) |
| **Intelligent Tutoring Systems** | **Provide immediate and customized instruction/feedback without human intervention using Adaptive Learning** |

Table Types of E-learning systems

## Introduction to adaptive learning

Adaptive learning is a type of scaffolding technique used in educational technology that is tailored to support all stakeholders in an educational institution, including teachers, students, and school administrators. According to (Jan­Martin Lowendahl et al., 2016) “Adaptive learning dynamically adjusts the way instructional content is presented to students based on their responses or preferences. Adaptive learning is increasingly dependent on a large­scale collection of learning data and algorithmically derived pedagogical responses”

### Importance of adaptive learning

Adaptive learning saves teachers time and provides data and analytics that help to understand students. For students, it provides a personalized learning experience better suited for their capacity and instant feedback. School administrators can improve student performance, such as pass rate and proficiency. (Clark, Kaw and Braga Gomes, 2022) advise using adaptive learning to improve pre-class preparation for both flipped and blended learning.

How adoptive learning works –

Ennouamani & Mahani, (2018) have summarized adaptive learning systems to 3 models. They are Learning model, Adaptation model and Domain model. Learner model contains the student characteristics such as learning style, reasoning style, interests and student performance history. Domain model contains knowledge of the studying domain, study materials and learning objectives. Adaptation model contains the adaptation rules that align the student performance and domain. It asses the student behavior and navigate the student to relevant materials in the domain model. Sophisticated adaptive learning system temporally update it rules and get feedbacks from external and internal learning environments.

Liu et al.,( 2017) Conclude adaptive learning positively impact student performance with empirical evidence, but it depends on the design of the adaptive learning system. It should be user centric and content must properly align with the learning outcomes. System should be able provide meaningful feedback and navigate student only to the relevant content.

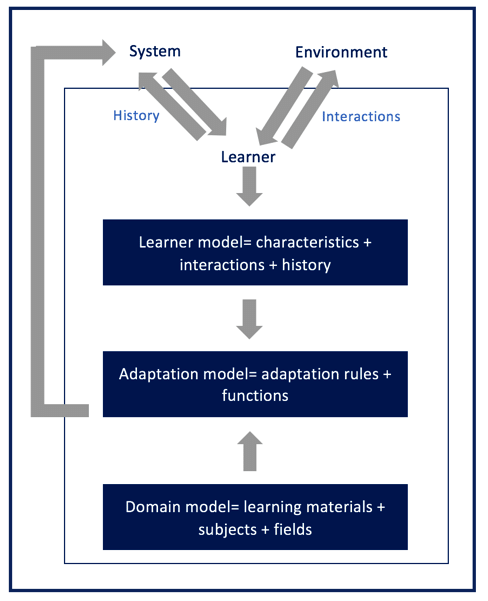


Figure ‑ Adaptive e-learning systems' components (Ennouamani and Mahani, 2018)

### Challenges of adopting to adaptive learning methods

According to (Martin et al., 2020) when educational institutes adopting adaptive learning methods they face 3 types of challenges. They are technology, instruction, and management. There are technological barriers when schools have to connect existing learning management system to adaptive learning methods, real time data sharing challenges and complexity of adaptive systems. Teachers and instructors not having enough experience can lead to adaptation of adaptive learning methods. Educational institutions have to train and monitor how well they adopt the adaptive learning methods. Some time educators resist to adopt adaptive learning methods due differences in the curriculums , additional work load or not having confidence that adaptive learning methods can improve students’ knowledge state. Lack of management support can also lead to adaptive learning method adoption failure. Incompatible organization goals or lack of leadership and insufficient human resources and financial resources can also cause to halt the implementation of adaptive learning systems.

# Research problem

In this research we study data set from a real world commercial adaptive learning platform. It provides practice questions and assignments targeting science and mathematics school curriculum. Practice questions are called Goals on this platform. Each goal consists with multiple answer questions that related a set of learning objectives. If a student gives correct answer student will proceed to next question. If the student fails the question, he or she will get a new question or presented with the study materials refresh their knowledge. This platform measures the mastery of a student’s using modified version of Item Response Theory (IRT) (F. M. Lord, M. R. Novick and Allan Birnbaum, 1968) which is a statistical technique. There is room to explore the possibility of applying deep learning-based models to measure the student mastery level.

Subjected adaptive learning platform has not assess the impact of study materials on students learning rate and factors affecting the students learning behavior in an adaptive learning platform.

## Research gap

When referring the literature, knowledge tracing is widely researched under many branches. In the early stages Bayesian knowledge tracing was the most popular method to KT method. Later IRT introduced and recently with the boom of deep learning deep knowledge tracing introduced. DKT outperformed all previous methods and under all the branches there are many applications. They are predicting students ability answer a question correctly, recommend learning materials /questions , asses the quality of the education and many more.

When our data set compared to the literature, our data set also have sequence of questions under different learning objectives and the correctness of the answers like in other studies. One specialty in our data set is, middle of the question sequence students have referred to learning materials if they have poorly performed for the related learning objective , and attempted again. In the previous research work study materials are not included in the research problem. This can be used to measure the quality of the learning materials and how it impacts each student. Additionally, we attempt to incorporate question difficulty to the problem formulation.

In terms of learner characteristics our study analyze how students prior knowledge and prior performance can be used to cluster students. Additionally we contribute by analyzing the impact of study materials/instruction materials shape the leaners characteristics.

## Research question

1.What are the factors impact students personalized learning in an adaptive learning environment?

2.What is the impact of learning materials on students personalized learning in an adaptive learning environment ?

## Research objectives

1. Identify the factors that influence personalized learning in an adaptive learning environment.
2. Evaluate the effectiveness of study material utilization towards improving student mastery level.
3. Explore the use of machine learning algorithms measure student mastery level in an adaptive learning environment.

# Research Methodology

1. Data collection – Required data is already collected
2. Data processing – Collected data in tabular format and they are required to change the data types and replace values for the ease of analysis.
3. Data analysis -
   1. Map student performance with direct learning objective, prerequisite learning objectives and study materials.
   2. Develop graph of student performance and learning objectives, then cluster these graphs to identify students with similar behavior
   3. Analyze student clusters and compare clusters identify how each cluster perform and different from other clusters.
      1. How study materials impact
      2. Compare cluster vice learning rate.
      3. Impact of prerequisite learning objectives to proceeding learning objectives
      4. Relationship between learning effort (time spend, number of questions done) with the learning progress
4. Recommendation engine building –
   1. Recommend study materials based on student knowledge statues
5. Recommendation engine result evaluation

# Reference

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