Reading Between the Lines

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Abstract

Through application of Large Language Model (LLM) to predict reading comprehension level and apply Learning Analytics (LA) to guide students elevate reading comprehension levels through feedback and monitoring. LA a continuously evolving sector at the intersection of education, technology, and Data Science. Learning analytics offers a robust understanding of the learning process, to create personalized education, and early intervention. One area where learning analytics can make a significant impact is in reading comprehension, a fundamental skill for academic and personal success.

I. Introduction

1.1 Background of the Study

The Philippines faces significant challenges in student literacy, as evidenced by its rankings in international assessments such as the Programme for International Student Assessment (PISA) conducted by the Organization for Economic Co-operation and Development (OECD). Despite a slight improvement in reading literacy scores from 2018 to 2022, the Philippines remains among the lowest-performing countries globally in reading comprehension, mathematics, and science. Notably, the performance of both top-performing students (TPS) and low-performing students (LPS) has shown minimal improvement, with some indicators even suggesting a decline in proficiency levels.[1] Although declining scores in reading, science, and math were observed even before 2018. The Department of Education acknowledges the urgency of addressing these issues and has initiated reforms to enhance students' performance, including the Established Philippine Informal Reading Inventory (Phil-IRI) to determine reading comprehension and assign an intervention. Reading Camps where every summer, there will be classes focus on reading, Workshops for teacher's pseudo CPD units to develop teaching capabilities, Curriculum revisions and DepEd introduced an intervention called "Drop everything and read" from their Catch-up Fridays that halts focus on subjects [2]

Large Language Models (LLMs), made an outstanding change in the realm of natural language processing (NLP). The model can understand and hold conversation that emulate human language superbly. OpenAI's GPT utilizes deep learning techniques, particularly transformer architectures, to see patterns and relationships in walls of text. LLMs capture a deep understanding of language from various text datasets through training of the model. This allows GPT to work on various NLP tasks like produce text, understand different human language, summarizing, and able to hold question and answering. LLMs are significant in various areas for its ability to generate text that is logical and suitable [15].

Learning analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs [8]. Once the learner data has been acquired a long with the curriculum can be integrated and analyzed. This will empower educators to assess the learners' capability in understanding. Through examining, the educators can gather insights of strength and weakness to support the students.

1.2 Research Objectives

The objective of this research is utilizing LLM-based prediction method through data gathered from AutoTutor Tool and integrate learning analytics techniques through understanding of learning patterns, behaviors and academic standing, ultimately aiming to improve reading comprehension levels among students.

1.3 Scope and Limitations

The scope of this research utilizing data from the results of AutoTutor lesson and integrating Learning analytics, this study aims to explore the use of LLMs in predicting the reading comprehension levels of student.

The research will encompass the examination of patterns in learners' interactions with the program, identifying factors that weights those patterns to be used for a learning analytics models based from the results of reading comprehension level from the LLM that will be used to create targeted feedback to encourage personal growth in reading comprehension.

With the goal of aiding decreasing reading comprehension through Data Science approach the research has its limits. Data gathered may or may not be able to able to work on based on the quality. Since no students are alike, variation may hurt the accuracy of the modes. From, the ethical standpoint the student data must be carefully navigated to ensure privacy and maintain trust with participants. The effectiveness of the interventions may differ from students' ideas and levels of understanding.

1.4 Significance of the Study

Reading comprehension does not stop adding value in education, it also boosts social and economic development. An Improvement of reading comprehension level can open opportunities for an individual through understanding information and making informed decisions. Through application of Learning analytics with data driven approach as jump start in solving reading comprehension challenges, the researcher aims to extend a helping hand to institutions, educators and students with potent tools and strategies to enhance literacy in the Philippines.

One of the major causes of reading deterioration of students stems from lack of enthusiasm [2]. This research can change educational practices that can target in encouraging students to start on their own journey in reading comprehension. In addition, this paper, highlights the importance of leveraging Data Science approach in dealing with education problem that plagues the country, findings of this research will

aid educational institute, educators, students and the field of educational research.

1.5 Research Methods

Large Language Model

The research [15] leveraged datasets sourced from AutoTutor lessons developed for the Center for the Study of Adult Literacy (CSAL) a publicly available tool. The AutoTutor system records the lesson taken by the student within the system the total number of learners, number of question and max attempt for the lesson.

The proposed LLM-based prediction method outlined in the research comprises three key procedures as seen in Figure 1: encoding, LLM component, and decoding.

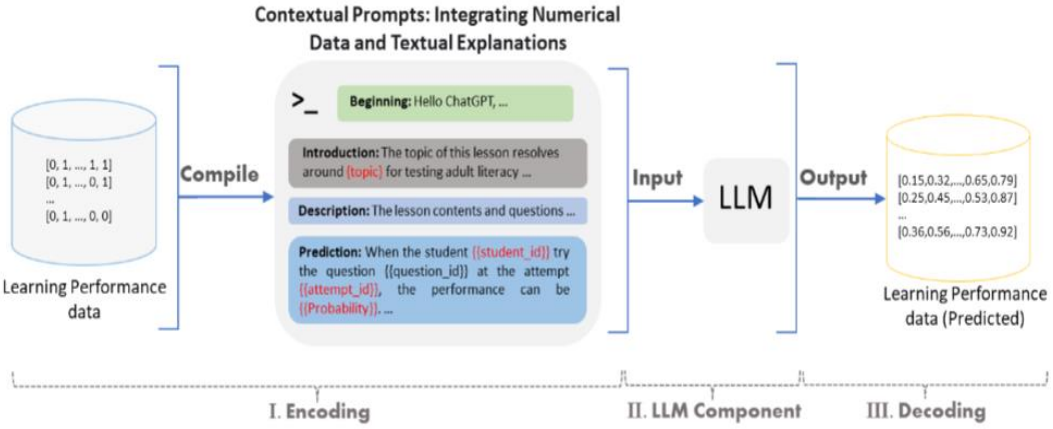

Figure 1. LLM-based prediction framework for learner learning performance

On the encoding process, the we start by processing the performance metrics into a one-hot encoded values, such as correct and incorrect answers, numbers of attempts made and compile these encoded values into contextual prompts. The results from the encoded data will be fed onto a prompt that contains the numerical values along with explanation for better understanding of performance. After which the LLM models will analyze the prompt to predict the students' performance on another set or repeated question, this leverages the capabilities of GPT-4 along the other ML models which GPT-4 selected and also find-tuned by GPT-4. Lastly the model decodes the results, these predictions are structured format as (seen in Figure 2.), incrementally increasing the dimensionality of the data until it fits with the original input size of the test dataset.

In general, the methods' objective is to determine the patterns, and learning features to predict the student's future performance based on their own attempts. See Table 1 provides summary of RMSE results with various models used.

Lessons / Models	Lesson 1 (RMSE)	Lesson 2 (RMSE)	Lesson 3 (RMSE)
BKT	$0.430_{0.004}$	$0.375_{0.009}$	$0.392_{0.006}$
PFA	$0.440_{0.015}$	$0.408_{0.005}$	$0.407_{0.012}$
SPARFA-Lite	$0.603_{0.039}$	$0.522_{0.017}$	$0.460_{0.015}$
Tensor Factorization	$0.437_{0.011}$	$0.385_{0.009}$	$0.395_{0.011}$
XGBoost	$0.412_{0.010}$	$0.366_{0.005}$	$0.384_{0.011}$
GPT-4	$0.415_{0.004}$	$0.370_{0.007}$	$0.381_{0.009}$
XGBoost (selected by GPT-4)	$0.398_{0.008}$	$0.351_{0.006}$	$0.381_{0.008}$

Table 1: Comparison of model performance using RMSE with the standard error from five-folds cross validation

```
{
  'learner ID': 12345,
  'Question ID': 789,
  'Attempt': 2,
  'Prediction': 'Correct',
  'Assessment': 'High likelihood of success based on historical performance'
}
```

Figure 2: Sample Visual representation of the Model's Output

Learning Analytics

The paper [16] discussed methods applied to come up with a LA model that will help students to be encouraged in being active and immersed with the lessons being taken. With reading comprehension and an understanding that learning and reading takes place in the students first. This research will use the influence of the paper to encourage the students from within through fostering support through positive messages and assisted recommendations based from the results of data gathered by the LLM model.

Through a clustering model that will determine if a student is doing good or not for a specific reading lesson or exercise from the results of the LLM. From the results, the instructor will have to prepare feedback generation based on the following Intent of feedback, Performance from the topic, and Incorporate question on the given feedback for students to ponder of plan, monitor and evaluate their own progress. Lastly, the educator will test and refine accordingly based on performance after the feedback.

II. Related Works

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