

A Feedback Generation System to Enhance Learning at Primary School

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Abstract— Feedback is an essential aid for the learning process of students. Unfortunately, with an increase in workloads and student numbers, teachers find it time-consuming and difficult to produce valuable and meaningful feedback for students. To maintain an environment in which students can continue to receive beneficial feedback, a feedback generation system in primary schools in Mauritius has been developed. This system is based on English subject where students can perform exercises in the form of multiple-choice questions and fill-in-the-blank questions where immediate feedback is provided to them after it is requested. Natural Language Processing (NLP) techniques has been used to generate feedback to students. The system also provides auto-correction and auto-grading of exercises. The aim of this system is to save teacher's time in providing immediate content-based and meaningful feedback to enhance student learning. The desktop application was tested in some primary schools and positive results were obtained from both instructors and students.

Keywords—primary, students, instructors, feedback generation, NLP, desktop application

I. INTRODUCTION

Student learning is positively affected by the timeliness and quality of feedback they acquire from their homework and assignments [1]. Feedback is considered as an essential approach in facilitating the development of students as independent learners to monitor, assess and regulate their own learning [2]. The notion of feedback is even crucial in educational psychology. According to an accepted psychological principle, feedback is assessed as one of the vital elements for effective learning process [3]. Feedback is described as the most powerful single moderator that reinforces achievement [4]. An absence of feedback has even been related to student failure [5]. Knowledge of results is needed to evaluate progress, rectify errors, and enhance performance. Along with answer correctness, information like motivational messages, learning guidance, critical comparisons as well as learning focus may be presented via feedback [3]. In traditional educational environment, feedback is normally given as a grade and verbal or written remark on the student's work. However, in today's educational settings, teachers are finding it gradually more difficult to provide timely and specific feedback to students because of an increase in class sizes and thus causing a decrease in student learning quality [1]. Some researchers even report current feedback practices as ambiguous, insufficient, and difficult to understand [6]. Researchers even

found that some students did not even bother to collect their written feedback in assignments despite the time and effort exerted by teachers in producing students' feedback. Some simply looked at their grades quickly before slipping their assignments into backpacks and even discarded the feedback if the grade was unsatisfying. Other students justified that they did not appreciate when feedback was given to them late as they had already proceeded with other topics making the feedback useless. Additionally, students complained that feedback was too negative and not that useful. This could be a reason why students act less on feedback to ameliorate their work. They thought that teachers were unwilling to spend time in writing meaningful feedback to them and were less concern about student learning [7]. The paper therefore aims to develop a feedback generation system to enhance learning at primary school. The paper is structured as follows: A brief literature review is provided in section II. Related work is discussed in section III. The proposed feedback generation system and the architectural design are described in section IV. Section V describes the implementation of the system. Testing and Evaluation are discussed in section VI and finally conclusion is provided in section VII.

II. LITERATURE REVIEW

A. Feedback

To promote learning, learners need to obtain information about their performance and the existing discrepancy between the real and desired state, and process that information effectively usually known as feedback [8]. Feedback is a prerequisite for all learning contexts and provides many benefits including assessment of students' achievements, develop students' capabilities and understanding and increase the motivation and confidence of students [9]. There are mainly two types of feedback known as **formative** and **summative** feedback.

1) Formative Feedback

Formative includes **feedback** given to learners during assessments to enhance their learning [10]. In order to be effective, formative feedback should be timely, constructive, personal and motivational. There are two types of formative feedback namely **directive** and **facilitative**. **Directive** feedback is used to inform learners about their errors and improvements in learning. **Facilitative** feedback guides students in their revision by providing hints, suggestions, and

comments. Some examples of formative feedback methods involve homework, surveys, and interactive activities in classrooms [11]. Formative feedback provides learners the opportunity to perform better, boosts student's confidence, and enables students to be self-regulated learners [10].

2) Summative Feedback

Summative feedback involves feedback given in grade or mark form after an assessment has been completed. It evaluates how much students have learned at the end of a topic or semester [10]. A study states that summative assessments make learners study more, learn more and feel more inspired. Along with grade, summative assessment also guarantees that students possess certain knowledge, capacities, and skills where strengths and weaknesses are identified [12]. In addition, summative assessment provides educators with an insight of redesigning their teaching practices to increase students' marks. Some examples of summative feedback methods include final projects, standardized tests, and exams [13].

B. Categories of Feedback

Below are some of the categories of feedback that boost the performance of students [14]:

- **Appreciation:** The key to open the “feedback door” is appreciating students. When students receive a positive and appreciative feedback, they feel more motivated and can get engaged with any other additional feedback being provided.
- **Provide next steps:** When next steps are provided, students get to know how to enhance their performance and look forward to gaining more knowledge and skills.
- **Provide guidance:** Student learning is more improved when they receive guidance. By receiving suggestions, hints and advice, students are more encouraged to reach beyond what they believe they can do.
- **Provide encouragement:** Students sometimes require some positive words of encouragement like “You can do it, keep on going” that shows supports in their learning. This motivates them in improving their work.

III. RELATED WORKS

A. Computer-Assisted Assessment System at the University of Mauritius

Computer assisted examination (CAA) system makes use of computers to deliver, mark and make analysis of assignments and examinations. The software enables lecturers to use the tools to create, store and deliver effective assessment to meet the needs of students learning. The system can be utilized for summative assessment which consists of marked coursework and provide immediate, quicker, detailed, and accurate feedback to students using a feedback generator. Through this feedback, students can get an idea how they are progressing with the course from the beginning itself and are encouraged to follow up the feedback suggestions concerning further research and reading. Time can be saved, and computerized marking can easily be done for large groups. CAA can be

utilized to enhance student learning. CAA consists of a feedback generator that enables lecturers to view marks of students and identify the ones with remedial needs, a question editor that enables lecturers to create questions, a test generator that enables lecturers to organize questions and a presenter that allows the delivery of tests [15].

B. A Cartoon Animated Science Learning Tool for Lower Secondary Students of Mauritius

This system has been designed and crafted to teach a topic in biology called digestive system to adolescents. It makes learning meaningful, effective and encourages self-learning at the same time. The system encourages group learning, provides feedback from teachers, contains a virtual agent to guide them in their learning and a cartoon animated lesson for student to better understand the topic. Tests are performed by students and auto-correction of the tests are done by the system. Students can have discussions on their learning issues using a forum and teachers can also take part in the discussions to guide students by leaving feedback on students' profiles and can also monitor their progress. Games were included in the system acting as a motivation for learning [16].

IV. PROPOSED DESIGN AND ARCHITECTURAL DESIGN

The proposed system consists of students and teachers. Students can perform exercises and receive instant feedback by using Natural Language Processing (NLP) techniques to find similar words and synonyms of a given word. These shall then be provided as feedback in the form of hints for guiding students towards the right answer. A spell checker shall also be used in the system to suggest corrections of words. Feedback shall be supported with audio by using a Text-To-Speech API. Students shall view their results and save as PDF File for later use. Teachers shall be able to set questions and record answers in a lesser time compared to the previous traditional system. Teachers can also register, search, and remove their students anytime. Besides, the system shall enable educators to monitor student progress and provide auto grading of exercises thus reducing workload and paperwork. Moreover, a customized English dictionary shall be created to provide simple definition of words as hints to students. Teachers can add, update, search and delete words and definitions using the dictionary page.

A. Proposed System

Figure 1 illustrates the operations of the proposed system.

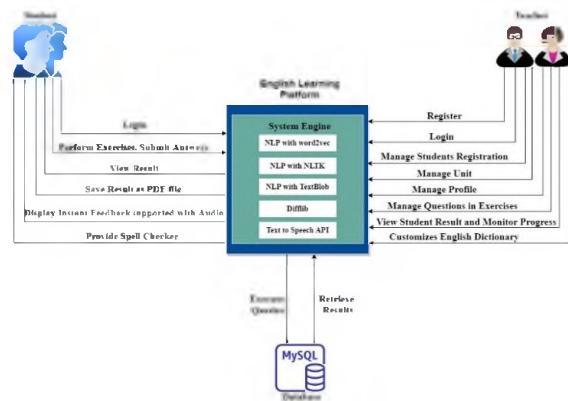


Fig. 1. Proposed System

B. Architectural Diagram

Figure 2 shows the architectural diagram of the system that was implemented. The architectural diagram makes use of a three-layer software pattern to define various components that were used within the proposed system.

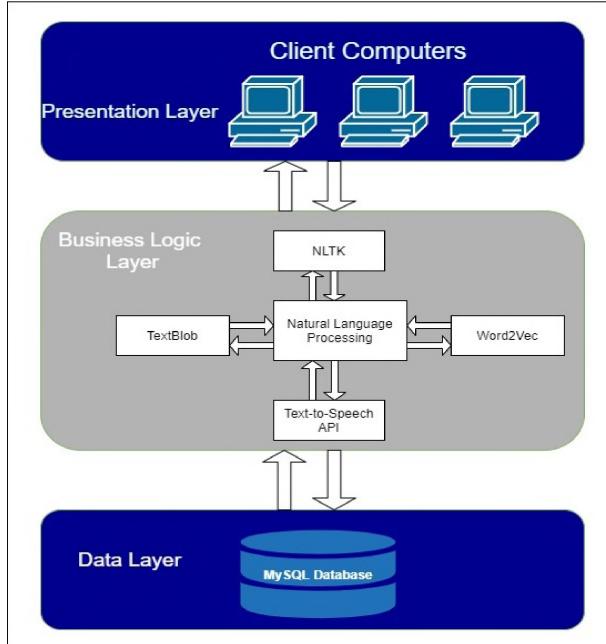


Fig. 2. Architectural Diagram

Presentation Layer

The presentation layer is the first and topmost layer of the application and consists of the graphical user interface. This tier is accessed through a desktop. The graphical user interface is built using Tkinter package provided by Python.

Business Logic Layer

The business logic layer contains the application's core capabilities. NLP techniques such as WordNet with NLTK and Word2Vec algorithm are used to fetch answers to questions stored in database and find their similar words and synonyms. Feedback is supported with audio by using a Text-To-Speech API which shall improve listening skills of many users. In addition, a spell checker is also used to suggest appropriate correct words by using NLP tools and python library like TextBlob and DiffLib.

Data Layer

The data layer comprises of the MySQL database that is for storage of data which is accessed by the application layer to perform NLP tasks and other tasks of the system.

C. Design Attributes

The following attributes have been considered while designing the proposed system:

Quality: The system shall be user-friendly, simple, visually appealing without long instructions since it is designed especially for students of grade 6 based on the PSAC framework.

Flexibility: The system shall allow students to perform exercises as many times as they want for better performance and shall be easily modified if new changes are to be made.

Security: The system shall be able to keep some information confidential and only authorized users shall be granted access after conforming to the authentication procedure.

Performance: The system shall have a good performance by ensuring that users do not have to wait for too long for the application to load.

V. SYSTEM PROTOTYPE

The system has been implemented using Python based on English language and for grade 6 students. NLP techniques have been used to generate feedback and data is stored on a MySQL database as it is scalable and easy to use. Xampp has been used as a local server to host the application as it is free and open source. It is also cross platform and supports MySQL. A desktop application has been implemented using Tkinter as it is popular and easy to use [17]. Text-to-Speech API in python has been used to convert text into audio. TextBlob has been used to auto suggest correction of words and DiffLib python library which contains a close match algorithm has been used as a spell checker to suggest words in the form of feedback. JSON python library has been used to store words and definitions in a JSON File to be used for the customized English dictionary.

Some of the user interfaces of the system are shown below.

A. Student Part



Fig. 3. Home Page



Fig. 4. Login Page



Fig. 5. Menu Page

Fig. 6. Fill-in-the-blank with option Exercise Page

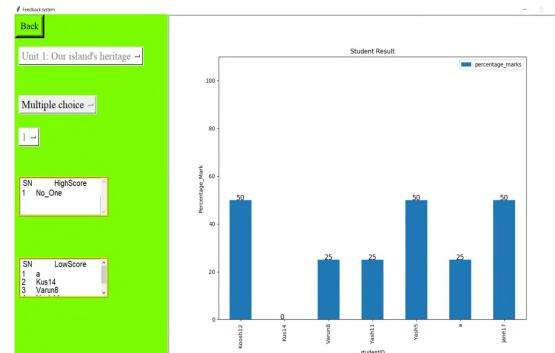


Fig. 10. View Result Page



Fig. 7. Result Page



Fig. 11. Customized Dictionary Page

B. Teacher Part

After logging into the system by entering the credentials, teachers can perform tasks as shown below:

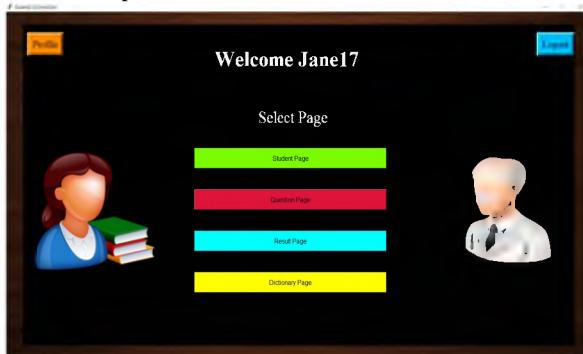


Fig. 8. Menu Page

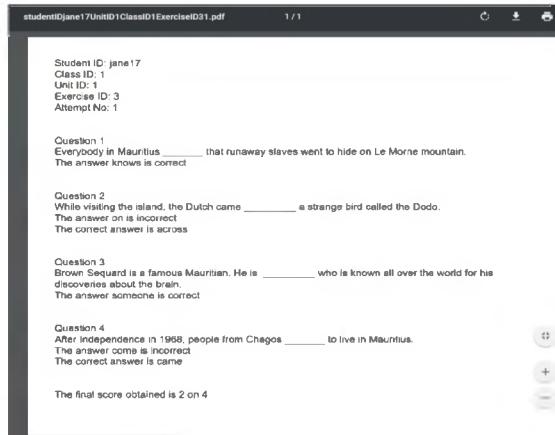


Fig. 12. Save Result as PDF File

Fig. 9. Question Page

VI. TESTING AND EVALUATION

The system has been tested in some primary schools in Mauritius with some students and teachers. Both students and teachers were given instructions on how to make use of the application and they were asked to use it. A survey was then carried out among teachers and students to give their feedback on the application. To achieve this, feedback questionnaires were given to teachers and students.

A. Results From Teachers

The results obtained from teachers are shown below:

Question 1: Was the application user-friendly?

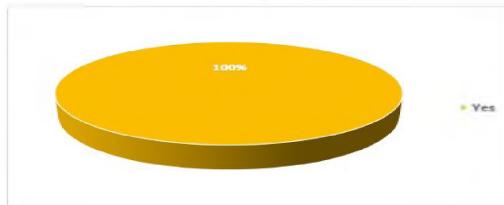


Fig. 13. Ease of use of application

Question 2: Was the application interactive?

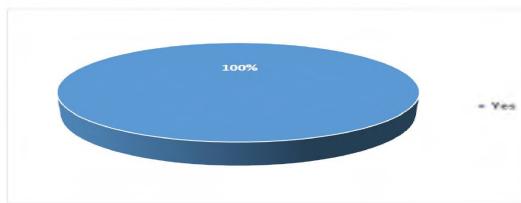


Fig. 14. Interaction with application

Question 3: How useful was the feedback provided in the application?

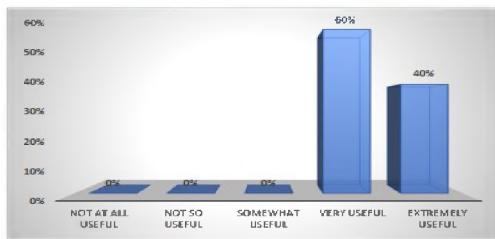


Fig. 15. Efficiency of feedback

Question 4: Overall, how would you rate the application?

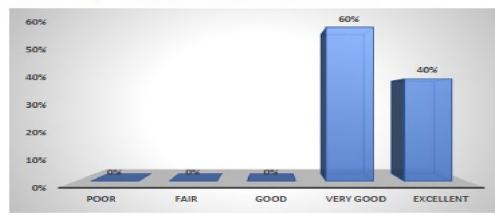


Fig. 16. Rate of application

Question 5: Will you use this application as a teaching aid?

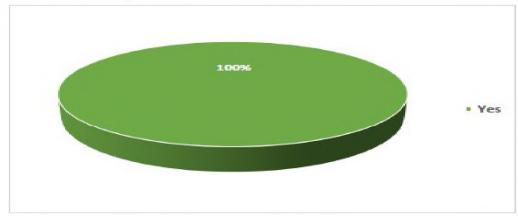


Fig. 17. Use application as teaching aid

The results showed that all participants found the application user-friendly and interactive. They were able to interact with the system successfully and found the interfaces visually appealing. Besides, most of the users found the feedback provided to students very useful. All agreed that the feedback given to students were valuable. Moreover, results showed that most of the participants found the application to be very good. All users agreed to use the application as a teaching aid. They believed that this application would help them in monitoring progress of students, planning their teaching

method accordingly, correcting, and grading exercises automatically. Thus, this would encourage students to work harder as well as enhancing their learning and performance. However, some issues were encountered by participants while using the application. Some of the users responded that children with low literacy level may have difficulty to navigate through the application and believed that more features such as videos, animations and pictures could be added to the system.

B. Results From Students

The results obtained from students are shown below:

Question 1: Was the application easy to use?

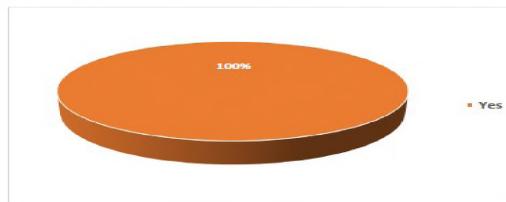


Fig. 18. Ease of use of application

Question 2: How would you rate the application?

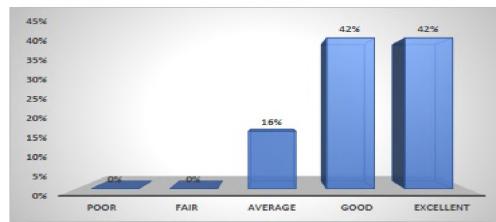


Fig. 19. Rate of application

Question 3: How useful was the feedback provided?

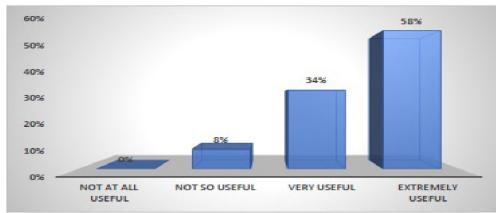


Fig. 20. Efficiency of feedback

Question 4: Do you want to use this application in school?

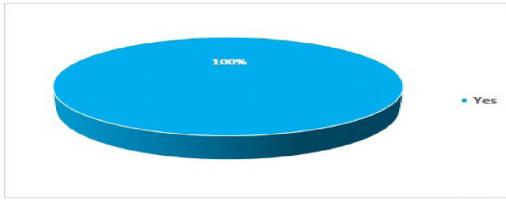


Fig. 21: Use application in school

Results showed that 100% of the users found the application to be easy and most of them appreciated the application. Besides, majority of the students found the feedback provided to them extremely useful and has helped them in making fewer mistakes. All users agreed to use this application as this would help them in learning English language in an interactive way at any time. They also responded that this application would enable them to revise their mistakes and attempt an exercise various times to improve their performance and learn from their mistakes.

C. Evaluation of System

An evaluation was made on the application to identify its responsiveness and effectiveness. The security of the application enforces users to firstly login into the system using their credentials before using other functionalities of the system. All details of students and teachers are kept secure and confidential in the system. The flexibility of this system allows students to attempt an exercise many times. In addition, the system is quite robust as it did not crash when users were navigating through the application. The system is also quite scalable as it was tested on a server by few users. The system has a good quality and performance since users found the system to be very user-friendly containing colourful interfaces and clear instructions as well as good response time.

D. Evaluation of Natural Language Processing Techniques

WordNet was found to be faster and of better performance than Word2Vec in generating feedback. Word2Vec had lower performance in generating feedback as the model had to be trained with a given text corpus. It also showed that WordNet was more effective in generating synonyms of words whereas Word2Vec was more effective in generating similar words. WordNet is symbolic and due to its hierarchical representation; computation of words' similarity is limited.

Table 1 shows the average execution time for each NLP techniques.

TABLE 1. AVERAGE EXECUTION TIME

Average Execution Time/s	
WordNet	Word2Vec
0.633	1.85

VII. CONCLUSION

In this project, a feedback generation system has been implemented that made use of both Natural Language Processing techniques such as WordNet with NLTK and Word2Vec algorithm. Immediate feedback was provided on students' work in a way that was beneficial to students' learning experience. An online survey was also conducted among primary school teachers to gain their feedback on the design of the system. After implementing the desktop

application, an acceptance testing was conducted in primary schools among teachers and students. Users were asked to utilize and test whether the application met the specified requirements. After evaluation, it was found that the application was reliable, produced beneficial feedback to students, improved learning experience and performance of students. Moreover, users were asked to fill in a feedback questionnaire to get a review on the application. The positive results obtained from the acceptance testing showed that users were very satisfied with the feedback generation system which can be deployed in primary schools in Mauritius.

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