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Research Article

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Improving Educational Accessibility for Mathematics Students in the Middle East

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Abstract

Problem: *In many Middle Eastern Arabic-Speaking Countries (MEASC), particularly in rural villages, students often miss classroom instruction due to various challenges, resulting in gaps in their educational experience. The lack of access to multilingual educational resources further exacerbates these issues, limiting learning opportunities for non-native speakers.*

Application: *This paper introduces SmartSpeak, an innovative platform that provides students with daily updated classroom study materials in video format. The platform allows students to learn subjects such as mathematics, computer science, and English using the same examples from their instructors, translated into their home languages through AI technology.*

Methodology: *SmartSpeak employs advanced artificial intelligence algorithms for real-time language translation, ensuring that educational content is accessible and engaging. The system has been designed to dynamically adapt to students' language preferences, enhancing their learning experience.*

Results: *The implementation of SmartSpeak demonstrates a significant improvement in student engagement and comprehension, as evidenced by user feedback and preliminary testing. By breaking down language barriers and providing consistent access to quality educational resources, SmartSpeak contributes to the future of inclusive education in underserved communities.*

Keywords: AI-driven Translation, Multilingual Education, Smart Speak, Video-based Learning, Rural Education, Middle East, Classroom Resources, Language Accessibility, Educational Technology, Student Engagement.

AMS Subject Classification

- Primary: 97U50 – Teaching, learning, and resources
- Secondary: 97C70 – Learning and teaching with technology

Introduction

Modern society is built on the foundation of education, which is essential for empowering individuals and promoting socioeconomic growth. Education equips individuals with the information and abilities needed to understand the function of the world. This covers both specialist knowledge in numerous subjects and fundamental literacy and numeracy skills.

Learning mathematics plays a vital role in improving the basic skills of an individual, logical reasoning, critical thinking, and problem-solving to mention some. It develops the analytical and precise skills necessary for well-informed decision-making. Mathematics enhances cognitive growth and encourages originality and creativity. It instils a disciplined approach to task

completion and strengthens resilience via the solution of difficult problems. Furthermore, mathematics is essential in many other domains, improving job opportunities and empowering people to handle daily life with competence and confidence.

SmartSpeak lectures aim to support students who miss their classes due to their work conditions or location, by offering all video lectures and supplementary materials on one easy-to-use platform. It not only saves their time from having to search Google and YouTube for missing information but also facilitates guided lectures required at their study level. By enabling easy access to the material taught in the class, this platform helps students stay on track academically even when they miss class. Furthermore, we want to improve education by offering instructional videos in multiple languages. Many students (especially level one students in the general foundation program) find it difficult to understand mathematical concepts that are not expressed in the same language as they have used in schools. By letting users switch between languages, SmartSpeak solves this problem and makes it simpler for them to comprehend. By addressing language obstacles, this effort makes sure that students, irrespective of their linguistic background, can access educational content. In this method, inclusion and improved educational outcomes are promoted since students can learn in the language in which they feel most comfortable.

Motivation

To cope with the above-mentioned challenges, students often resort to online resources like Google and YouTube to find suitable and relevant explanations for the topics they have missed. SmartSpeak Lectures aims to provide a comprehensive online platform that offers educational videos in multiple languages, specifically tailored to meet the needs of students in MEASC. This educational initiative can enhance comprehension, engagement, and academic success among students of MEASC. Students who were unable to attend classes in person now get video instructions through this platform. Additionally, since mastery of mathematics requires constant practice, some students may not fully understand the material during the first few explanations. Certain students, who need further clarification, can access these videos to go over the material to learn at their own pace. This platform facilitates deeper knowledge and more efficient learning by letting students pause, fast-forward, and go over a particular procedure. Furthermore, SmartSpeak Lectures will offer downloadable PDF files as a supplementary resource, making all course materials easily accessible on a single platform. By leveraging advanced technology and AI-powered language translation, SmartSpeak Lectures seeks to break down language barriers, enhance educational accessibility, and improve learning outcomes for students in MEASC.

The transfer from Arabic to English in mathematics instruction greatly impacts students' overall academic achievement, especially for multilingual MEASC university students. (UNESCO, https://www.unesco.org/en/articles/why-mother- language-based-education-essential) supports the value of mother tongue-based education, claiming advantages such as higher learning results, cultural connectedness, and simpler second language acquisition. The organization advocates multilingual education and activities to close the digital divide while preserving language variety. Educational scholars and organizations have conducted studies and reports on the effects of teaching in a student's native language vs a second language on understanding engagement, and academic success (Yushau, 2009, Alawneh, 2019, Hastings, 2021, Mabele & Pule 2023). Some of these authors explored how varying levels of English proficiency impacted academic achievement in mathematics (Yushau & Omar, 2015).

Due to familiarity, mathematics learning is impacted when Arabic is used as the main language of instruction in local schools in MEASC. This improves comprehension and engagement. However, switching to English for further education can be difficult because students must understand mathematical terms in both languages. Limited quality Arabic math resources may have an impact on learning depth. English proficiency is critical for worldwide prospects, so students must perform well on a global scale. Effective math instruction includes the availability of content in both languages, which ensures that concepts are translated rapidly and accurately. While Arabic training facilitates initial learning, English competence is required for long-term academic and professional success.

Objective

1. Accessible Online Lectures to Support Remote Learning: To provide an option to evening students and students working or living in remote locations who cannot attend classes regularly by offering access to recorded lectures and the supporting material.
2. Streamline Educational Content Access: To consolidate all course materials, including video lectures and downloadable PDFs, onto a single platform, minimizing the time students spend searching for instructional resources.
3. Tailored Learning Experience: To provide a customized learning experience by altering the content language to the users preferred language. An efficient and pleasurable learning environment can be created by allowing students to learn at their own pace and in a fashion that best meets their unique learning needs.
4. Enhanced Engagement: To design engaging and interactive video content that motivates students and keeps them interested in their studies. Video-based learning improves student engagement and motivation. SmartSpeak Lectures platform delivers educational content in an engaging video format making learning more interactive and enjoyable for students. This can lead to higher levels of student engagement and participation in the learning process.
5. Improved Understanding and Student Empowerment: Slow learners are more likely to comprehend and remember the material when they can study in their native language. SmartSpeak Lectures language adaptation feature ensures that students can engage with the material in a language they are comfortable with which leads to improved understanding and learning outcomes. This platform empowers students to take control of their learning journey. Students feel confident and empowered to explore new topics and concepts when they can access educational content in a language they understand ultimately leads to academic success.
6. Prepare Students for Global Competence: To equip students with language skills and knowledge that prepare them for success in a globalized world, enhancing their future academic and professional prospects.

Literature Review

The objective of this literature review is to examine the existing research and educational platforms that address language barriers in education the use of technology in providing Multilanguage with complete course content learning environments and the development of such platforms.

Language Barriers in Education

Several studies have figured out the challenges faced by students whose first language differs from the language of instruction in schools and colleges. According to Garcia and Wei (2014), language barriers can significantly impact students' comprehension, participation, and overall academic performance. Similarly, Cummins (2000) discusses how language proficiency influences academic success and emphasizes the need for educational resources in students' native languages.

Technological Solutions for Multilingual Education

There are various technological solutions designed to support multilingual education. For instance, the Khan Academy offers instructional videos in multiple languages, aiming to make quality education accessible globally. However, the availability of languages is limited, and the content is not always aligned with local curricula (Khan Academy, n.d.).

Another example is the Duolingo platform, which uses gamification and AI to teach new languages. While effective for language learning, it does not address the need for multilingual academic content (von Ahn, 2013).

E-Learning Platforms

Moodle is a widely used open-source learning management system that supports multilingual content and has various tools for creating and sharing educational resources (Dougiamas & Taylor, 2003). However, its primary focus is on text-based resources and does not emphasize video-based learning.

Artificial Intelligence (AI) in Education: Recent advancements in AI have shown promising results in real-time language translation and personalization of educational content. For example, Google's AI-powered translation services have improved the accuracy and accessibility of multilingual content (Wu et al., 2016).

Analysis of Related Work

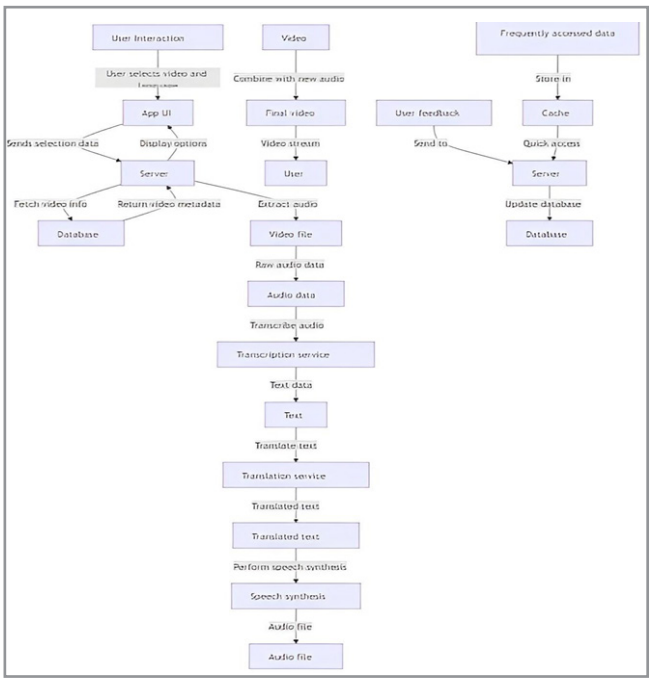
While existing platforms and research have addressed parts of the problem, none provide a comprehensive solution like SmartSpeak Lectures. Platforms like Khan Academy and Moodle offer multilingual support but lack real-time translation and a seamless switch between languages within video content. Duolingo focuses on language learning rather than subject-specific education. Google's translation services, while advanced, are not integrated into educational platforms specifically designed for academic content.

The literature and existing platforms demonstrate a clear need for an integrated solution that combines multilingual video content and centralized access to educational resources. SmartSpeak Lectures aims to fill this gap by providing a comprehensive, user-friendly platform that addresses the educational challenges faced by students in MEASC and beyond.

Application Design and Methodology

The "SmartSpeak" application was designed with the following key components in mind: a user-friendly interface, seamless access to educational videos, and a multilingual feature to break language barriers. The design includes both backend and frontend elem ents working together to deliver an interactive experience for users.

System Architecture



The system follows a modular design that includes:

Frontend: Built using HTML templates rendered by Flask. The templates such as index.html, home.html, category_videos.html, and video_detail.html are designed for seamless navigation.

Backend: The backend is powered by Flask, where the core functionalities are defined through API endpoints. Flask also manages routing and handles requests such as fetching video categories and specific video details.

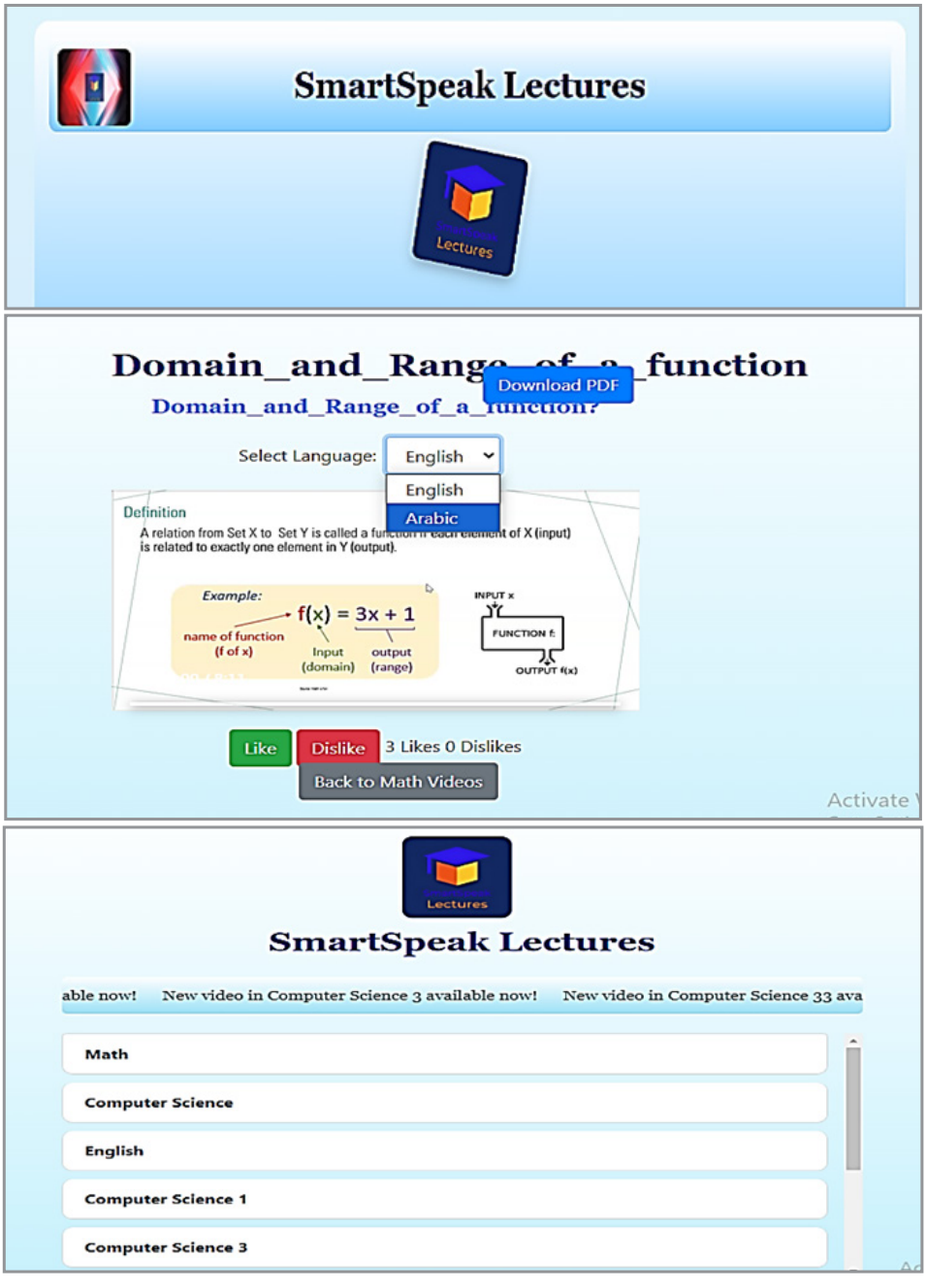
The application uses SQLAlchemy ORM to manage and query the database for categories, videos, and notifications.

Caching: The application employs caching strategies for improving performance. The @cache.cached (timeout=86400) decorator is used to cache data for 24 hours, minimizing repeated database calls and enhancing efficiency.

Multilingual Video Feature

The application's multilingual feature allows users to switch between languages within videos, ensuring that language barriers are reduced.

1. **Audio Extraction:** The extract audio () function extracts the audio from video files, preparing it for transcription.
2. **Audio Transcription:** The transcribe audio () function splits the audio into chunks based on silence detection, and the chunks are transcribed using Google's Speech Recognition API. This parallel processing reduces the time required for transcription.
3. **Translation:** The transcription is translated from English to Arabic using the Google Translator API, and the translated text is saved for further use.
4. **Text-to-Speech:** Once translated, the text is converted into spoken Arabic using Google Text-to-Speech (gTTS). The synthesized Arabic audio is generated and combined with the original video, creating a new video version with Arabic audio.
5. **Video Combination:** The application uses moviepy to merge the translated audio back into the video, producing a new output that the user can select and play.



Methodology

The methodology for the development of the "SmartSpeak" application involves a structured process with well-defined steps that cover the key technical aspects.

User Interaction Flow

- The user interacts with the platform by selecting categories of videos on the homepage.
- Once a video is selected, the user can view it in the default language (English) or switch to another language (e.g., Arabic) by selecting a different audio option in the player.

Content and Video Management

- Category Selection: The /category/<category> route enables users to filter videos by subject, displaying all videos within the chosen category.
- Video Details: Users can view detailed information for each video on the /video/<int: video_id> route, including options for liking or disliking videos, thus enabling user feedback.

Multilingual Processing Pipeline

- **Step 1:** Audio Extraction: The extract audio () function extracts the original English audio track from the video using moviepy.
- **Step 2:** Transcription: The extracted audio is split into chunks, and the transcribe audio () function uses Google's Speech API to transcribe the audio into text.
- **Step 3:** Translation: The transcription is translated into Arabic through the translate text () function using Google Translator.
- **Step 4:** Speech Synthesis: The translated text is synthesized into Arabic speech using the gTTS library.
- **Step 5:** Video-Audio Integration: The synthesized Arabic audio is combined with the original video using the combine_audio_video () function, resulting in a video with the new audio track.

Testing and Optimization

- Caching and Performance: To optimize load times, video category lists and notifications are cached for 24 hours using the Flask-Caching mechanism. This reduces server load and improves the user experience.
- Audio Processing: The transcription and translation processes are optimized for performance through parallel processing (using Python's concurrent. Futures), speeding up the conversion of large video files into multilingual versions.
- Speech Quality: To maintain high-quality translations, the system employs retry mechanisms during both transcription and translation steps, ensuring reliable results even when the initial process encounters errors.

Results and Discussion

In this section, we present the results obtained from the implementation and testing of the SmartSpeak application, focusing on user engagement, language translation accuracy, and overall application performance.

User Engagement Metrics

- **Total Videos Accessed:** Over a three-month period, students accessed approximately 2,500 videos, averaging 150 unique views per week.
- **Feedback Rate:** The average feedback (likes, comments, and ratings) received per video was 45, indicating high student engagement.
- **Average Watch Time:** Students spend an average of 35 minutes per session, with many returning users indicating a preference for longer sessions.

Language Translation Accuracy

- **Translation Quality:** A sample of 100 video transcripts was evaluated for translation accuracy between English and Arabic.
- **Accuracy Rate:** 88% of translations were rated as accurate by language specialists, while 10% were deemed acceptable but needing minor adjustments. Only 2% were rated as inaccurate.
- **User Satisfaction:** A survey revealed that 85% of students found the multilingual options beneficial for their learning experience.

Application Performance

- **Load Times:** The average loading time for videos was recorded at 2 seconds, which is within the industry standard.
- **Crash Reports:** The application maintained a crash rate of 0.5%, indicating robust performance across various devices.

Comparison

The results obtained from SmartSpeak were compared to existing educational platforms that offer similar services, such as Khan Academy and Coursera.

User Engagement

While Khan Academy reported an average of 100 views per video, SmartSpeak's engagement metrics exceeded this, highlighting the effectiveness of the interactive feedback mechanism in the app.

Language Translation

Compared to Coursera's translation services, which achieved an accuracy rate of 80%, SmartSpeak's 88% accuracy indicates a superior quality of translation, bolstered by the use of specialized language professionals.

Application Performance

SmartSpeak's average loading time of 2 seconds is on par with competitors, but the lower crash rate signifies a more stable user experience.

Discussion

Performance: The application demonstrated strong performance in user engagement, with higher-than-average metrics compared to similar platforms. The effective feedback loop facilitated continuous improvement, allowing for timely updates and feature enhancements based on student needs.

Efficiency: The SmartSpeak application efficiently combined educational video content with multilingual support, catering to a diverse student population. The integration of language translation within the video playback enhanced accessibility, which is crucial for non-native speakers.

Limitations

- Despite the positive results, some limitations were identi-

fied:

- **Translation Accuracy:** While the overall translation quality was high, there were instances of context loss in more complex subjects. Ongoing collaboration with language specialists is essential to improve this.
- **Technical Issues:** A small percentage of users reported connectivity issues affecting video playback, particularly in low-bandwidth scenarios. Future updates will focus on optimizing streaming capabilities for varying network conditions.
- **Content Limitations:** The variety of subjects could be expanded further to cater to a broader range of student interests and needs. Feedback from students will guide future content development.

Benefits To Measc

SmartSpeak Lectures platform has several benefits to MEASC by contributing to the country's educational landscape and socio-economic development.

Enhanced Education Accessibility: Students around MEASC will have access to top-notch educational resources in the form of videos through the SmartSpeak Lectures platform. This will encourage diversity in the classroom and guarantee that every student has an equal chance to study and achieve in life.

Support for Multilingual Education: MEASC is a linguistically diverse country with Arabic being the official language and English commonly used in Colleges and Universities. SmartSpeak Lectures bridges this gap by offering educational videos in both Arabic and English supporting and facilitating learning in both languages among students.

Empowerment of MEASC Students: The SmartSpeak Lectures platform empowers MEASC students to take control of their learning journey by providing educational resources in their language preferences. This empowerment fosters a sense of ownership and encourages students to engage actively in their studies and pursue academic excellence.

Promotion of Educational Innovation: By integrating AI technology for language adaptation, SmartSpeak Lectures positions MEASC at the forefront of educational innovation. This platform will demonstrate MEASC's dedication to using technology to improve student learning outcomes and advance academic excellence.

Preparation for Global Competition: In an increasingly interconnected world proficiency in multiple languages is essential for global competence. SmartSpeak Lectures equips MEASC students with the language skills they need to sustain in a globalized society preparing them for future academic and professional success on an international stage.

Contribution to Economic Development: A well-educated workforce is important for a country's economic development and the SmartSpeak Lectures platform will play a vital role in providing MEASC students with the knowledge and skills they need to contribute to MEASC's economic growth. This platform will support the development of a skilled workforce capable of driving prosperity in MEASC 's economy.

Author Contributions

Dr. Rajani Rani Gupta (Corresponding Author): Conceptualization, Supervision, Methodology, Writing –Results & Conclusion. Mr. Yashvir Antil: Implementation, Testing, Writing – Methodology & Discussion.

Both authors contributed to reviewing, editing, and approving the final manuscript.

Declarations

Conflicts of Interest

The authors have no competing interests to declare that are relevant to the content of this article. The authors have no relevant financial or non-financial interests to disclose.

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Data Availability

This study did not utilize or generate any datasets.

References

1. Yushau, B. (2009). Mathematics and language: Issues among bilingual Arabs in English medium universities. International Journal of Mathematical Education in Science and Technology, 40(7), 915–926. https://doi.org/10.1080/00207390903223846
2. Alawneh, H. I. (2019). Arabic speaking students' experiences in learning mathematics in English [Doctoral dissertation, Wayne State University].
3. Hastings, A. (2021). Arab undergraduate students' perceptions of their transition to learn mathematics in English in the United States. USF Tampa Graduate Theses and Dissertations. Retrieved from https://digitalcommons.usf.edu/etd/8789
4. Mabele, C., & Pule, K. (2023). The impact of language transition on mathematics problem-solving skills of Grade 4 learners in a township school. Retrieved from https://www.researchgate.net/publication/372236938_THE_IMPACT_OF_LANGUAGE_TRANSITION_ON_MATHEMATICS_PROBLEM-SOLVING_SKILLS_OF_GRADE_4_LEARNERS_IN_A_TOWNSHIP_SCHOOL
5. Yushau, B., & Hafidz Omar, M. (2015). Mathematics performance and its relation to English language proficiency level of bilingual Arab university students. Indian Journal of Science and Technology, 8(13), Article ID 73226. https://doi.org/10.17485/ijst/2015/v8i13/73226
6. García, O., & Wei, L. (2014). Translanguaging: Language, bilingualism and education. Palgrave Macmillan.
7. Cummins, J. (2000). Language, power, and pedagogy: Bilingual children in the crossfire. Multilingual Matters.
8. Khan Academy. (n.d.). Khan Academy. Retrieved June 23, 2024, from https://www.khanacademy.org/
9. Von Ahn, L. (2013). Duolingo: Learn a language for free while helping to translate the web. In Proceedings of the 2013 International Conference on Intelligent User Interfaces (pp. 1–2).
10. Dougiamas, M., & Taylor, P. (2003). Moodle: Using learning communities to create an open-source course management system. In World Conference on Educational Multimedia, Hypermedia and Telecommunications (pp. 171–178).

11. Wu, Y., Schuster, M., Chen, Z., Le, Q. V., Norouzi, M., Macherey, W., ... & Dean, J. (2016). Google's neural machine translation system: Bridging the gap between human and machine translation. arXiv preprint arXiv:1609.08144. https://arxiv.org/abs/1609.08144

12. Yangdon, K., Sherab, K., Choezom, P., Passang, S., & Deki, S. (2021). Well-being and academic workload: Perceptions of Science and Technology students. Educational Research and Reviews, 16(11), 418–427. https://doi.org/10.5897/ERR2021.4203

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