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Theoretical foundation in designing and developing a mobile app to support ESL learning for STEM learners

Biodata

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Abstract

Computer-Assisted Language Learning (CALL) has become an emerging trend amid the pandemic alongside the rise of science, technology, engineering, and mathematics (STEM). However, the decline in STEM learners' pursuing STEM is worrying, and one reason is the decline in English language proficiency. Hence, this paper aims to review theories in design and develop ME4STEM (Mobile English for STEM) to enhance STEM learners' English vocabulary. This paper adheres to the Design and Development Research (DDR). The design and development of ME4STEM is underpinned by English for specific purposes, mastery learning, cognitivism, social constructivism, problem-based learning, and cognitive theory of multimedia learning theories. Referring closely to the theories, the development of ME4STEM consists of 6 elements: 1) learning videos, 2) practices, 3) reviews, 4) mini-assessments, 5) language exploration, and 6) discussions. The rationale for designing and developing ME4STEM is to encourage learners to learn in a personalized space and at their own pace, especially in this pandemic. ME4STEM is a prototype, contributing to Smart CALL by serving as a bridge between STEM and the

English language, leveraging opportunities for interdisciplinary study along with contributing to society by providing sustainable and novel English for STEM supplementary material. ME4STEM caters to all aspects of Smart CALL: personalization, contextualization, and socialization, thus contributing to emerging CALL trends.

Conference paper

Introduction

Computer-assisted language learning (CALL) has become an emerging trend amid the pandemic alongside the rise of science, technology, engineering, and mathematics (STEM). However, the decline in STEM learners pursuing STEM is worrying, and one reason is the decline in English language proficiency. This issue calls for a smart solution from the perspective of Smart CALL. The term Smart CALL includes personalization, contextualization, and socialization. To solve the language issue of STEM learners, this paper aims to review theories to design and develop ME4STEM (mobile English for STEM) to enhance STEM learners' English vocabulary. This study adheres to the Design and Development Research (DDR). Yet, before designing and developing ME4STEM, the theoretical foundation should be paid attention to, as a well-designed application should have solid theories.

Aspects of SMALL CALL

First, the personalization aspect of Smart CALL should be looked into. Personalization refers to adhering to learners of a specific profile. Due to that, ME4STEM is designed according to the needs of STEM learners, which caters to the personalization aspect. The needs of learners adhere to the Needs Analysis Model by Dudley-Evans and St John (1998). Findings from the needs analysis are fundamental in designing ME4STEM. The rationale for including the findings from the needs analysis is to ensure that the mobile application is personalized to STEM learners, enhancing language learning via a mobile app.

The second aspect of Smart CALL is the contextualization aspect. Considering this, ME4STEM should be contextualized, and learners could use the mobile app to learn vocabulary in their settings. ME4STEM is contextualized to STEM education. Using the cognitive constructivism theory (Piaget, 1974), social constructivism theory (Rieber & Wollock, 1997), and problem-based learning (Barrows, 1996), ME4STEM ensures that the content is authentic and contextualized.

Also, the design and development of ME4STEM includes the socialization aspect, which encourages learners to interact with peers and instructors via a forum in the mobile app. According to The Framework for the Rational Analysis of Mobile Education (FRAME), a mobile app's social aspect is essential. In ME4STEM, the socialization aspect is emphasized in the discussion section. Learners can freely use the forum platforms to chat, comment, and interact with peers to solve STEM-related problems using the language forms and functions. They are also encouraged to join a Telegram group for extra guidance and scaffolding by instructors. The rationale for including the socialization aspect is to ensure that the mobile app encourages active learning rather than unidirectional passive learning.

Theoretical foundation

The learning theories are chosen to provide a solid foundation for this study. Mastery learning is selected because it allows learners to review their learning. This theory underpins the mobile app's learning video, practice, and mini assessment. Cognitive constructivism is selected to ensure that learning modules are created with learners'

prior knowledge and background, focusing on assimilating previous experiences to new knowledge. This theory underpins the review element in the mobile app. The ESP functional language is selected because English for STEM requires authentic resources, thus rendering the importance of language for the specific context, and this theory underpins the language exploration element. Social constructivism is chosen as it allows interaction and discussion among peers to ensure the mastery of learning and is incorporated into the discussion forum. Since learners are discussing, there is a need to include problem-based situations to encourage learners to use the vocabulary in STEM-related contexts. This is because problem-based learning is constructivist (Barrows, 1996). These two theories underpinned the discussion element in the mobile app.

Positive feedback has been received from mastery learning, particularly in improving learners' various skills. The systematic method of presenting lessons, a step-by-step technique that helps learners properly comprehend the lesson, is one element of mastery learning (Desta et al., 2021). This is because the mastery learning strategy offers learners a thorough guide, improving their cognitive capacities to grasp the subject. In support of this claim, Komalawardhana et al. (2021) said mastery learning helped students learn the topics better. According to the findings of these studies, mastery learning offers students a chance to grow as individuals in the future. Orak and Al-Khresheh (2021) emphasize using technological advances to encourage English learners to accumulate knowledge by implementing cognitive constructivist strategies. It is also mentioned that optimal learning is achieved by learners applying their knowledge in real-world settings. Suhendi et al. (2021) support that cognitive constructivism can improve individual understanding by introducing a positive environment.

The materials used in ESP are authentic, have clear objectives, and are self-directed. One aspect of ESP is the authenticity of the contents. Dudley-Evans and St John (1998) said ESP learning materials do not have to be built from scratch. The authenticity of ESP materials is preserved since they are designed for a specific setting (Hutchinson & Waters, 1987). This demonstrates that ESP materials, created or utilized in language education, are unique in that they pertain to specific content for individual learners and settings.

Based on previous research, social constructivism allows learners to analyze their learning and make progress on their own (Amna Saleem et al., 2021). Du and Liang (2021) studied how social constructivism drives multimedia implementation in English classrooms. They say that the social constructivism of multimedia promotes English teaching and improves learners' learning ability. A study by Amna Saleem et al. (2021) mentioned that scaffolding could improve learners' critical thinking and encourage independent learning. However, the same study also showed that scaffolding could be built between learners. Learners who communicate with each other help create a meaningful learning environment. Tomak (2022) supports this claim by noting that learners who support peer learning tend to perform better and have higher critical and collaborative skills. In addition, these learners learn better from their peers who have better language skills than them because they feel more comfortable and can understand each other. This shows that scaffolding learning via interaction promotes a more desirable outcome.

In a study by Nurul Iskandar et al. (2021), English as a foreign language (EFL) for vocational students is practical through problem-based instruction. In addition to adequate language skills, vocational school students also need critical thinking and problem-solving skills. Because of this, they incorporated problem-based learning into the EFL classroom, providing learners with more opportunities to connect learning to their context. This is supported by Alemi et al. (2021), who reported similar results. In addition, research has shown that problem-based learning is fun (Jasti & Pavani, 2021) and develops students' understanding (Putra et al., 2021). Jasti and Pavani (2021)

conducted a study in an engineering school. They found that learners who understood problem-based instruction were more likely to enjoy problem-solving because they were allowed to structure their learning. A study by Putra et al. (2021) is consistent with this finding. They emphasize the importance of creating authentic problem-based tasks to ensure learners can think critically and solve problems based on their understanding of previous lessons. This highlights the importance of authenticity in lesson planning.

The rationale for choosing cognitive constructivism is to ensure that learning modules are created based on the learner's prior knowledge and context, emphasizing the ability to adapt the previous experience to new knowledge. This theory underpins the validation elements in this study. Effective study instruction is related to the learner's ability to process information. Social constructivism was chosen because it allows interaction and discussion among peers to ensure mastery of learning and integration into discussion forums. As learners discuss, problem-based contexts need to be included to encourage learners to use vocabulary in STEM-relevant contexts. This is because problem-based learning is constructivist (Barrows 1996). The language form and functionality in the mobile app are based on purpose-built English and created so that the language can be applied to a specific STEM context (Dudley-Evans & St John, 1998). The rationale for creating a contextualized mobile app is to encourage learners to use language in familiar contexts, empowering English language learning.

Conclusion

Therefore, the design and development of ME4STEM caters to all elements in Smart CALL to contribute to emerging trends in CALL research. This research will guide researchers in designing and developing a language mobile application to cater to learners' current needs. Additionally, with a well-designed mobile application, everyone could access language learning, contributing to equal access to education as the Sustainable Development Goals (SDG) aspired.

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