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Fostering Science-themed Reading Comprehension of Elementary Students: The Effect of Digital Simulations and Content and Language Integrated Learning

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Abstract

While integrated learning is not a novel concept, it continues to capture attention. For instance, in elementary schools, merging English content with science is gaining traction. Successful implementation requires innovative media and relevant approaches. This study explores the effect of employing digital simulation media using a Content and Language Integrated Learning (CLIL) approach on sixth-grade students' comprehension of science-themed English texts. This research, employing a quasi-experiment with a one-group pretest-posttest design, involved 17 elementary school students. They underwent pretest, treatment, and posttest stages, with tests as the main data collection tool, validated and deemed suitable for use. Statistical analysis using the t-test in the SPSS software revealed a p-value of < 0.001, lower than 0.05, leading to the rejection of the null hypothesis. In essence, the use of digital simulation media with a CLIL approach significantly influences students' ability to understand science-themed English texts. Pedagogically, these findings suggest teaching alternatives with the potential to enhance both reading skills and science understanding. The integration of digital simulation media and the CLIL approach adds an engaging dimension to the learning process.

Keywords: Science, reading comprehension, digital simulation, CLIL

Introduction

Science education in elementary schools aims to provide students with foundational science concepts and skills. Specifically, in the 6th grade, the emphasis is on deepening students' comprehension of various scientific concepts, enhancing their abilities in conducting scientific processes, and fostering critical scientific attitudes (Fitri et al., 2022; Setiyawan, 2019; Sulthon, 2016; Dewi & Putra, 2022; Darmayanti & Setiawati, 2022). A crucial topic covered in 6th-grade science is the study of the solar system (Kemdikbud, n.d.). Throughout the learning process, students are encouraged to explore their understanding of the solar system's structure and the distinctive characteristics of each element through engaging observation activities (Fitri et al., 2022).

Teaching the solar system concept requires engaging and effective learning methods. However, this presents unique challenges for educators. Previous research highlights that science education at the elementary school level often faces obstacles due to a lack of innovation and diversity in teaching approaches (Winangun, 2022). Additionally, many teachers adhere to traditional methods, relying heavily on textbooks and memorization (Saleh & Jing, 2020). Beyond these challenges, there is another crucial aspect to consider in elementary science education: the incorporation of English as the language of instruction. While not fully implemented, there is a growing trend of using English as an instructional language, particularly evident in events like the National Science Olympiad (OSN) and the Madrasah Science Competition (KSM). This trend underscores the emerging need to integrate English into science education at the elementary level.

To address the aforementioned challenges, a fresh and more creative approach is essential for teaching science concepts, particularly those related to the solar system. Utilizing modern technology as a learning tool can be a key solution to overcome obstacles in integrating English into science education. Digital simulation stands out as a valuable learning medium for delving into the intricacies of the solar system. Numerous studies have underscored the pivotal role of digital simulation media in enhancing science education. Samanthula et al. (2020) crafted a cloud-based learning system, effectively employing interactive simulations to teach earth and environmental concepts, resulting in heightened student engagement and achievement. Fan and Geelan (2013) delved into the integration of interactive simulations in science education, emphasizing their potential to boost scientific literacy and student engagement. Quellmalz et al. (2020) accentuated the significance of simulations in elevating scientific literacy, providing compelling evidence that simulations enrich curricula, tailor learning environments, and foster stronger connections between students and teachers.

To incorporate digital simulation media and address the challenges of integrating English into science education, teachers can employ the Content and Language Integrated Learning (CLIL) approach. CLIL centers on using the target language throughout the learning process. Students are prompted to concentrate on and learn to use the new language as they grasp the freshly acquired subject matter (British Council, n.d.). Consequently, students not only acquire knowledge about the subject but also enhance their communication skills in the target language.

Several prior studies underscore the significant role of CLIL in elementary school science education. In a study by Setyaningrum et al. (2020), the authors explored the adaptation of CLIL in science learning for elementary schools amid the COVID-19 pandemic. They outlined strategies for online science instruction that accentuate the use of English and actively engage students in the learning process. Additionally, research conducted by Nugraha et al. (2020) affirmed that CLIL enhances both students' understanding of science concepts and their language skills.

While previous research has demonstrated the individual benefits of utilizing digital simulation media and the CLIL approach, there remains a scarcity of studies exploring their combined effects, particularly within the context of integrating science learning with English at the elementary school level. Moreover, existing research tends to concentrate on higher levels of education. Consequently, there is a need for further research specifically investigating how the combination of digital simulation media and the CLIL approach influences students' proficiency in comprehending science-themed English texts. This is essential for gaining a deeper insight into the potential advantages, particularly in terms of enhancing students' grasp of science concepts and proficiency in English.

Methods

This study involved 17 sixth-grade students from an elementary school. The rationale behind selecting the sixth grade is that, at this level, the solar system is covered in both Natural Sciences and English subjects. However, it is essential to highlight that these subjects are taught separately. The integration of the same material from both subjects in this research is expected to yield dual benefits. Not only will it enhance the students' comprehension of the solar system concept, but it will also contribute to the development of their reading skills related to this topic.

Moreover, given the school's structure with only one sixth-grade class, it was not feasible to establish separate experimental and control groups. Creating two distinct groups posed challenges as it could disrupt the school's learning system. Consequently, this research employed a one-group pretest-posttest design (Ary et al., 2010). The students underwent a pretest, received the treatment, and subsequently took a posttest. The comparison between pretest and posttest outcomes served as the basis for evaluating the effectiveness of the provided treatment.

The primary tool for data collection in this study is tests. Before implementation, the test underwent both validity and reliability assessments. To ensure content validity, the researchers collaborated with 6th-grade teachers from three different schools. Simultaneously, a reliability test was conducted using a test-retest procedure, wherein the test was administered to the same participants twice. This process yielded a reliability coefficient of 0.927, signifying high reliability of the test. The test employed is a comprehension test comprising various question types, including multiple-choice, true-false, and short-answer questions.

The test data were analyzed using the SPSS software, employing the t-test. This statistical method aimed to assess the effect of employing digital simulation media with the CLIL approach on the students'

proficiency in comprehending science-themed English texts. The data subjected to t-test analysis comprised pretest and posttest outcomes, both processed through the Paired Samples Test on IBM SPSS Statistics 27 software. When drawing conclusions, the null hypothesis is rejected if the p-value is less than 0.05. In this study, the null hypothesis is articulated as follows: "The utilization of digital simulation media with the CLIL approach does not significantly affect the students' proficiency in understanding science-themed English texts."

Result and Discussion

To assess the effect of digital simulation media with the CLIL approach on the students' proficiency in comprehending science-themed English texts, a sequence of activities was conducted, encompassing pretest, treatment, and posttest phases. During the pretest, the students engaged with an English text related to the solar system, supplemented by 16 questions designed to gauge their comprehension. These validated questions were then transformed into digital quizzes for enhanced efficiency in completion and score processing.

Following the pretest results, the researchers proceeded to administer treatment to the students. The treatment spanned four sessions, each lasting 2 hours (70 minutes). Throughout these sessions, digital simulation media from NASA was employed, featuring animated PowerPoint presentations accompanied by English text tailored for children.

During the initial treatment, the emphasis was on introducing vocabulary associated with the solar system. The simulation media showcased the solar system and its components, with a particular focus on the planets. Utilizing NASA content, the researchers incorporated solar system simulations complemented by explanations in English. In the second treatment, longer texts were introduced to enhance the students' familiarity with previously learned vocabulary. Additionally, new words were introduced during this session, and the students utilized the Google Translate tool to aid in understanding key terms. During the third treatment, the researchers showcased a planetary simulation using animated PowerPoint. Information about planets was presented in English through PowerPoint slides. The students revisited the learning of new vocabulary, particularly adjectives describing each planet. Following the activity, the students participated in a quiz using the Quizizz Paper Mode platform to assess their comprehension of the studied material. In the fourth treatment, PowerPoint media was designed in the form of a game to showcase a planetary simulation. The students who had mastered the vocabulary related to planets could excel in the game. In this interactive activity, the students had to decipher three clues for each planet and identify the corresponding planet. The correct answers were then revealed through an engaging planetary simulation.

Following the completion of the treatment stage, the subsequent phase involved the posttest. Similar to the pretest, the researchers presented a text about the solar system for the posttest. Although the number of questions remained consistent at 16, the researchers opted for a different question format in the posttest. While maintaining the theme and question indicators, the shift in question format for the posttest offered a more comprehensive assessment of the students' comprehension of the material. Table 1 illustrates a comparison of student scores between the pretest and posttest.

Table 1. The comparison of student scores between the pretest and posttest

No.	Name	Pretest	Posttest
1.	AZ	44	88
2.	RZ	44	75
3.	AK	25	75
4.	BR	19	88
5.	DF	19	69
6.	JM	44	63
7.	JL	19	88
8.	GL	19	75
9.	NB	19	69
10.	SQ	50	88
11.	NY	19	75
12.	NK	38	81
13.	QI	31	50

14.	RH	38	63
15.	AY	38	75
16.	TY	31	88
17.	ZS	31	69

The quantitative data collected from the pretest and posttest were subsequently analyzed using the SPSS software. This data underwent two types of statistical analysis: descriptive analysis and inferential analysis. Descriptive analysis was employed to offer a more detailed depiction of the obtained data, encompassing calculations of the average score, highest score, and lowest score from both the pretest and posttest. Figure 1 illustrates the outcomes of the descriptive analysis for the pretest and posttest.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	17	19.00	50.00	31.0588	10.94001
Posttest	17	50.00	88.00	75.2353	10.90028
Valid N (listwise)	17				

Figure 1. Descriptive Analysis

As depicted in Figure 1, the results of descriptive statistics reveal a significant improvement in the mean scores of the students on both the pretest and posttest. Initially, at the pretest stage, the mean stood at 31.06. This number demonstrated a substantial increase, reaching 75.23 in the posttest stage. Notable improvements were also observed in the minimum and maximum scores. During the pretest, the minimum score recorded was 19, whereas in the posttest, the minimum score elevated to 50. Similarly, the maximum score exhibited an increase from 50 in the pretest to 88 in the posttest.

Subsequently, to test the hypothesis, the researchers performed an inferential analysis. This step holds significance in ascertaining whether the administered treatment, involving digital simulation media with a CLIL approach, exerted a substantial impact on the students' proficiency in comprehending science-themed English texts. Figure 2 illustrates the outcomes of the inferential analysis through the Paired Samples Test in IBM SPSS Statistics 27.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest - Posttest	-44.17647	15.24072	3.69642	-52.01252	-36.34042	-11.951	16	<,001

Figure 2. Inferential Analysis

As depicted in Figure 2, the obtained p-value is < 0.001, considerably smaller than the 0.05 significance level. The criterion for rejecting the null hypothesis is when the p-value is less than 0.05. Consequently, there is compelling evidence to reject the null hypothesis. In other words, the use of digital simulation media with a CLIL approach significantly impacts the enhancement of the students' proficiency in understanding science-themed English texts.

The utilization of digital simulation media with a CLIL approach has indeed demonstrated a positive impact on the students' proficiency in comprehending science-themed English texts. This favorable influence stems from the treatment administered in this study. This research employs digital simulation media seamlessly integrated with the CLIL approach as a cohesive unit. This signifies that the digital simulation media used does not solely furnish information regarding the solar system but also presents it in English. Practically, the digital simulation media has the capacity to offer captivating visualizations of the solar system's components. This practice aligns with CLIL principles, which underscore the utilization of the target language as the primary tool in learning, coupled with the incorporation of visual media to fortify the students' comprehension throughout the learning process (British Council, n.d.).

The integration of digital simulation media with a CLIL approach in this research not only positively influences learning outcomes but also enhances student engagement in the learning process. This study combines two learning environments—the traditional classroom and the computer

laboratory—to create a more comprehensive learning experience. During classroom sessions, the students actively interact with visualizations of the solar system presented through animated PowerPoint. They not only pay attention but also actively learn planetary vocabulary, the distinctive characteristics of each planet, and other vital information about the solar system, all presented in English. This approach allows the students to deepen their understanding while honing their English language skills.

Furthermore, the students participate in digital quizzes using Quizizz Paper Mode as a follow-up to the material presented through simulations. The students' enthusiasm is evident during the quiz, where, guided by the researchers, they attempt to identify key words and connect them to the studied material. Active student involvement is also observed in the computer laboratory. With computer and internet access, the students can gain a more effective understanding of science-themed English texts. For instance, when studying a text about the solar system, the researchers guide them to identify relevant key words. To enhance their grasp of vocabulary, the researchers assist the students in using an online translation tool, along with the text-to-speech feature to listen to the pronunciation of these words. After achieving a thorough understanding of the vocabulary, the students practice applying that understanding in the context of the texts they read.

The aforementioned findings offer tangible evidence of the heightened level of student engagement in the learning process. The utilization of digital simulation media makes the students more proactive in their study of the material. This aligns with previous research findings emphasizing the positive impact of employing digital simulations in science learning, demonstrating an increase in student engagement, comprehension of concepts, and interaction between students and teachers (Samanthula et al., 2020; Fan & Geelan, 2013; Quellmalz et al., 2020).

Student engagement is further enhanced through the CLIL approach. The incorporation of digital simulation media along with English text yields positive outcomes by prompting the students to participate more actively in the learning process. For instance, they enthusiastically seek the meaning of key words, practice pronouncing vocabulary, and comprehend texts based on the vocabulary they have acquired. Throughout this process, the students engage in lively discussions, both with peers and the researchers. These findings regarding active student involvement align with prior research results emphasizing the advantages of the CLIL approach in the realm of science learning in elementary schools (Setyaningrum et al., 2020; Nugraha et al., 2020). This approach not only fosters active student engagement but also enhances students' grasp of science concepts and English language skills.

Conclusion

The findings from this study underscore the significant impact of employing digital simulation media with a CLIL approach on students' proficiency in comprehending science-themed English texts. The amalgamation of science content and English has demonstrably heightened student engagement, enhanced the absorption of science concepts, and nurtured English language skills, particularly in the domain of reading. While this research contributes valuable insights, it is essential to acknowledge its limitations, primarily tied to the restricted number of participants. The limited participants precluded the establishment of a control group. Future researchers might consider conducting similar investigations with two distinct groups—experimental and control—to elucidate the effects. Furthermore, enriching CLIL research by integrating it with additional content areas would contribute to a more comprehensive understanding of its effectiveness in enhancing students' content comprehension and English proficiency.

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