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Empowering Minds: Elevating Students' Problem-Solving Skills Via Personalized 4a's Infused Module

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Abstract

The objective of this study was to assess how the implementation of a personalized 4A's infused module in mathematics impacts the problem-solving skills of students. The research took place in the first semester of the 2020-2021 academic year at Bohol Island State University, Philippines, involving 57 students who were pursuing the BS Electrical program. To conduct the study, a descriptive survey approach was utilized along with a quasi-experimental pre-test-post-test control group design. For the study, a problem-solving test designed by the researchers was employed. Prior to the main study, the test underwent a pilot testing phase, which demonstrated a high level of reliability with an alpha coefficient of 0.7381. The participants were divided into two distinct groups during the implementation phase. The experimental group was taught using a personalized 4A's infused module, while the control group received instruction through an online blended approach. Both groups underwent pre-test and post-test evaluations using a 6-item problem-solving test. The gathered data was subjected to analysis using mean, standard deviation, and a one-way analysis of covariance (ANCOVA). The findings indicated a significant difference in problem solving skills between the experimental and control groups. The findings indicated a notable disparity in problem-solving abilities between the experimental group and the control group. Those students who were exposed to the personalized 4A's infused module displayed significantly enhanced problem-solving skills in comparison to those who received instruction through the online blended approach.

KeyWords: online learning, blended learning, Personalized 4A's Infused Module, problem solving skills, mathematics education

1. INTRODUCTION

The importance of problem-solving has been widely acknowledged as a crucial element within the realms of mathematical and scientific literacy (Crippen & Earl, 2007). This concept encapsulates engagement in mathematical endeavors that not only intellectually stimulate students but also nurture their development and understanding of mathematics (Novita, 2012). The augmentation of students' problem-solving capabilities has been recognized as a noteworthy focal point within the education sphere. However, past research has illuminated the challenges and intricacies associated with pinpointing effective pedagogical techniques
or resources to improve students' prowess in problem-solving (Kuo et al., 2012).

The incorporation of technology into the learning process has displayed potential in nurturing the development of students' problem-solving abilities (Mauch, 2001). Over the past few years, the amalgamation of web-based methodologies and problem-solving strategies has captured considerable attention within the research community (Hwang et al., 2012; Hung et al., 2016).

Oh (2021) conducted a study that scrutinized blended instruction within the realm of online learning environments. The study emphasized that the conventional form of blended learning, which combines both online and offline teaching, has lost its viability within the current context. Instead, the study proposes the incorporation of a varied array of instructional elements within online learning environments, offering effective solutions that are in line with both the present and future circumstances. The study's findings underscore that learners no longer favor the traditional approach of blended learning, where online and offline classes

are mixed.

In light of these findings, the researcher suggests that instructors should channel more effort into implementing optimal practices within the online learning environment. Furthermore, the study calls for additional research to ascertain the most suitable strategies for seamlessly integrating community engagement and learning activities into online learning settings.

Furthermore, the research conducted by Hadjerrouit (2010) emphasized that the creation of web-based learning materials is predominantly spearheaded by technical and software specialists, rather than educators and learners. As a result, a significant portion of these resources is deficient in a sincere grasp of the learning-oriented aspects and pedagogical factors that play a pivotal role in their efficacy (Amuko, 2015).

Prior research has predominantly concentrated on the broader benefits associated with web-based learning, encompassing heightened learner engagement, enriched knowledge assimilation, and elevated critical thinking (Kazu & Kuvvetli, 2023). Nonetheless, there is a scarcity of studies that have specifically delved into the repercussions of web-based modules on the cultivation of problem-solving abilities. These skills hold paramount significance for achieving success across a spectrum of academic, professional, and personal scenarios (Kabael & Baran, 2023).

In the current investigation, the utilization of a personalized module infused with the 4A's framework (Activity, Analysis, Abstraction, Application) serves as a means for learners to effectively comprehend mathematical concepts. This methodology fosters learning by prompting students to formulate their own concepts and understanding derived from their interactions with the software. Encouraging active involvement in the learning journey not only cultivates independence but also augments students' capabilities in resolving problems (Basturk, 2005). Consequently, through thorough, pertinent, and practical engagement with the software, students' prowess in problem-solving can experience noteworthy enhancement.

Based on the background provided, the primary objective of this study was to explore the influence of Personalized 4A's Infused Module Instruction and Online Blended Instruction on students' problem-solving abilities. The intention behind this investigation is to offer valuable perspectives that can guide the creation and execution of efficient web-based learning settings. Consequently, educators, instructional designers, and researchers can gain deeper insights into how personalized 4A's infused module module can proficiently nurture problem-solving skills, thereby equipping learners to thrive across various scenarios.

2. METHODOLOGY

The research was conducted at the Main Campus of Bohol Island State University (BISU) located in Tagbilaran City, Philippines. The researcher employed a quasi-experimental research approach, specifically utilizing a pre-test-post-test control group design. For this design, two complete groups of participants were chosen to explore the influence of the newly created Personalized 4A's Infused Module on the problem-solving skills of students. The participants were first-year students enrolled in the BS Electrical Technology program, and two intact sections were randomly assigned to either the experimental group (BS Electrical Technology 1-1) or the control group (BS Electrical Technology 1-2).

To evaluate the problem-solving skills of the students, a teacher-constructed Problem-Solving Test (PST) containing six open-ended questions was employed. Prior to implementation, this tool underwent preliminary testing and item analysis, with a reliability coefficient (alpha = 0.7381) indicating a substantial level of consistency. The initial testing phase involved thirty-seven first-year students who were enrolled in the Bachelor of Science in Industrial Technology program. The students' responses to the PST were assessed employing an assessment framework adapted from Roble's work in 2018. The PST was administered both before and after the instructional session, and the scoring was carried out by three mathematics educators, one of whom was the researcher.

The descriptive equivalent illustrating the

extent of students' problem-solving proficiency is presented below:

Score	Rating	Description
22-24	90-100	Excellent
19-21	86-89	Proficient
13-18	80-85	Approaching Proficiency
7-12	75-79	Developing
1-6	below 75	Beginning

The gathered data and information underwent analysis through descriptive and inferential statistical methods, encompassing computations of the mean, standard deviation, and the application of One-Way Analysis of Covariance (ANCOVA).

3. RESULTS AND DISCUSSION

Table 1. *Mean and Standard Deviation of Students' Problem Solving Skills*

	Control Group n=30		Experimental Group N=27	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Mean	5.97	13.23	6.44	15.37
Standard Deviation (SD)	2.75	3.44	2.49	3.19
Qualitative Description (Mean)	Beginning	Approaching Proficiency	Beginning	Approaching Proficiency

Table 1 presents the mean and standard deviation of the pretest and posttest scores on the problem-solving test. The pretest scores for both groups are categorized as at the beginning level. This signifies that both groups possessed limited prior understanding before the intervention. Nevertheless, following the implementation of the intervention, the experimental group outperformed the control group in the problem-solving test. The experimental group's performance surpassed the control group by a margin of 2.14 points. The illustrations below depict sample pretest-posttest results for both groups.

Table 2. *One-way ANCOVA Analysis of Pretest and Posttest Score of Students' Problem Solving Skills*

Source	Sum of Squares	Df	Mean Square	F	P-value
Treatment(teaching Methods)	55.40	1	55.40	5.03	0.016 *
Error within	594.70	54	11.01		
Total	652.87	55			

significant at 0.05

Table 2 shows the analysis of covariance that was executed on the pretest and posttest scores for the problem-solving test. The outcome of this analysis yielded a probability value of 0.016, which falls below the predetermined significance level of 0.05. This outcome indicates the rejection of the null hypothesis, demonstrating a significant difference between the scores of the experimental and control groups. Furthermore, the posttest mean score for the experimental group (15.37) surpasses that of the control group (13.23), implying that the implementation of Personalized 4A's Infused Module Instruction has notably enhanced students' problem-solving performance. This enhancement can be attributed to the incorporation of the 4A's framework into the personalized module, fostering experiential learning and stimulating creative thinking. These findings align with the assertion posited by Kauffman et al. (2008), suggesting that students exposed to a web-based environment with problem-solving prompts exhibit improved problem-solving skills and more articulate written responses compared to students without such prompts. In a similar vein, Kuo et al. (2014) discovered that the creative thinking approach bolsters students' problem-solving abilities in a web-based context. It's worth noting that experiential learning has been demonstrated to elevate students' problem-solving aptitude, surpassing the outcomes of direct instructional approaches (Hulaikah & Degeng, 2020).

4. CONCLUSION AND RECOMMENDATIONS

In summary, the results of this research point out that the created Personalized 4A's Infused Module emerged as a successful method for boosting students' problem-solving abilities. By employing this module, students displayed progress in their capacity to dissect and resolve problems. The module's interactive format enabled students to actively participate with the material and implement problem-solving approaches within a digital educational setting. The favorable results witnessed indicate the promise of Personalized 4A's Infused Module as a valuable instrument for fostering problem-solving skills among students.

Based on the findings of this study, it is advisable for educators and instructional designers to integrate Personalized 4A's Infused Module into their teaching methods as a means to enhance students' problem-solving proficiencies. The interactive and self-paced nature of such modules presents students with the chance to cultivate critical thinking, analytical reasoning, and decision-making capabilities. Additionally, educators should contemplate the inclusion of diverse problem-solving scenarios and practical applications within these modules to infuse the learning experiences with authenticity and pertinence.

Moreover, it is recommended that continuous research and assessment be carried out to delve into the enduring effects of Personalized 4A's Infused Module on students' problem-solving skills. This entails exploring the potential transfer of problem-solving skills obtained through Personalized 4A's Infused Module to real-world contexts and evaluating the efficacy of varied instructional designs and approaches embedded within the modules.

Furthermore, it is essential to furnish educators with professional development initiatives and training sessions. These endeavors are aimed at equipping them with the requisite competencies and understanding to proficiently integrate Personalized 4A's Infused Module into their instructional methodologies. By doing so, educators can maximize the utility of these modules, and in turn, offer adept guidance and assistance to students as they interact with the materials and hone their problem-solving proficiencies.

Overall, utilizing Personalized 4A's Infused Module as a means of instruction offers significant promise in enhancing students' capacity to solve problems. To fully harness the advantages of these modules and equip students with the skills needed to excel in both academic and real-life problem-solving scenarios, it is imperative to sustain research endeavors, provide comprehensive teacher training, and continually refine the curriculum.

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