

RESEARCH ARTICLE

Problem-solving skills of Sulu State College freshmen students in flexible learning education: An assessment

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ABSTRACT

The pandemic has prompted the adoption of online, modular, and blended learning modalities, emphasizing the importance of integrating these in daily teaching and learning processes. Problem-solving skills, considered crucial for 21st-century decision-making, are also essential. This study aimed to analyze the level of problem-solving skills of the freshmen college students in Sulu State College in (i) modular learning, (ii) online learning, and (iii) blended learning. Purposive sampling was used to sample A questionnaire adapted from related studies was used to elicit quantitative data using a 5-point modified Likert Scale. The freshmen college students were randomly sampled (n=119) from six schools in the college. Findings indicated that freshmen college students at Sulu State College demonstrated high competence in problem-solving across three learning modalities. Each modality offered unique benefits that effectively enhanced the students' mathematical problem-solving abilities. In modular learning, students felt confident in managing math problems independently highlighting the empowerment and self-learning capacity inherent in this approach. Online learning also proved effective, with students showing high competence in problem-solving because of flexibility and accessibility. Blended learning was particularly beneficial, with students reporting the highest levels of competence because it enhanced engagement, creativity, and problem-solving skills by providing a comprehensive and flexible learning experience.

Keywords: blended learning; flexible learning; modular learning; online learning; problem-solving Skills; learning process

1. Introduction

Mathematical problem solving has long been seen as an important aspect of mathematics, the teaching of mathematics, and the learning of mathematics. It has long been believed that solving problems involving numbers is an essential part of mathematics. Globally, there is a need for these curricula to teach the learners how to solve problems^[1,2].

Problem-solving skills are advantageous when resolving complicated and multidimensional challenges. Problem-solving skills can be developed through active learning models that engage students in the learning process^[3]. Solving problems is a fundamental component of the mathematics curriculum that is utilized not just in the Philippines but also in other parts of the world. Hence, some of the findings suggest that learners struggle to solve mathematical puzzles. If teachers consider more teaching and learning factors, they can accomplish the goal of helping students develop their problem-solving skills^[4].

ARTICLE INFO

Received: 11 March 2024 | Accepted: 9 April 2024 | Available online: 4 June 2024

CITATION

Antao MA., S. Morales Jr.R, Samparani-Ututalum CC. Problem-solving skills of Sulu State College freshmen students in flexible learning education: An assessment. *Environment and Social Psychology* 2024; 9(7): 2635. doi: 10.59429/esp.v9i7.2635

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According to Simamora & Saragih (2019)^[5], mathematics education should support and mentor students in comprehending mathematical ideas, procedures, and methods as well as helping them become proficient problem solvers. But perhaps most importantly, it should assist them make decisions in life^[4]. Students' ability to apply mathematical knowledge to various situations has been one of the major concerns in mathematics education research^[6].

In December 2019, Huanan Seafood Market in Wuhan, China, saw the first epidemic of the novel coronavirus infection identified as COVID-19. Preschools, schools, and postsecondary educational institutions across the globe have been placed under lockdown because of the COVID-19 pandemic. The implementation of lockdowns sped up the shift from a mostly face-to-face form of delivery of higher education to one that emphasizes flexibility. Policymakers appeared to act rapidly and decisively, the rushed implementation of strict lockdowns in 2020/21 probably did more harm than good^[7]. In addition, it presented significant difficulties for some university students in managing their coursework, particularly in collaboration, since they were forced to live in a single home with roommates, partners, and dependents, along with the accompanying duties that had become a part of their everyday lives. This affected how they felt about themselves. As the crisis caused education to move online everywhere,

To maintain educational continuity and support all schools in fulfilling their mission and vision of offering high-quality education to every Filipino learner, the Department of Education developed the Modular Distance Learning modality. This allowed students to continue their studies in the convenience of their own homes. Modular learning is the most popular type of distance learning, which takes the role of conventional in-person training^[8]. Another advantage provided to the students is the chance to learn at their own pace, which will assist them in becoming more independent and useful^[9]. It is the teacher's duty to keep an eye on the progress of the pupils. Students can communicate with the teacher through text messages, phone conversations, emails, and other methods that don't need in-person interactions^[10,11].

The study emphasizes how important it is for college students to acquire and improve their skills in problem-solving, especially considering the rapidly changing nature of flexible learning. Teachers may assist students in thriving academically and preparing for success in their future occupations by addressing these issues and offering support when needed.

2. Literature

2.1. Problem solving in mathematics

A key component of the mathematics curriculum is problem solving, which calls for students to utilize and integrate concepts and skills while making decisions^[12]. Studies have pointed out that students' mathematics achievement can be improved by equipping them with computational thinking. Therefore, this study examined the development of computational thinking skill and mathematics problem-solving skills via mathematics modelling activities among secondary students in Malaysia. Sentence-based mathematics problem-solving skills are essential as the skills can improve the ability to deal with various mathematical problems in daily life, increase the imagination, develop creativity, and develop an individual's comprehension skills. However, mastery of these skills among students is still unsatisfactory because students often find it difficult to understand mathematical problems in verse, are weak at planning the correct solution strategy, and often make mistakes in their calculations. This study was conducted to identify the challenges that mathematics teachers face when teaching sentence-based mathematics problem-solving skills and the approaches used to address these challenges^[13].

In the 20th century, there was a surge in the study of mathematical problem solving and strategies for providing different levels of support. Several studies on problem-solving processes that highlight the employment of heuristic procedures (heurism) in problem solving were conducted in the early stages of problem-solving research, especially in the 1960s and 1970s^[14]. It was believed that educating and familiarizing pupils with heuristic concepts, methods, and tools would support their ability to maintain concentration in the face of difficulties.

Problem-solving is, by nature, a creative process which, by teaching through the implementation of research and discovery activities, allows students to create their knowledge, revise it and link it to broader systems. The aim of the research was to describe and analyze the process of solving biological problems through activities that are performed during the process of solving them, as well as to study how the implementation of these activities affects the level and quality of student achievement in biology^[15].

The ability to analyze a situation, identify potential solutions, and implement the best course of action is a valuable skill that can lead to positive outcomes. In the context of flexible learning education at Sulu State College, it is important to assess the problem-solving skills of freshmen students. The ability to solve problems well makes students more capable of overcoming obstacles in their curriculum, which is one advantage. The study assessed the challenges of the students in the implementation of flexible learning in the new normal^[16]. They possess the capacity for critical thought, well-informed decision-making, and situational flexibility. However, the problem can be that certain students have trouble solving challenging puzzles or feel overburdened by demanding assignments.

As to Liljedahl^[2], since the inception of mathematics education, researchers have been drawn to mathematical problem solving as a crucial component of mathematics, its instruction, and students' acquisition of mathematical skills. More significantly, mathematical problem solving has been a part of every ICME conference since 1969. In line with this, there had been a compilation of four conclusions that distinguish four distinct but related facets of solving mathematical puzzles.

The field has grown in part because of the study of more detailed approaches to particular issues and the comparative analysis of those ways to find correlations in abstract approaches, or heuristics. Zimmermann^[17] summarized heuristic methods and resources from American literature in 1983 and issued recommendations for math classes. It divides heuristic methods that can be used in educational settings into three main groups: tools, strategies, and principles. Most of the previous research on mathematical problem solving for secondary school pupils has its roots in the works of Polya, cognitive psychology, and more especially cognitive science. While math educators aim to comprehend how their pupils engage with mathematics, cognitive scientists and psychologists work to create or validate theories of human learning. Computer simulations of problem solving have been particularly useful in the field of cognitive research. A computer program is a model or theory of behavior if it produces a sequence of behaviors that resembles the sequence for human participants.

The ideas of design-based problem solutions are further developed by Alan Schoenfeld's work. Pólya improved these ideas theoretically, but Schoenfeld improved them empirically and practically. Apart from examining methods that are taught to solve problems, he has successfully recognized and categorized a wide range of methods that pupils use on their own, most of which are ineffective^[18]. Furthermore, it was also found out that it enhances the knowledge of how students approach problems and how to teach problem solving skills by doing this. According to Schoenfeld^[18], solving an issue eventually involves a conversation between the problem solver's past knowledge, his efforts, and his reflections during the process.

In 1957, Polya successfully applied the mathematical paradigm to problem solving. Polya suggests that there are four possible processes in solving a mathematical problem: comprehending the issue, formulating a

plan of action, executing the plan, and evaluating the outcome. To solving mathematical problems in elementary, secondary, and university education, the Polya approach is commonly employed. Students use self-regulated learning, a self-directed process, re-evaluate their learning as they work toward academic objectives^[19,20]. This method assists students in breaking down challenges into manageable chunks and completing tasks by analyzing the results. This situation closely resembles the broad principles for managing or executing an operation, which include formulating a plan, gathering necessary components, directing and executing actions, and achieving the intended result. Polya recommended four actions. As a result, understanding a problem is necessary before solving it. Prior to beginning problem-solving activities, comprehension must be completed. As per John Dewey, the initial step towards resolving an issue is to obtain information about it^[21]. This suggests that gathering information from a variety of sources is a first step in comprehending the issue that has to be addressed. There are three primary methods for understanding the problem: 1) determining the issue's contributing factors; 2) figuring out how the identified variables relate to one another; and 3) determining the variables needed for solutions.

Once an issue has been identified, the following stage is to choose a plan of action and create workable solutions. Understanding the problem produces several factors needed to choose the approach to take in order to address it. Planning that includes strategies, tactics, and procedures pertinent to addressing a problem should be developed to ensure that an activity is carried out effectively. A few things you should have prepared when making a plan to solve a problem include: 1) choosing steps based on the information you have about the problem to solve; 2) drawing a suitable diagram that could help you identify the right step in the problem's solution; and 3) creating an analogy in an effort to use a diagram to identify a suitable strategy, approach, and method with situations that are roughly similar is important since different problems require different approaches, and not every strategy, approach, or method can be applied to address every problem.

It is pointless to identify a problem and develop a solution if a clever plan to solve it is not implemented. An effort is made to show that the method is the best way to solve the problem by applying problem solving in line with the chosen approach, strategy, and model. Everything that is made by humans is sometimes planned and sometimes unplanned; the same is true when plans are carried out. One should make an effort to review the solutions found when responding to a question. To find out if the solution truly fits the intended solution to the problem, the activity could, for instance, involve applying the inverse technique to the response. In relation to the multiplication problem, it might possibly be completed by looking back through steps of division.

Numerous studies have been conducted in the Philippines to ascertain the problem-solving techniques and aptitude of learners in handling non-routine tasks. However, the study's subjects are exceptionally talented students from selectively admitted universities. This would close the gap by giving a varied sample of pupils the same study. The non-routine problem-solving mathematical skills of the respondents would be analyzed and detailed in this way. Educators would also discover that intelligence has no bearing on non-routine problems. Additionally, this would help teachers identify the approaches to problem-solving that various learners take, allowing them to adjust and create more varied teaching strategies to promote students' development as math problem-solvers^[22-24].

2.2. Flexible learning modality

According to a study by Ambayon & Millenes^[9], modular instruction is more effective in the teaching-learning process than traditional teaching approaches because it lets students' progress at their own speed. Students are prompted and piqued in by prompt reinforcement and comments to practice exercises in this unrestricted self-learning environment. Some students find flexible learning to be an ineffective way to learn math. However, with the proper support and teacher guidance, students can have a successful and rewarding

experience teaching mathematics through flexible learning^[25]. This kind of learning modality reinforces the student-centered learning approach. But parents, educators, and students faced several difficulties while implementing modular learning. According to Dangle and Sumaoang^[26], the primary issues were children's difficulties with independent study, parents' ignorance of the best ways to guide their child or children academically, and a lack of money for the schools. As a result, it also offers evidence that shows how poorly modular distant learning can impact students.

“Online learning” can be a scenario in which the teacher and students communicate via an online platform. Teachers may be in the same institution as their students, and they receive training and instruction via an online platform^[27-29]. Many contemporary factors, such as trauma, anxiety, staffing problems, and schedule interruptions, cause learning loss^[30,31].

3. Research questions

This study assessed the extent of problem-solving skills in flexible learning of freshmen college students in Sulu State College. Specifically, this research answered the following questions:

- What was the profile of freshmen student?
- What was the level of problem-solving skills of freshmen college students in flexible learning?
- Did the level of problem-solving skills of freshmen college students differ based on their demographic profiles?

4. Methods

4.1. Research design

In this investigation, a descriptive-comparative design was utilized to determine the level of problem-solving skills of freshmen college students in Sulu State College. Quantitative data was acquired to describe, quantify, and draw conclusions regarding the regarding the math skills of the freshmen students. The study aimed to provide understanding of the students' problem-solving skills, offering data about their current proficiency levels.

A descriptive-comparative study is a research design that combines elements of both descriptive and comparative research methodologies. In this type of study, researchers aim to describe the characteristics of a specific population or phenomenon and explore potential interactions between different variables within that population. The descriptive aspect focuses on providing a detailed account of the subjects being studied, often through the collection of quantitative data that captures various attributes, behaviors, or conditions^[32-34]. The comparative aspect, on the other hand, examines how these variables interact with one another potentially determining cause-and-effect relationships^[35].

4.2. Participants and sampling

The researcher randomly selected 119 students from six schools in Sulu State College—the School of Education, School of Nursing, School of Arts and Sciences, School of Business Administration and School of Computer Science, Information Technology and Engineering, and School of Agriculture in Sulu State College, Jolo Sulu.

The sampling process involved first obtaining a complete list of students enrolled in each of these schools. Each student was then assigned a unique number. Using a random number generator, the researcher selected 119 numbers corresponding to the students' assigned numbers. This method ensured that every student had an

equal chance of being included in the sample, which reduced selection bias and enhancing the representativeness of the survey results.

4.3. Research instruments

The research instrument of this study consisted of four parts. The first part consisted of items that gathered the respondents' demographic profiles to include their name (optional), age, gender, civil status and academic course. Part II, III and IV consisting of 30 items corresponds to the three modalities such as the Modular learning (10 items), Online learning (10 items) and Blended learning (10 items) modality respectively.

The sample survey questionnaire used in this study was taken from, patterned after, and collected from various survey questionnaires of various studies, including Wahyudi et al.^[36], Ramdani et al.^[37], Wismath et al.^[38], and Robertson, I.^[39].

The quantitative data was obtained using a 5-point modified Likert Scale such that 5 = Strongly Agree (SA), 4 = Agree (A), 3 = Moderately Agree (MA), 2 = Disagree (D), 1 = Strongly Disagree (SD).

4.4. Data gathering procedure

Initially, the researcher received a letter of authorization from the Dean's Office of Graduate Studies to conduct the data gathering. With this approval, the researcher approached the President of Sulu State College to request a letter of agreement, which was required before gathering the data within their institution. Upon receiving the President's consent, the researcher then informed the deans of the various schools within the college—School of Education, School of Nursing, School of Arts and Sciences, School of Business Administration, School of Computer Science, Information Technology and Engineering, and School of Agriculture—about their intent to conduct and collect data for the study.

After securing the necessary permissions from the deans, the researcher personally distributed 200 questionnaires to first-year students across the different schools. Throughout this process, they ensured that all participants were aware of the confidentiality measures in place to protect their identities and responses. The researcher emphasized that participation was voluntary, and all data collected would be anonymized and used solely for the purposes of the study.

4.5. Data Analysis

This study utilized the Statistical Package for the Social Sciences (SPSS) version 29.0.2.0 to perform statistical analysis on the collected survey data. The demographics of the participants were analyzed using percentages, which provide an objective method for representing relative values.

To describe the problem-solving skills of freshmen students in three learning modalities, this study used weighted mean. A weighted mean, or weighted average, is an average where different data points are assigned different weights^[40-42]. To calculate a weighted mean, each value in the dataset is multiplied by its corresponding weight, and the results are summed. This sum is then divided by the total of the weights.

The study also used inferential analysis to examine differences between demographic profiles. In comparing the problem-solving skills of freshmen students, parametric tests were used. Specifically, this study used Student's t-test and Analysis of Variance (ANOVA). An independent samples T-test was conducted to analyze differences between two sub-groups of demographic variables (e.g., sex, age). For groups with more than two variables (e.g., year level, parental educational attainment, family income), a one-way analysis of variance (ANOVA) was used. Following the identification of statistical differences in ANOVA, Tukey's Honest Significant Difference (HSD) test, a post-hoc test, was applied to determine which specific variables

differed. These tests were considered statistically significant at $\alpha < 0.05$, leading to the rejection of the null hypothesis.

5. Results

Question 1. What was the profile of freshmen students?

Table 1 shows the demographic profile in terms of sex, age, course, and marital status of the freshmen college students. In terms of sex, 80 or 67.23% of the respondents were females while only 39 or 32.77% were males. In age, it showed that 59 or 49.58% of the respondents were between 18–20 years old and only 4 or 3.36% were between 15–17 years old. Based on their courses, each of BSE/BEED, AS, BSBA, Agriculture, and CSITE had 20 participants (or 16.81%) and only 15.13% were from BSN. Lastly, majority of the freshmen students ($n=115$; 96.64%) were single and only 3.36% were married.

Table 1. Demographic profile of the sampled participants.

	Demographics	Frequency (N=119)	Percent
Sex	Male	39	32.77%
	Female	80	67.23%
Age	15 – 17 years old	4	3.36%
	18 – 20 years old	59	49.58%
	20 years old & above	56	47.06%
Course	BSE/BEED	20	16.81%
	AS	20	16.81%
	BSBA	20	16.81%
	Agriculture	20	16.81%
	BSN	18	15.13%
	CSITE	21	17.65%
Marital Status	Single	115	96.64%
	Married	4	3.36%

Question 2. What was the level of problem-solving skills of freshmen college students in flexible learning?

This study analyzed the level of problem-solving skills of freshmen college students based on three methods of flexible learning—(i) modular learning, (ii) online learning, (iii) blended learning. Descriptive analysis was used to describe the level of their problem-solving skills. By using descriptive statistics, the study was able to quantify the levels of problem-solving skills among the students and identify trends or patterns within each learning method.

5.1. Modular learning modality

Table 2 presents the summary findings for the level of problem-solving skills of freshmen college students in modular learning modality. Descriptive analysis revealed that, in terms of modular learning modality, the freshmen students generally agree ($M=4.14$; $SD=0.300$) they were capable in managing/solving math problems even in modular learning. Specifically, they feel that “*there is enough time to understand what was taught*” ($M=4.59$; $SD=0.617$), “*excited about modular learning to assess their problem-solving skills*” ($M=4.36$; $SD=0.550$), and “*they like to work alone with modules*” ($M=4.38$; $SD=0.730$). Modular learning

could provide a supportive structure that accommodates different learning paces and styles, enabling students to effectively engage with and solve mathematical problems independently.

Table 2. Problem-solving skills of freshmen students in modular learning modality.

Statements	Mean	SD	Interpretation
1. I am excited about this modular learning to assess my problem-solving skills.	4.36	0.550	Agree
2. The module ran smoothly.	4.19	0.470	Agree
3. I get frustrated when I can't solve a problem.	3.47	1.145	Moderately Agree
4. I am confident about my ability to solve problems	4.13	0.768	Agree
5. A summary is provided to make it easier for me to understand the material I have just learned.	4.04	1.172	Agree
6. Clarity of description and discussion on material.	4.12	0.997	Agree
7. There is enough time to understand what was taught in the module so that I can have more creative problem solving.	4.59	0.617	Strongly Agree
8. Effectively apply methods to problem solving.	4.19	0.470	Agree
9. There is time allocation to study the module.	3.94	0.809	Agree
10. I like to work alone with my modules	4.38	0.730	Agree
Composite	4.14	0.300	AGREE

Legend: 4.50 – 5.00=Strongly Agree (SA); 3.50 – 4.49=Agree (A); 2.50 – 3.49=Moderately Agree (MA); 1.50 – 2.49=Disagree (D); 1.00 – 1.49=Strongly Disagree (SD)

5.2. Online learning modality

Table 3 summarizes the findings regarding the level of problem-solving skills of freshmen students in the online learning modality. Descriptive analysis indicated that they agree (M=3.95; SD=0.287) they have competence in solving mathematics problem during the online learning. Specifically, they manifested prominent skills in “*figuring things out for myself*” (M=4.25; SD=0.669) and “*learn in group and have learning autonomy*” (M=4.25; SD=0.666). They were also “*comfortable surfing the Internet*” (M=4.32; SD=0.783), “*can ignore distractions*” (M=4.17; SD=1.150), and “*allowing them to study independently to increase problem-solving skills*” (M=3.95; SD=0.986). Based on the responses, it was essential to note that online education could effectively support mathematical problem-solving skills especially student’s learning autonomy and critical thinking.

Table 3. Problem-solving skills of freshmen students in online learning modality.

Statements	Mean	SD	Interpretation
11. I can easily access learning material anywhere without being limited to time and place restrictions.	3.57	0.577	Agree
12. Well prepared online lecture facilities.	3.58	0.744	Agree
13. Online lecture facilities are provided allowing me to study independently to increase my problem-solving skills.	3.95	0.986	Agree
14. The provided online lecture facilities demanded student creativity to produce a good work.	3.90	0.744	Agree

15. With this kind of dissolving system, it will increasingly make me creative to solve the math problem.	3.66	0.731	Agree
16. I can ignore distractions around me when I study.	4.17	1.150	Agree
17. I am comfortable surfing the Internet.	4.32	0.783	Agree
18. I have developed a good way to solve problems I run into.	3.86	0.670	Agree
19. I learn best by figuring things out for myself.	4.25	0.669	Agree
20. I like to learn in a group, but I can learn on my own, too.	4.25	0.666	Agree
Composite	3.95	0.287	AGREE

Legend: 4.50 – 5.00=Strongly Agree (SA); 3.50 – 4.49=Agree (A); 2.50 – 3.49=Moderately Agree (MA); 1.50 – 2.49=Disagree (D); 1.00 – 1.49=Strongly Disagree (SD)

5.3. Blended learning modality

Table 4 presents the problem-solving skills of freshmen students in blended learning modality. Descriptive analysis revealed that they agree (M=4.229; SD=0.189) they were competent in solving mathematics problems in the blended learning modality. Specifically, they manifested competence in “studying independently given the resources/facilities available” (M=4.42; SD=0.605) and having the “willingness to be creative in problem solving” (M=4.32; SD=0.761). They also reported that “learning materials provided were helpful” (M=4.55; SD=0.548), “it is interesting to learn how to solve math problems” (M=4.33; SD=0.796), and “it was easier to learn with the media being prepared” (M=4.20; SD=0.548).

Table 4. Problem-solving skills of freshmen students in blended learning modality.

Statements	Mean	SD	Interpretation
1. I am more free to study independently with the facilities provided.	4.42	0.605	Agree
2. It is easier to learn with the media being prepared and used so that I am more motivated to study independently.	4.20	0.548	Agree
3. Every time I see a friend who is making a result, it makes me challenged to make a more creative problem solving.	4.32	0.761	Agree
4. Learning methods are interesting and facilitate me to learn how to solve math problems.	4.33	0.796	Agree
5. I am flexible.	4.25	0.829	Agree
6. The lecture activities demanded my creativity in planning creative problem solving.	4.06	0.548	Agree
7. I see every week friends show creativity in solving math problems and it motivates me.	4.07	0.725	Agree
8. The learning materials provided were helpful.	4.55	0.548	Strongly Agree
9. I have benefited from this pandemic to increase my problem-solving skills.	4.19	0.488	Agree
10. I am willing to spend 10-12 hours each week on this course, including any break weeks and weeks after the modules end until the final assignment is due.	3.90	0.684	Agree
Composite	4.229	0.189	AGREE

Legend: 4.50 – 5.00=Strongly Agree (SA); 3.50 – 4.49=Agree (A); 2.50 – 3.49=Moderately Agree (MA); 1.50 – 2.49=Disagree (D); 1.00 – 1.49=Strongly Disagree (SD)

Question 3. Did the level of problem-solving skills of freshmen college students differ based on their demographic profiles?

Table 5 presents the inferential analysis based on the students’ sex. Comparing the two sexes, findings indicated that there was significant difference ($t=38.638$; $p=0.000$) between the problem-solving skills of the students. It was determined that the female students manifested higher level of problem-solving skills in the flexible learning compared to the male students.

Table 5. Inferential analysis based on students’ sex.

t	df	Sig.(2-tailed)	Mean difference	95% confidence interval of the difference	
				Lower	Upper
38.638	115	0.000	1.707	1.62	1.79

*Significant at $\alpha=0.05$

Table 6 presents the summary table for inferential analysis conducted for age, civil status, and course of the freshmen students. Findings indicated there was no significant differences on the problem-solving skills of the freshmen students based on their age ($F=0.996$; $p=0.372$), civil status ($F=0.185$; $p=0.831$), and course ($F=0.249$; $p=0.780$).

Table 6. Inferential analysis based on age, civil status, and course.

	Sum of Square	Df	Mean Square	F	Sig.
Age					
Between Groups	0.602	2	0.301	0.996	0.372
Within Groups	34.729	115	0.302		
Total	35.331	117			
Civil Status					
Between Groups	0.125	2	0.063	0.185	0.831
Within Groups	38.833	115	0.338		
Total	38.958	117			
Course					
Between Groups	0.184	2	0.092	0.249	0.780
Within Groups	42.629	115	0.371		
Total	42.814	117			

*Significant at $\alpha=0.05$

6. Discussion

This study discovered that the freshmen college students in Sulu State College were highly competent in problem-solving in three learning modalities—the modular learning, online learning, and blended learning. Each modality provided distinct benefits that enhanced the students' capacity to proficiently solve mathematical problems and have problem-solving skills.

For instance, findings of this study revealed that students generally perceive themselves as capable of managing and solving math problems during the modular learning modality. For example, the preference for independent work suggested that modular learning may be particularly beneficial for students who thrive in self-directed learning environments. This finding was consistent with the previous studies about modular

learning. Learners who use modular distance learning advance independently by developing their capacity for self-learning, hence gaining empowerment^[43,10]. In the findings of Utami et al.^[44], problem-based learning with assistance from modules, contributed to the enhancement of their capacity to solve problems. Additionally, Amaliyah et al.^[45] noted that modules serve as valuable tools for promoting self-directed learning and facilitating the development of students' problem-solving skills.

In online learning, the freshmen students reported slightly lower level of problem-solving competence compared to their perceived competence in modular learning—although they still manifested high level of competence. Previous studies noted that the online learning offers students greater accessibility to education compared to traditional teaching methods, granting them the flexibility and convenience to study at their preferred time and location^[27,29,46-49]. Similarly, findings of this study revealed that freshmen students from Sulu State College feel competent in solving math problems in the online learning, highlighting their skills in self-directed learning and group collaboration. Their comfort with using the Internet and ability to ignore distractions further support the effectiveness of online learning for developing problem-solving skills. This finding also transcended the findings of previous studies. For instance, Wang & Wu^[50] found out that information technology compensates for the limitations of cooperative learning in online settings, enhances the content of courses, stimulates students' motivation to study, and enhances the overall effectiveness of the learning process, creating a beneficial feedback loop.

The study also found out that the freshmen students from Sulu State College had high level of competence in problem-solving in blended learning modality. Students report high competence in studying independently and a willingness to be creative in problem-solving. The helpfulness of learning materials and the ease of learning with prepared media suggest that blended learning provides a balanced approach that caters different learning preferences. Blended learning enables students to not only show their learning but also assess the knowledge they have acquired throughout the semester^[51]. Blended learning offers flexibility, enhances personalization, improves student outcomes, fosters autonomy and self-directed learning, offers opportunities for professional development, reduces costs, enhances communication between students and lecturers, and promotes collaboration among students^[52,53]. The findings of this study added that this modality also offered structured, self-paced learning opportunities alongside collaborative and interactive elements. The positive student responses implied that blended learning could enhance engagement, creativity, and problem-solving skills by providing a comprehensive learning experience not to mention they rated their competence in blended learning slightly higher compared to online and modular learning.

Findings of this study revealed no significant differences on the problem-solving skills of freshmen college students in Sulu State College based on their demographic profiles. Contrary to previous studies^[54,55], this study observed no difference on the perceived competence in problem-solving based on the sex of the students. Increasing awareness and efforts to promote STEM (Science, Technology, Engineering, and Mathematics) education among both sexes have likely contributed to diminishing traditional gender gaps in perceived and actual competencies. Educational initiatives and programs aimed at empowering all students to excel in mathematics and problem-solving could have also contributed to decrease the disparity in gender-fitted courses and subjects^[56,57].

This study also believed that the increased access to quality education in the Philippines caused decrease in the disparity in students' perceived competence based on their marital status. Over recent years, significant efforts have been made to improve educational access and equity across the country, ensuring that students from various backgrounds, including those who are married, receive the same quality of education and support. Philippine educational institutions have progressively implemented inclusive policies and support services to

accommodate the different needs of their student populations^[58,59]. These advancements in education were also prominent among Muslim populations in the Philippines^[59,60].

In summary, this study discovered that freshmen college students at Sulu State College were highly competent in problem-solving across three learning modalities—modular learning, online learning, and blended learning. Each modality provided distinct benefits that enhanced the students' capacity to solve mathematical problems effectively. In modular learning, students perceived themselves as capable of managing math problems independently, consistent with previous research that emphasizes the empowerment and self-learning capacity fostered by modular education. Online learning also proved effective, with students demonstrating high competence in problem-solving, benefiting from the flexibility and accessibility of this modality, which aligns with findings from previous studies on the advantages of online education. Blended learning emerged as particularly beneficial, with students reporting the highest levels of competence, due to its balanced approach combining independent study and collaborative, interactive elements. This modality was found to enhance engagement, creativity, and problem-solving skills by offering a comprehensive and flexible learning experience.

7. Conclusion

In today's world, the ability to solve problems is crucial. It is regarded as one of the essential 21st century abilities for learning and teaching since it offers more authentic learning opportunities. This holds true for daily life as well as the teaching and learning process. When people learn these talents, they will be able to address problems both analytically and creatively. The two years that these students spent under lockdown in the comfort of their own homes prevented them from developing their problem-solving skills further, and it appears that using various modalities during this time was not very beneficial.

This study has shown several results that will provide important details and information in terms of the usage of the different modalities. The goal of this study was to ascertain the level of mathematical problem-solving proficiency among Sulu State College freshmen during the 2021–2022 flexible learning year. The study was restricted to students who had prior experience with distance learning and who had used online, blended, and modular learning. Furthermore, it was proven that the usage of modular learning modality provides more learning opportunity, and for public use than online learning modality, and blended learning modality. This was also proven during the existence of the coronavirus where lockdowns are implemented, and so with learners who had to stay with their own homes.

Furthermore, it revealed that the level of problem-solving abilities among first-year college students was unaffected by demographic factors such as gender, age, marital status, and course. Students who are having difficulty on their problem-solving skills have nothing to do with what learning modalities they are using. Therefore, the learners are adaptable and will always depend on how they are going to learn using the different learning modalities.

Author Contributions

Conceptualization, MAA, RSM and CCSU; Methodology, MAA, RSM and CCSU; Software, MAA, RSM and CCSU; Validation, MAA, RSM and CCSU; Formal Analysis, MAA, RSM and CCSU; Investigation, MAA, RSM and CCSU; Resources, MAA, RSM and CCSU; Data Curation, MAA, RSM and CCSU; Writing-Original Draft Preparation, MAA, RSM and CCSU; Writing-Review & Editing, MAA, RSM and CCSU; Visualization, MAA, RSM and CCSU; Supervision, MAA, RSM and CCSU; Project Administration, MAA, RSM and CCSU; Funding Acquisition, MAA, RSM and CCSU. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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