LEARNING MANAGEMENT BASED ON STEM EDUCATION CONCEPTS TO PROMOTE PROBLEM-SOLVING SKILLS IN CHONGQING, CHINA

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Abstract

This study aims to understand university students' knowledge and perception of STEM (Science, Technology, Engineering, and Mathematics) education, focusing on gender, age, and educational background. It also explores students' views on how STEM education promotes problem-solving skills.

The sample population mainly consisted of female students (59.3%), those under 20 years old (36.9%), and undergraduates (36.9%). Overall, students demonstrated a good level of understanding about STEM education (57.72% correct answers), with the distribution of scores revealing that a significant number of students performed at excellent, reasonable, and moderate levels (29.8%, 28.6%, and 25.9%, respectively). Only a small percentage (15.7%) were categorized as having a low level of understanding. Notably, there was no significant difference in STEM education understanding when data were analyzed by sex, age, or educational status, suggesting an equitable distribution of knowledge across these demographic factors. The results were generally

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favorable regarding students' opinions about using STEM education to foster problem-solving skills (average score $\bar{x}$= 3.43). Comparative analyses using One-Way ANOVA revealed no significant difference in these opinions when classified by sex, age, or educational level.

These results underscore the value students place on STEM education as a tool to enhance problem-solving skills, reinforcing the importance of supporting these educational programs. Further, similar levels of understanding and opinion across demographic factors point towards the equitable impact of STEM education in the sample population.

Keywords: STEM education, students' knowledge, students' perception.

Introduction

The world is evolving quickly across many sectors, including economics, social matters, politics, and technology, demanding critical thinkers and problem solvers. Problem-solving is an essential 21st-century skill in navigating day-to-day challenges and fostering intellect, attitudes, and understanding of social circumstances. Hence, it's crucial to incorporate problem-solving in student education across all levels. This equips them with the practical application of knowledge, enhancing their chances of success in the modern workplace. However, most education systems focus predominantly on lecturing and memorization, stifling creativity and real-life application of learned concepts.

STEM (Science, Technology, Engineering, Mathematics) Education offers a solution by integrating various disciplines, allowing students to apply their knowledge across different fields to solve problems and innovate. STEM

Education develops the necessary skills for the 21st century, transforming students into creative, innovative individuals. Furthermore, it encourages solving problems with integrated knowledge, even in complex situations. Despite its inception in the United States in 2001, the understanding and application of STEM education remain new to many students, necessitating further efforts to develop their understanding of this concept. Teachers play a vital role in this transformation, intermediating the curriculum and the learner. Effective STEM education-based learning management design should consider student opinions and needs, often overlooked in conventional teaching methodologies. This helps meet course objectives and ensures students can apply their knowledge to real-world contexts.

Therefore, it is worthwhile to research student understanding of STEM education and their views on its application to enhance problem-solving skills. The insights gathered will be beneficial in structuring practical STEM education-based learning activities.

Research Objectives

1. To study students' knowledge and understanding of STEM Education classified by gender, age, and educational background.

2. To study opinions about learning management according to the STEM Education concept to promote a student’s problem-solving skills

1. Literature review

Definition of teaching and learning management using STEM format (STEM)

STEM teaching and learning management is an innovative educational approach that integrates Science, Technology, Engineering, and Mathematics (STEM). It's gaining prominence in early childhood education, particularly in today's technologically advanced world, aiming to equip young learners with vital life skills.

Multiple scholars have elaborated on STEM education:

Polchaiya (2014, pp.7) and Samahito (2014, pp.1) emphasize STEM as integrating science, engineering, technology, and mathematics. It's an educational approach designed to foster problem-solving, innovation, and the practical application of knowledge. Prasertporn (2015) and the Institute for the Promotion of Teaching Science and Technology (2014, pp. 4) highlight that STEM education aims to solve real-life problems, enhance skills, and prepare students for tasks requiring science, math, and technology skills. Buesa (2015, pp.10), Sangpromsri (2015, pp.11), Khankaew (2016, pp.3), and Siripattrachai (2013, pp.49) underscore that STEM education combines the four disciplines' knowledge to enable students to understand their relationships and apply them to solve real-world problems. Chulawathon (2013, pp. 16), Saeneewong (2013, pp. 30), and Samahito (2014, pp. 1) point out that STEM is not about memorization but about fostering thinking, problem-solving, and analytical skills. It enables learners to blend knowledge from various fields to solve significant real-life problems. Chanprasert (2014, pp. 4) and Tsupros (2009) mention that STEM education must integrate expected behaviors into content learning. It should cultivate interest, logical thinking, effective collaboration, and the ability to apply knowledge in global contexts. Gonzalez and Kuenzi (2012) define STEM education as formal learning activities in the classroom and informal ones, like extracurricular programs. Koehler et al.

(2013) see STEM education as encouraging learners to understand technical knowledge and apply it to solve everyday problems. Roberts (2013, pp. 22-27) defines STEM education as a design-based, problem-solving, and exploratory learning strategy combining the four disciplines.

As proposed by various academics, STEM teaching, and learning management guidelines focus on integrating the subjects of Science, Technology, Engineering, and Mathematics. The ultimate aim is to encourage learners to value and love learning these subjects, recognizing their everyday applications. According to Khankaew (2016, pp.3), STEM learning management has five characteristics: 1) Integration-focused teaching, 2) Facilitating connections between the four subjects and their relation to daily life and careers, 3) Emphasizing 21st-century skills development, 4) Challenging students' thinking 5) Allowing students to express their ideas and understandings that align with the four subjects. Timsuksai (2015, pp.2-3) identifies five stages of the STEM education management process: Creating Interest:

1. The lesson’s introduction involves questioning, reviewing previous knowledge, and outlining the teaching actions and desired goals.
2. Exploration and Search: Enables students to classify the learning topic using existing concepts. Students perform experimentation and collaborative scientific research, with the teacher as a guide.
3. Explanation and Conclusion: Uses the exploration stage as a foundation to study the concept, involving information collection from readings and group discussions.

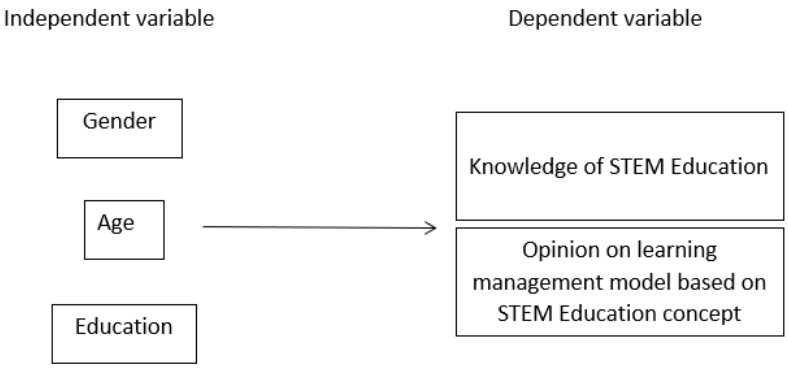
4. Knowledge Expansion: Students apply the knowledge from the previous steps to complete their understanding of skills, processes, and interrelationships of different knowledge areas.
5. Evaluation: Students evaluate vital concepts they have learned by self-assessment. The teacher also assesses student learning.

The STEM Teacher Training Course Manual (2014:15-17) suggests a six-step engineering design process:

1. Problem Identification: Understand daily problems and identify minor problems within the broader issue.
2. Collect Information and Ideas: Gather information to solve problems. This includes data collection and finding concepts that can be applied to problem-solving.
3. Solution Design: Apply gathered knowledge to design a solution.
4. Planning and Development: Develop a solution prototype, clearly defining the goals and timings for each sub-steps implementation.
5. Testing, Evaluation, and Design Improvement: Test and evaluate the prototypes, and use the results to improve and develop the solution.
6. Presentation: After development and testing, present the results to the public quickly and engagingly.

In conclusion, STEM education management requires various teaching techniques and a comprehensive understanding of the learning process to promote integrating and applying knowledge from science, technology, engineering, and mathematics.

Conceptual Framework



Research Methodology

Population and Sample

In this study, the researcher was interested in studying the Students in Secondary schools in Chongqing, China, with 75 schools total of 122,200 students. (Ministry of Education,2022)

Sample Group

The sampling size in this research, the researcher used Taro Yamane's formula (Taro Yamane, 1967), is 399 samples.

Research Result

Table 1 Demographic of Respondents

Respondents	Frequency	Percentage
Gender		
Male	152	38.0

Respondents	Frequency	Percentage
Female	248	62.0
Total	**400**	**100**
Age		
Under 14 years	155	36.9
14-15 years	124	31.9
15 years above	121	31.2
Total	**400**	**100**

Table 1 Presents demographic data from a survey of 400 respondents. Regarding gender, 38.0% (152) identified as male, and 62.0% (248) as female. Regarding age, 36.9% (155) were under 14 years old, 31.9% (124) were aged 14-15 years, and the remaining 31.2% (121) were aged 15 years and above.

Table 2 One-Way ANOVA Test by Gender

Variance Source	Df.	Sum of Squares	Mean Squares	F	Sig.
Between Groups	2	0.036	0.018	0.151	0.86
Within-Groups	319	50.066	0.121		
Total	**401**	**50.102**			

Table 2 represents an Analysis of Variance (ANOVA) test used to compare the means of more than two groups. The sample of students of different genders' opinions about learning management based on the concept of STEM Education to promote problem-solving skills was found to be similar.

Table 3 One-Way ANOVA Test by Age

Variance Source	Df.	Sum of Squares	Mean Squares	F	Sig.
Between Groups	2	0.287	0.144	1.202	0.302

Variance Source	Df.	Sum of Squares	Mean Squares	F	Sig.
Within-Groups	319	49.815	0.119		
Total	**401**	**50.102**			

Table 3 represents an Analysis of Variance (ANOVA) test used to compare the means of more than two groups. The sample of students of different ages' opinions about learning management based on the concept of STEM Education to promote problem-solving skills was similar.

Conclusion

The research analyzed data from a sample of university students, predominantly female (59.3%) and under 14 years old (36.9%). Students demonstrated good knowledge and understanding of STEM education, with an overall correct answer rate of 57.72%. A detailed analysis revealed a spread across very good (29.8%), good (28.6%), and moderate (25.9%) levels of STEM knowledge, with a smaller group exhibiting a low level of understanding (15.7%). However, no significant differences were found in STEM knowledge when segmented by gender, age, or level of education. Regarding opinions on learning management following the STEM concept to promote problem-solving skills, the average sentiment was generally agreeable ($\bar{x}$=3.43). Using one-way ANOVA, the study found that these opinions did not vary significantly when classified by sex, age, or educational level.

Suggestion

The study found that higher education students demonstrated a good understanding of STEM education, irrespective of sex, age, or educational level. This consistent understanding of STEM education could be attributed to

educators' efforts to integrate STEM into everyday learning and academic promotion policies from educational agencies emphasizing STEM instruction at all levels. The relevance of STEM education spans from kindergarten to higher education and extends beyond rote learning, fostering critical thinking, problem-solving, and analytical skills. This aligns with the views of Montri Chulawattanathon and findings from a 2013 study by Maltese et al. In the U.S., for example, adopting STEM education as a state-level educational policy has led to teaching methods such as Project-based Learning, Problem-based Learning, and Design-based Learning. As seen in some U.S. states, these methods promote student creativity and capability, primarily when implemented from an early age. Thus, the study concludes that applying STEM education concepts across all educational levels contributes to a homogeneous understanding of STEM education among students, regardless of gender, age, or academic status. The survey of higher education students revealed a consensus on the effectiveness of STEM Education for enhancing problem-solving skills, which is considered crucial for the 21st-century learner. The highest-ranking opinion supported the idea that STEM-based learning management provides a solid framework to foster these skills. This widespread agreement likely stems from STEM's pedagogical approach, which encourages students to generate knowledge across the four intertwined domains: Science, Technology, Engineering, and Mathematics. This integration aids in creating novel solutions, beneficial for both workplace scenarios and daily life. This perception aligns with the research of Wichayaporn Onpui (2022), who found a high level of support for the STEM education model in nurturing problem-solving and decision-making skills among student teachers. Similarly, a study by Corbett et al. (2013) demonstrated how using STEM in an

engineering design process could help middle school students adopt a more systematic approach to problem-solving.

Therefore, these results validate that STEM-based learning management can effectively enhance students' problem-solving abilities, a critical skill for the modern world. Hence, the surveyed students' overall opinion of the utility of STEM Education in fostering problem-solving skills was positive.

Suggestions

The research found that students generally have a good level of understanding of STEM education. Teachers could leverage this existing knowledge base and design learning plans to deepen this understanding of an excellent story.

Students have shown a favorable opinion toward the role of STEM Education in fostering problem-solving skills. Teachers can use these insights to enhance their curriculum planning, integrating more STEM-based learning approaches to nurturing these skills effectively.

Recommendations for Future Research

In addition, qualitative research should be conducted to identify areas where students and teachers might need more understanding of STEM education. This research can guide the development of intervention strategies to enhance and correct these gaps in knowledge.

Researchers should focus on designing and developing more tailored learning strategies that align with the STEM education approach, mainly aimed at enhancing problem-solving skills. These strategies should consider students' specific problems and need to ensure their effectiveness.

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