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Research Article

Improving the Quality of Education and Local Development by Coding and STEM Education Learning Management of Mahasarakham Hight School, Thailand

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Abstract

The concept of STEM education serves as an approach to learning that integrates knowledge from four disciplines: science, technology, engineering, and mathematics. This educational process aims to promote the holistic development of individuals, encompassing both physical and mental well-being. It emphasizes self-directed learning, enabling learners to develop critical thinking skills, management abilities, problem-solving, and the application of knowledge to prevent and resolve issues.

The project on enhancing educational quality and local development through Coding and STEM Education learning management was conducted with a sample of 30 secondary school teachers from three schools in Mahasarakham Province. Data collection tools included satisfaction questionnaires and assessments measuring knowledge and skills in Coding and STEM Education. The study found that participants reported the highest level of satisfaction with the overall activities, scoring a full 5.00. Furthermore, participants demonstrated significantly higher levels of knowledge and thinking skills after the activities compared to before, with a statistically significant difference at the .05 level.

Introduction

Education is regarded as a crucial foundation for national development. A nation whose citizens receive quality education inevitably experiences progress in all dimensions. Therefore, the educational process must be designed to foster holistic human development, encompassing both physical and mental well-being, while emphasizing learner-centered approaches. Learners should be encouraged to engage in self-directed learning, acquire problem-solving skills, practice cognitive processes, develop management and decision-making abilities, and apply knowledge effectively to prevent and resolve real-life problems. The ultimate goal of contemporary education is to prepare individuals to participate effectively in a society characterized by rapid advancements in science and technology. This necessitates an integrative approach to education that connects multiple disciplines, enabling learners to acquire competencies essential for life in the 21st century. Central to these competencies are the four core learning and innovation skills: critical thinking, which entails the ability to analyze, reason, and evaluate issues systematically; communication, which refers to the ability to use language and technology effectively, along with interpersonal skills to convey ideas clearly and persuasively; collaboration, defined as the ability to work cooperatively with others across differences in knowledge, beliefs, or perspectives to achieve shared goals; and creativity, the capacity for imaginative thinking and the generation of novel ideas or innovative solutions to problems.

However, current science education practices in Thailand remain heavily reliant on rote learning, focusing primarily on preparing students for examinations. Instruction tends to be lecture-based, leaving learners with limited opportunities for inquiry, experimentation, and knowledge synthesis. Consequently, students often lack confidence, critical thinking, and creativity, which hinders their ability to apply knowledge effectively or to generate innovative solutions. In response, this project seeks to enhance the role of educational institutions in developing human capital-particularly teachers and students-by strengthening their knowledge and skills in coding and STEM education. STEM (Science, Technology, Engineering, and Mathematics) represents an integrated learning approach promoted by the Institute for the Promotion of Teaching Science and Technology [1]. The four disciplines are interconnected and mutually supportive, and their integration does not necessarily require equal representation; rather, emphasis may be placed on one field while incorporating relevant elements of the others. Unlike traditional rote-based methods, STEM education emphasizes problem-solving, knowledge application, and experiential learning. It encourages learners to engage in creative thinking, experimentation, and the construction of new knowledge through project-based activities. STEM education also integrates disciplinary knowledge and skills with engineering design processes and the use of diverse technologies, fostering creativity and innovation. This approach aligns with the theory of constructionism, which highlights learning through the design and creation of tangible artifacts [2,3]. By engaging in hands-on activities and utilizing appropriate technologies, learners can construct their own knowledge, develop curiosity, and strengthen critical thinking [4,5].

Objective

i. Develop teachers to students to have knowledge, abilities and skills to develop students to have potential in academics, coding and STEM, life skills and morality and ethics.

ii. Improving the quality of education and local development by Coding and STEM Education leaning management [6].

Methodology

i. Pre-project evaluation: Assess the participating teachers' knowledge and perceptions regarding coding and STEM education in order to determine their baseline knowledge and current instructional practices.

ii. Design of development activities: Develop professional learning activities in coding and STEM education, including the preparation of a teaching and learning manual specifically focused on coding and STEM integration [7].

iii. Teacher training for coding and STEM education: Conduct training sessions for teachers across the three participating schools.

   a. Training in 3D modeling: Introduce the use of Tinkercad, a web-based application accessible at www.tinkercad.com, to design and create three-dimensional models.

   b. Training in 3D printing: Provide instruction on the use of 3D printers to fabricate physical objects based on computer-aided designs. Currently, several software applications support 3D design for beginners. The 3D printer operates by heating and extruding PLA (Polylactic Acid), a biodegradable polymer derived from natural resources and non-toxic to users, layering it into precise structures according to the programmed design. The production time for each object ranges from approximately 1 to 4 hours.

   c. Training in the use of electronic boards: Introduce the KidBright microcontroller board, which features an integrated display and sensors applicable to real-life contexts. Teachers will be trained in block-based programming techniques that enable users to connect programming commands intuitively, facilitating rapid and effective learning with immediate feedback through the KidBright system.

   d. Post-project evaluation: Assess the outcomes through knowledge tests, presentation of project outputs, and evaluation of the teachers' competency development in coding and STEM education.

Result

The improving the quality of education and local development by Coding and STEM Education leaning management of Mahasarakham hight School, Thailand

Table 1: Results of the evaluation of the training project to develop learning management in coding and STEM education.

Satisfaction assessment questions	Mean	Satisfaction Level
Project Publicity	4.38	Highest
Suitability of the location	4.77	Highest
Appropriateness of time period	4.85	Highest
Appropriateness of the time period	4.69	Highest
Sequencing of activities	4.85	Highest
Knowledge of the speakers	4.92	Highest
Ability to transfer knowledge	4.77	Highest
Answering questions	4.85	Highest
Overall suitability of the speakers	4.92	Highest
Training atmosphere promotes learning	4.92	Highest
Audiovisual equipment	5	Highest
Staff support	4.92	Highest
Food and beverages	5	Highest
The new knowledge, skills and experiences in coding and STEM education.	4.92	Highest
The knowledge gained from the training can be applied to develop learning management.	4.77	Highest
The results from the project met expectations.	4.62	Highest
Curriculum activities facilitate learning and skill development	4.62	Highest
Benefits you receive from the training program	4.62	Highest
Satisfaction with the overall project	5	Highest

Table 2: Comparison results of Knowledge and critical STEM thinking skills of sample teachers participating in the project.

Item	Before activity			Before activity			t	P
	$\bar{X}$	S.D	Level	$\bar{X}$	S.D	Level		
Knowledge and critical STEM thinking skills	11.45	3.9	Low	24.05	2.98	Hight	-39.325	.001*

*significant level .05

Table 2, the results of the comparison of teachers' knowledge and critical STEM thinking skills who participated in the program revealed that, prior to the implementation of the activities, the overall level was low ($\bar{X}\bar{X}$= 11.45). After the implementation of the activities, the participating teachers demonstrated an overall average score of knowledge and critical STEM thinking skills at a high level ($\bar{X}\bar{X}$ = 24.05). When comparing the knowledge and critical STEM thinking skills before and after the activities, it was found that the teachers' post-activity average scores were significantly higher than their pre-activity scores at the .05 level of statistical significance.

Discussion

The result found that the participating teachers expressed the highest level of satisfaction with the professional development program on coding and STEM education. In particular, aspects related to audiovisual equipment, food and beverages, as well as the overall organization of the program received the highest mean score ($\bar{X}$ = 5.00). This indicates the quality of program management and supportive resources that foster a conducive learning environment, which is consistent with Bybee's [8] assertion that creating a supportive and comfortable learning environment enhances participants' positive engagement and learning. More importantly, the teachers demonstrated a clear improvement in their knowledge and critical STEM thinking skills. Their average score before participation was at a low level ($\bar{X}$= 11.45) and increased to a high level ($\bar{X}$= 24.05) after the training activities, with the difference being statistically significant at the .05 level. These results reflect the effectiveness of the training program that emphasized the integration of coding and STEM in enhancing teachers' knowledge and practical skills. This aligns with Kolb's [9] theory of experiential learning, which explains that the integration of practice, reflection, and experimentation leads to meaningful transformations in knowledge and skills. In terms of developing STEM-related thinking skills, the present study also supports the findings of Beers [10], who emphasized that integrating real-world problems and contexts into mathematics and science learning can enhance learner engagement and deepen understanding. Within this context, coding and STEM training not only strengthened teachers' instructional skills but also enabled them to effectively transfer knowledge by connecting subject content to real-world applications.

Furthermore, the outcomes of the training are consistent with the principles of cooperative learning described by Slavin [11] and Johnson and Johnson [12], which highlight that collaborative processes and experience sharing among teachers contribute to both cognitive and social outcomes. These collaborative interactions serve as key factors in fostering 21st-century skills. This finding resonates with the policy framework of UNESCO [5], which emphasizes the preparation of both teachers and learners to meet the challenges of the digital age.

In summary, the result indicate that the coding and STEM training program, which was designed with experiential activities and appropriate support, significantly enhanced both the satisfaction and skill development of the participating teachers, while aligning with international concepts and research. The results also highlight challenges and obstacles in implementing teacher training in coding and STEM education, particularly the limited training time, which was insufficient to cover complex content and restricted participants' opportunities for deep learning. This corresponds with the findings of Margot and Kettler [13], who emphasized that effective STEM teacher development requires adequate time and a sustained training structure in order to foster the growth of skills and confidence in instructional practice.

Another issue identified was that some teachers did not have prior backgrounds in science, mathematics, or technology, which limited their understanding of coding and STEM education. To address this, the facilitators structured the content broadly,

enabling its application across multiple subject areas. This approach aligns with the perspective of Kennedy and Odell [14], who argued that STEM should be designed to integrate across disciplines so that teachers from diverse subject areas can effectively adapt and apply it in their instruction. In addition, the shortage of equipment and resources for hands-on learning was recognized as a critical limitation. A practical solution was to seek external support and promote the sharing of resources with other institutions. This strategy is consistent with Nadelson and Seifert's [15] recommendation that building collaborative networks and sharing resources across schools or organizations can significantly enhance access to innovative STEM teaching and learning opportunities [16-18].

Conclusion

In conclusion, effective teacher training in coding and STEM education requires a program design that is continuous, comprehensive, and sufficiently resourced, while also encouraging participation from teachers across multiple subject areas. Such an approach is crucial for fostering practical application and ensuring the sustainable integration of coding and STEM education within the Thai educational context.

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