# Learning Management Model with STEM-Focused Careers for Students in a Multicultural Society

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**Abstract**

This research aimed to develop a learning management model with STEM-focused careers for students in a multicultural society. The target groups included administrators, teachers, and students of the Ban Mueang Kuat School, Mae Taeng District, Chiang Mai Province. The study involved a participatory action research design and was conducted in two cycles. Data were collected through group conversations, in-depth interviews, participatory learning management, and lessons learned. Data were analyzed through content analysis.

The learning management model developed in this study was based on system theory, which describes inputs, transformative processes, outputs, and key successes. Inputs involved dynamic changes in the world, STEM education-driven policy, development of student's career skills, and societal context (learning resources, tourism, agriculture, and culture). The transformative process can be divided into two parts: change management and learning management. Change management involved STEM teachers' competency development, higher education mentors, and development partnerships. Learning management involved STEM-focused careers, transdisciplinary learning, evaluation, and assessment of goals by outputs and outcomes, and supervision, monitoring, and coaching by professional learning community or PLC. Outputs reflected teachers' STEM competency, students' STEM competency, and STEM-focused careers in a multicultural society. Key successes included the provision of space for STEM education by school principals, the changing of teachers' minds, and the support of educational government policy on learning.

**Keywords**: STEM-Focused Careers, Learning Management Model, Multicultural Society, Transdisciplinary

## Introduction

The global urgency to improve STEM education may be driven by environmental and social impacts of the twenty first century which in turn jeopardizes global security and economic stability. (Kelley & Knowles, 2016) The Thai Ministry of Education established an educational reform policy to support national development with international competitiveness by developing curricula and learning processes that allow students to develop specific skills and achieve age-appropriate development. Moreover, the Ministry should seek to develop knowledge relevant to the present context, especially to enhance learning in science, technology, engineering, and mathematics (STEM) education. STEM is an educational management approach that integrates specific academic fields to solve real-life problems encountered and enhance experiences, life skills, and creative thinking. STEM education prepares students to perform tasks that require specific knowledge and skills. It involves developing processes or new products through project- or problem-based learning activities, leading to future innovation. (Chulavatnatol, 2013)

In response to a policy announcement by Thai government agency regarding the promotion of STEM education for at least five years, Office of the Education Council, Ministry of Education (2016) found that the current system of STEM education the foundation for the development of manpower, innovation, and economic development does not operate effectively. The decentralization of legal and administrative power and implementation mechanisms present problems that affect budget operations, including a lack of educational

resources, such as professionals, management locations, and guidelines and mechanisms to drive STEM education. Addressing these issues involves allocating personnel resources with knowledge and expertise in the curriculum to the local area. In addition, the societal understanding of STEM education and its benefits to students and society, including possible STEM career paths, is yet comprehensive. This was in line with Tungputthipong & Piromsombat (2017) studied perceptions about implementing national STEM education policy in the classroom. They found that teachers who taught subjects related to STEM professions had a higher level of understanding of STEM education than other teachers. After the STEM education policy announcement, teacher education organizations for both preservice teachers and in-service teachers reacted by launching various teacher professional development programs. Schools recruited mathematics and computer science teachers to participate in the workshops for 3-5 days. Workshops involved learning activities designed by knowledgeable people and were implemented across the country. The aim was for teachers to develop skills and learn activities that they can impact their students.

Teachers should design activities that are appropriate and consistent with students' lifestyles, in line with Chamrat (2019), who stated that teacher professional development has complex factors that are difficult to examine. Short-term teaching development training that focuses on lectures, knowledge transfer, and passive learning without hands-on or minds-on activity, are not effective enough. Especially STEM teacher competency training, is even more complex. Since the training activities need to integrate the knowledge and skills of the four STEM disciplines, including co-teaching, creating new works, and building a practitioner learning community, they must focus on STEM education practice. Consequently, the design of STEM learning units is crucial and should allow students to face and solve problems in authentic situations. This will allow for meaningful learning for the students (Marginson, Tytler, Freeman, & Roberts, 2013).

Considering the differentiation of areas, Chiang Mai Province is a multicultural society and is the center of the North of Thailand. The province and its environment are experiencing rapid changes in physical features, ways of life, and cultural society. Most students, upon completing compulsory education, work as unskilled workers and lack the necessary skills. Therefore, many schools have adapted their curricula to facilitate occupational employment, providing skills related to the ownership of an establishment rather than participation in the day-to-day workforce. As a result, the school curriculum provides students with the necessary skills to enter the workforce (Chiang Mai Provincial Administrative Organization, 2020).

The primary principle in STEM is to develop knowledge and skills that can be applied in various opportunities and STEM careers. Byars-Winston (2014) suggests a multicultural STEM-focused career development framework for promoting knowledge, awareness of STEM education and careers, and considerations for increasing the achievement of groups in the STEM fields. The introduction of STEM-focused careers in the case context involved adjusting this learning management model to suit the multicultural context. This focused on 1) developing a curriculum in accordance with STEM education development, 2) modifying teaching methods by integrating learning, applying, and thinking practices to solve problems through new processes, learning through hands-on practice, and conducting assessment in accordance with STEM education, 3) developing regular teachers' STEM competency, 4) building school administrators and staff members' understanding and awareness and their capacity to supervise teachers' development of STEM skills, and 5) providing opportunities for the private sector/industry/companies to become more involved in learning management to manage education and develop manpower in STEM education.

According to the literature and the significance of learning management in STEM education, implementing policies in schools must involve precise goals and operational directions. This study, therefore, explored a learning management model with STEM-focused careers for students in a multicultural society. The research area was the Ban Mueang Kuat School, Mae Taeng District, Chiang Mai Province. It is a model school for career learning management. These researchers applied a STEM-focused career framework through a participatory action research design to develop teachers' and students' awareness of the link between science, technology, engineering, and mathematics. Knowledge and understanding of the role of STEM can lead to societal, environmental, and economic development, as it allows students to grow into productive members of society in STEM careers. Achieving these objectives will allow Thailand to improve its international competitiveness and overcome the middle-income trap, developing the country's stability, prosperity, and sustainability.

## Research Objective

The present study aims to address three research objectives:

1. To study the conditions and guidelines related to learning management with STEM-focused careers for students in a multicultural society.
2. To develop a learning management model with STEM-focused careers for students in a multicultural society.
3. To identify lessons that can be gleaned from the development of a learning management model with STEM-focused careers for students in a multicultural society.

## Conceptual Framework

The conceptual framework is a study of the policy of promoting learning management with STEM Education that suitable for schools in a multicultural society. It involved a 10-step participatory action research design investigating two cycles, it was considered in two parts: principal management and teacher learning management. The research findings were managed and constructed from the perspectives of system theory with correlated components, including inputs, transformative processes, outputs, and key success. Figure 1 presents an outline of the conceptual framework of the research design.

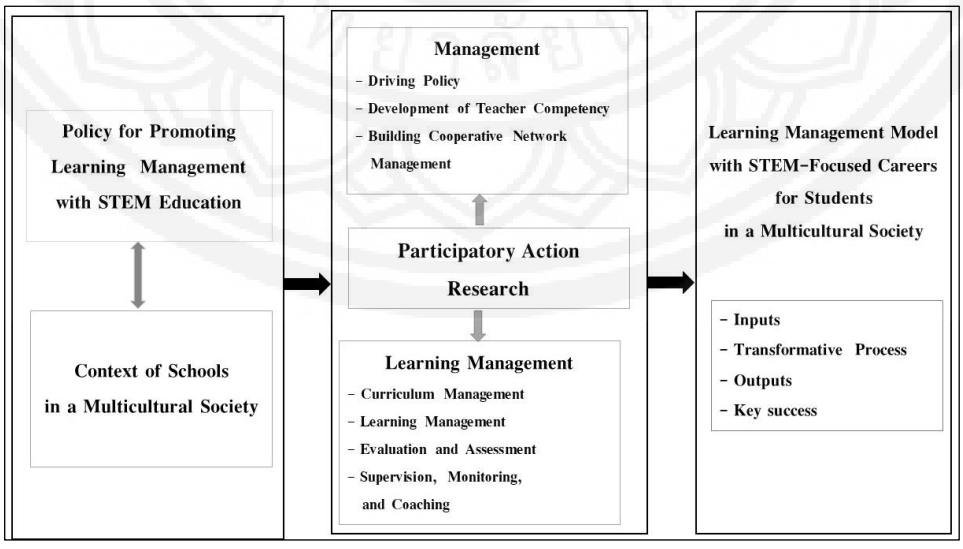


**Figure 1** Conceptual Framework.

## Research Methodology

The research area was the Ban Mueang Kuat School, Mae Taeng District, Chiang Mai Province. This school provides education to multi-ethnic and multicultural students and is a model school for professional learning management according to the Office of the Basic Education Commission, Ministry of Education Research. The study was in the first and second semester of the 2017 academic year and the first semester of the 2018 academic year.

**The Participatory Action Research: The First Cycle**

In the first half of the study, the target group consisted of 24 participants: a school principal, 18 teachers, and 5 student teachers at the Faculty of Education at Chiang Mai University.

**Data Collection:** Data were collected through small group discussions, workshop record forms, field study record forms, and lesson transcript forms. The researchers constructed the instruments according to the synthesis of concept, document, and related research based on the conceptual framework, presented the instruments to a research advisor periodically and revised them according to recommendations and research situation. Data collection was carried out in five steps: **1) Preparation**—The research team conducted small group discussions with the target group to clarify the development goals and objectives, the feasibility assessment of the resource, and operational guidelines, **2) Planning**—The research team organized the workshop, set goals for collaborative working, divided groups for brainstorming, and managed learning related to STEM-focused careers, **3) Acting**—The teachers collaboratively designed and tested the learning management plan for STEM-focused careers. The research team followed and provided periodic consultations, **4) Observing**—The research team participated in observation and follow-up, reviewed the performance, and took notes on the implementation process, the environment, and the results and limitations of the practice, **5) Reflecting**—The research team reviewed the performance and reflected on the results.

Content analysis was conducted in 4 steps: 1) Data preparation, 2) Setting the analytical issues, 3) Encoding and classification, and 4) Analysis and presentation of research results.

**The Participatory Action Research: The Second Cycle**

The results from research objective 1 were used to construct the prototyping of the learning management model with STEM-focused Careers, it was implemented in the second cycle of the study to confirm the transferability in the school context. The target group consisted of 87 participants: a school principal, 18 teachers, 63 secondary school students in Mattayom 1-3, and 5 student teachers at the Faculty of Education at Chiang Mai University.

**Data Collection:** The research instrument for data collection comprised a workshop record form, field study record form, lesson transcript form, and small group discussion record form. The researchers constructed the instruments based on the analysis results obtained from the first participatory workshop, presented the instruments to a research advisor periodically and revised them according to recommendations and the research situation. Data collection was carried out in five steps: **1) Re-planning**—The research team organized a workshop using the information obtained from the first cycle workshop to review the performance, define the issue, and plan for how to engage students with STEM-focused careers, **2) Reacting**—The research team organized learning activities according to the designed patterns for knowledge exchange and evaluation of progress, **3) Re-observing**—The research team observed, monitored, and reviewed the performance and took notes about the process, the environment, and the results and limitations of the practice, **4) Re-reflecting**—The research team summarized performance/learning problems and obstacles that arose, as well as recommendations for the learning management

of STEM-focused careers for students in a multicultural society, **5) Conclusion**—The team reviewed, considered, and summarized the key elements and related sub-elements of STEM-focused careers for students in a multicultural society.

Content analysis was conducted in 4 steps: 1) Data preparation, 2) Setting the analytical issues, 3) Encoding and classification, and 4) Analysis and presentation of research results.

## Research Results

The research results are presented below according to the research objectives.

**Research Objective 1**: To study the conditions and guidelines related to learning management with STEM-focused careers for students in a multicultural society.

The results related to the first research objective are summarized as follows:

**1. The Original Cost of Providing Education to Promote Careers.** The case school provides education to ethnically diverse students. The school curriculum promotes careers and employment by using resources and learning resources around the school under the motto, *"Our school is small, but our classrooms are wide"*. The school has a network of cooperation from many sectors. There is an area for students to practice, encouraging them to earn income while studying by allocating students' time for work placements. The school was selected as a model for learning management schools for students to develop professional skills by working with affiliated agencies.

**2. The STEM Education-driven Policy of School Principals.** The school principals recognized the importance of the concept of *"interdisciplinary"* education. They also had an *"open-up space"* for teachers of all groups of learning to collaborate on designing STEM learning activities for all levels of the students on Wednesday afternoons. All teachers participate in the activities, but there is still a lack of activities linked with learning standards and design thinking, including evaluation and assessment. Moreover, the teachers expressed concern about national testing (O-NET).

**3. Resource Feasibility Assessment.** The school was well equipped with a good location, cultural diversity, an abundance of natural resources, and a good environment. The school also had access to the local wisdom of folk experts. Therefore, the design of learning activities aimed to combine new scientific knowledge with local knowledge to increase professionality and product value.

**4. Guidelines for Collaborative Working.** Collaboration was achieved through participatory action research, knowledge exchange, and building a professional learning community. The research team was an academic mentoring team. The student teachers shared their knowledge to fulfill the shared knowledge and the guidelines for learning focused on the students' collaboration in groups. There was an exchange of knowledge and feedback provision.

**4.1 STEM-focused Career Curriculum Development Involves the Development of Professional Activities.** The school wanted to reduce study time and increase learning time by adjusting and developing existing career activities according to the standards and indicators related to STEM. However, the steps of curriculum development require an academic mentoring team and take time to be implemented. The master teachers were ready to learn but were unable to develop a full STEM-focused career curriculum.

**4.2 Designing and Organizing Learning Activities Related to STEM Careers.** The teachers selected existing professional activities to design and organize learning activities related to STEM. They used content analysis to link interdisciplinary integration. However, teachers often spend more hours working than they do instructing students. Consequently, they do not have sufficient time to design learning activities that integrate

science into their profession. Therefore, the organization of professional activities at the school was carried out using the traditional method.

**4.3 Supervision, Monitoring, and Coaching of STEM Education is Interdisciplinary.** The school principals had to be aware of and be leaders in driving change, opening up areas for teacher competency's development, and organizing integrated learning activities across science. They had to be the facilitators of activities and learn together with teachers and students. Importantly, they had to promote and support the development of STEM teacher competencies by operating the whole school and building networks in cooperation with higher education institutions.

**4.4 Evaluation and Assessment.** The master teachers were aware of how to measure and evaluate learning outcomes with authenticity. However, most teachers were still concerned about agency audits and national testing. Most teachers would like to adjust their learning management. However, designing integrated learning management requires knowledge, understanding, and applied adaptation in measurement and evaluation. Consequently, this was an issue that could not be achieved in the first cycle of the participatory action research.

**Research Objective 2**: To develop a learning management model with STEM-focused careers for students in a multicultural society.

The learning management model developed in this study was based on four elements: inputs, transformative process, outputs, and key success. These conditions were the vital mechanism that drove the relationship between each element, as shown in Figure 2.

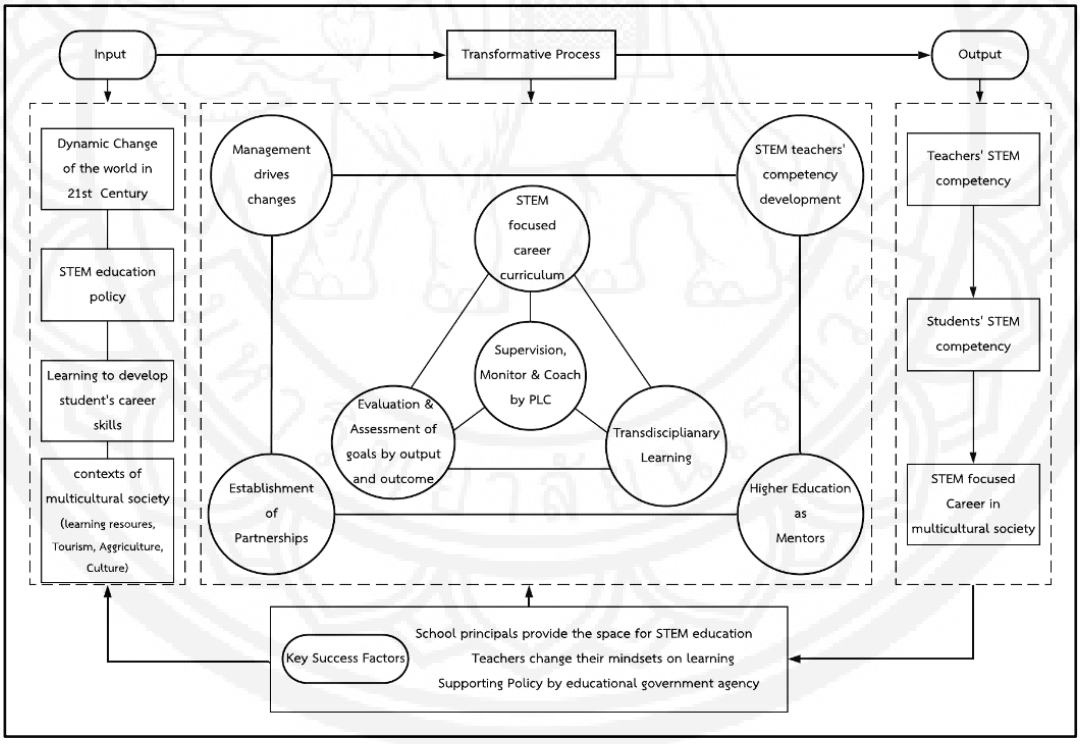


**Figure 2** The Learning Management Model with STEM-focused Careers for Students in a Multicultural Society.

**Inputs**

Inputs were related to the learning management process. They included dynamic changes in the world, STEM education-driven policy, the development of students' career skills, and multicultural societal contexts (learning resources, tourism, agriculture, and culture).

**Transformative Process**

The transformative process involved change management and learning management. Change management was the driving force behind school principals. It involved STEM teachers' competency development, higher education mentors, and development partnerships. In comparison, learning management was the driving process behind teachers. It involved STEM-focused career development, transdisciplinary learning management, evaluation and assessment of goals, and supervision, monitoring and coaching by PLC.

**Outputs**

Outputs reflected the change in teachers' STEM competency, students' STEM competency, and STEM-focused career activities in a multicultural society.

**Key Success**

Key success represented the most effective outcomes in the learning management of STEM-focused careers. Successes included the provision of space by school principles for STEM-focused careers to develop as interdisciplinary learning, teachers changing their minds about learning by having a growth mindset, and the promotion and support of policy by affiliated agencies.

**Research Objective 3**: To identify lessons that can be gleaned from the development of a learning management model with STEM-focused careers for students in a multicultural society.

The successful operation of learning management model with STEM-focused careers involved building the teachers' understanding of STEM education as an interdisciplinary concept and introducing STEM-focused careers to enhance the level of occupation available at the school. It also involved building collective knowledge between school principals, teachers, student teachers, and the research team through the participatory action research study. Additionally, it involved exchanging knowledge and experiences between in-service teachers and student teachers as a way for them to empower one another.

Several obstacles to development of learning management model with STEM-focused careers were identified. First, the policy driving STEM education was not systematic and lacks continuity. Second, there was a lack of systematic and continuous development of STEM teachers. Third, the opportunity to access media and resources was rare. Fourth, procurement/procurement regulations, materials, and equipment did not support the learning activities. Fifth, teachers' documentary workloads were enormous, which meant that most teachers had relatively little time to design learning activities for STEM-focused careers. Finally, there was inadequate supervision, monitoring, and coaching.

To address these barriers, we propose several recommendations. First, the school should raise awareness and adjust the growth mindset of school principals, teachers, and parents. Teachers' competency should be emphasized, and competency-based concepts should be applied in learning management and evaluation measures. Networked partnerships should be established. Second, the Office of the Educational Service Area should establish a driving center for STEM education to develop and increase the number of professional supervisors with knowledge and expertise in STEM education. Moreover, there should be budget allocation and freedom for the schools to purchase and procure equipment and materials as appropriate for the activities designed and developed by the schools. Learning exchange activities should also be organized by the Office of the Educational Service Area.

## Discussion

According to the perspectives of system theory by exploring the interacting and interrelated elements, the developed learning management model with STEM-focused careers for students in a multicultural society was based on four essential elements: inputs, transformative process, outputs, and key success.

**Inputs**

The research results indicated that inputs consisted of dynamic changes in the world, STEM education-driven policy, the development of students' career skills, and multicultural societal contexts. This was consistent with the research of Grimes, Arrastía-Chisholm, & Bright (2019), who found that three themes about STEM-focused career development emerged from interviews conducted with school counselors, namely, a lack of opportunities and resources, challenging local impact, and ideas for much needed place-based innovations. Several key players were considered to have the ability to increase and improve STEM advising among rural students. For example, practicing school counselors could provide intentional career counseling efforts to rural families, and counselor educators could provide rural field placements and assignments that emphasize rural students' career needs. Rural communities could also combine local business and industry with the school counselor's efforts to increase and emphasize STEM career awareness among students and their families.

Our findings also relate to those of Nuangchalerm (2018), who stated that the revolution of information technology has been influenced by the social and cultural contexts of the 21st century, leading to rapid knowledge expansion and transfer into society. Students must adapt themselves to search for knowledge, access information, and gain various experiences. The concept of instructional practices also requires updating and compatibility with changing learning environments. Additionally, students should be able to integrate acquired knowledge with their real lives and to think, act, solve problems, and live in society peacefully. STEM education is a holistic approach that balances learning and responsibility for constructing a body of knowledge through thinking, doing, evaluating, and concluding to gain an understanding of the concept.

**Transformative Process**

The transformative process involved change management and learning management. As mentioned previously, change management was the driving process behind school principals. It involved STEM teachers' competency development, higher education mentors, and development partnerships. Pongchai & Xupravati (2019) suggest that a school's operational concept in organizing STEM education consists of five areas: 1) STEM education curriculum designed as a structural determination process, 2) Promotion and support for human resource development in STEM education with an analysis of the readiness for organizing STEM education activities among personnel, 3) Support of STEM education facilities, 4) Allocation and management of STEM education budgets, 5) Public relations and building cooperation in STEM education to disseminate the school's learning management to those who are interested.

In comparison to change management, learning management is the driving process behind the teachers. It involves STEM-focused career development, transdisciplinary learning management, evaluation and assessment of goals, and supervision, monitoring, and coaching by PLC. Kedthongma, Srijumnong, & ArdKaew (2018) summarized the self-improvement approach of teachers in learning management according to the STEM guidelines as integration. The teachers should jointly design courses and organize teaching and learning activities. Students should be involved in designing learning activities to meet their needs. This can be difficult for older generation teachers because STEM education is a modern concept that they need to be educated in. The instructional

management of STEM education in various fields consists of training in teaching techniques and writing a workshop plan at least once a year. Moreover, there should be an exchange of knowledge in PLC into the STEM camp, and there should be supervision and teaching materials to promote internal and external learning sources. Training should be provided to educate teachers and students about the physical assessment method, to provide opportunities to participate in practice camps, to create authentic measurement tools and rubrics, and to determine the effectiveness of the tools. Administrators should supervise training on the use of social media for knowledge seeking to guide the teachers' self-development, evaluation, and assessment according to authentic conditions.

**Outputs**

Outputs reflected the change in teachers' STEM competency, students' STEM competency, and STEM-focused career activities in a multicultural society. This was in line with Chamrat (2019), who concluded that the essential goals of teacher development are that teachers must design and create lessons or learning activities based on STEM education on their own so that the knowledge, skills, and attributes become ingrained in their minds. Even if there is a change in teaching science or if a future learning reform takes place, the teachers will still be able to apply this competency to design learning management through new educational management processes or concepts to cope with the changes.

These changes in light of teaching and learning science will occur by linking STEM to life, the economy, and society. This conclusion is in accordance with that of Sanguankhruea & Julsuwan (2020), who suggest that the components and indicators of teacher competency in proactive learning management in accordance with STEM education guidelines have five elements: 1) teachers' knowledge about STEM education goals, 2) the STEM education curriculum, 3) understanding their students, 4) STEM education teaching strategies, and 5) learning assessment.

**Key Success**

The research results indicated that key success represented the most effective outcome in the learning management of STEM-focused careers. Successes included school principals opening areas for the development of interdisciplinary learning management, consistent with Khwana & Khwana (2019) research that concluded that school principals are key to successful change. STEM learning management requires professional principals who are able to manage strategically. They are scholars focused on developing the teaching and learning process, allowing all parties to participate in thinking and management. They build good relationships between families, communities, and education, and pay attention to the changes for development. They are dynamic leaders who are ready to develop their profession to keep pace with the changes. Moreover, they are ready to coordinate and work collaboratively with all departments to support instruction and provide opportunities for outsiders to become involved in the schools.

Adjustment of the teachers' mindset in learning management is in accordance with the research of Wiwanthamongkon (2018), who revealed that teacher development must begin according to the development concept of faith and the creation of belief in the initiation process, with activities or increased self-awareness and roles that enable learning to be clear and beneficial to all parties. This includes the teacher development division, which must create various types of manuals to implement the teachers' professional community learning process which follows the implementation steps and is effective at the educational and classroom level. This is in line with Ladachart, Phothong, Rittikoop, & Ladachart (2019) study, which mentioned that although many teachers agree with STEM education, they have concerns when conducting new teaching and learning practices. In this regard,

the introduction of the STEM education policy has challenged several teachers to leave their comfort zones. These teachers must be supported by teacher professional development. Development should focus on 1) participating in and practicing engineering design, 2) recognizing a model for promoting learning through engineering design, 3) reflecting on engineering design as both a learner and teacher, 4) recognizing differences and connections between different disciplines, and 5) realizing that engineering design is a social process. These professional developments may improve concerns and prepare teachers for more STEM-based teaching and learning practices.

In terms of the promotion of and support for the policy by the affiliated agencies, it must be clear and continuous. This is compatible with the research of Chaemchoy & Usaho (2012), which suggested that the Ministry of Education should set policies for affiliated agencies to cooperate in managing cycle classes to provide all students with the opportunity to develop professional skills. This is consistent with Apaijai (2018), who concluded that affiliated agencies have to support the policy and external organizations regularly, which is also in line with Tungputthipong & Piromsombat (2017). They summarized the policy guidelines for driving the STEM education policy of stakeholders. The process should be as follows: 1) Clarify the goals of STEM education, provide the complete details of the action plan, and clarify the responsibilities for those involved at each level to acknowledge and enable all levels of people to understand and act collaboratively, 2) Plan the systematic operation, including preparation of STEM education trainers, course preparation for STEM education, preparation of the STEM education centers and network schools, preparation of assessors, supervisors, and coaches, and budget preparation, 3) Summarize operational performance, achievement, obstacles, and problems, 4) Analyze success, obstacles, and problems that arise and adjust the operating direction accordingly. Follow up continuously.

## Recommendations

From the key research results and discussion, there are recommendations for research implementation in both policy level and school level as follows:

**Policy Level**

1. The Faculty of Education should improve the preservice teacher curriculum by fostering knowledge, skills, and STEM characteristics in every new teacher. This includes developing the STEM skills of in-service teachers because this can help enhance the STEM skills of students, in particular, helping them recognize the connection between STEM and everyday life.

2. Affiliated educational agencies should allocate budgets to promote the management of STEM learning. They should provide schools with the freedom to purchase and procure the materials and equipment required for the activities designed and developed by the schools, not a set of equipment purchased or sourced from the center. This involves building understanding and developing STEM capabilities among school principals and supervisors to supervise teachers in the development of STEM skills.

**School Level**

1. Schools should raise awareness and adjust the mindset of school principals, teachers, and parents in the management of STEM education. All teachers must have a growth mindset and believe that students will learn and be able to create innovation, as innovation ultimately helps drive the country's economy and defeats the middle-income trap.

2. Teacher competency should be worked on continuously during the first phase of development. Weekly workshops can be organized. Teachers can learn from good practice, discuss matching development, and work with a mentor. Although the change will be slow, everyone must be convinced that positive change is possible.

3. Network partnerships should be developed with local government organizations, higher education institutions, and the private sector to implement STEM learning management that focused the STEM professions and careers. Each sector should help support expertise in each area by providing academic mentoring or budget support for learning management, for example.

**Recommendations for Future Research**

1. Further research should be conducted on the model of STEM teacher competency development and how it relates to students because, in driving STEM learning, the focus is primarily on the quality of the teachers. However, most in-service teachers still lack a sufficient understanding of STEM. The current development of STEM teachers is based on undeveloped programmed activities. Therefore, teachers have not yet developed the essential competencies and have no concept of the benefit of teaching students how to be innovative creators.

2. Guidelines for curriculum development and learning management design that are consistent and connected with the lifestyle of the students should be developed. Since current learning management is based on the Basic Education Core Curriculum, BE 2551, divided by subject areas, it still lacks the integration of the body of knowledge. Therefore, it is necessary to further develop STEM-focused careers.

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