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Heuristic Evaluation in Practicing STEM Education Administrative Model for Extra-large Sized Secondary Schools: A Fieldwork Approach

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Abstract

The study aimed to verify a STEM education administrative model for extra-large sized secondary schools in Thailand using heuristic evaluation. A total of eight evaluators were selected to participate in heuristic evaluation to verify the model in terms of its suitability, possibility, and usefulness. A multi-case study was employed using a fieldwork approach to evaluate the quality of the STEM education administrative model. The research tool was a set of established usability principles to evaluate the overall quality of the STEM education administrative model in three facets, namely suitability, possibility, and usefulness. A five-point Likert scale assessment document was used as a tool to measure the evaluators' interpretations ranging from minimal to most appropriate levels. The overall findings showed that all the six factors of STEM education administrative model were found most appropriately practiced in terms of usefulness with mean score range from 4.93 to 4.95, suitability with mean score range from 4.79 to 4.84, and possibility with mean score range from 4.77 to 4.89.

Keywords: *Extra-large Sized Secondary Schools, Fieldwork Approach, Heuristic Evaluation, STEM Education Administrative Model*

INTRODUCTION

Science, Technology, Engineering, and Mathematics (STEM) education is highly popular and prioritized worldwide due to several compelling reasons. The strengths of STEM education are its alignments with the global demand for skills that drive innovation, economic growth, and solutions to complex global challenges (Geesa et al., 2021). Therefore, STEM administrative model is expected to equip students with essential knowledge and skills in order to prepare them to tackle complex challenges in an increasingly technological and interconnected world (Geesa et al., 2021). Many governments include Thailand have launched national strategies and policies to promote STEM education. For example, Office of the Secretariat of Education (2020) emphasized research and innovation, with substantial investment in STEM fields as educational reforms and policies, aiming to prepare students for the demands of the modern workforce, where proficiency in STEM subjects is increasingly valued across various industries since 2012.

There is a need to have a STEM education administrative model for extra-large sized school administrators because it is not only can establish a clear vision and mission that aligns with school's overall goals but also develop a strategic plan that outlines short-term and long-term goals for STEM programs (Petrosino et al., 2020). The administrative practices for general education in secondary schools are to form a dedicated team or committee that oversees STEM initiatives, including administrators, educators, and industry partners (Petrosino et al., 2020). This STEM leadership team create policies that support STEM education, including curriculum standards, teacher qualifications, and resource allocation (Office of the Secretariat of Education, 2020).

Teachers are required to develop an interdisciplinary curriculum that integrates science, technology, engineering, and mathematics, so-called integrated curriculum. Moreover, teachers are encouraged to promote the use of innovative teaching methods, such as project-based learning, inquiry-based learning, and experiential learning. Therefore, school administrators have to provide on-going professional development for teachers to enhance their STEM teaching skills (Kelley & Knowles, 2016). In addition, school

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administrators should collaborate with local businesses, industries, and higher education institutions to provide real-world experiences and mentorship opportunities for students. School administrators should also engage with the community to raise awareness about the importance of STEM education and to gain support initiatives (Geesa et al., 2021).

A total of three sets of soft skills are highly emphasized in STEM education, namely critical thinking and problem-solving, collaboration and teamwork, and adaptability and lifelong learning as 21st Century Skills. STEM education emphasizes analytical thinking and the ability to approach and solve complex problems systematically. Many STEM projects and activities require teamwork, helping students develop collaboration and communication skills. STEM fields are constantly evolving, and STEM education encourages adaptability and continuously learning vital for success in a rapidly changing world (Mumcu et al., 2023).

Following this line of reasoning, STEM education's popularity in international education reflects its essential role in preparing students for the 21st century, driving economic growth, and addressing global challenges. Consequently, Thailand Ministry of Education aims to build a workforce capable of innovation and adaptation in a rapidly changing world by emphasizing STEM education. The National Education of Thailand focuses on STEM education to ensure that students are equipped with the skills necessary to contribute to and thrive in the modern economy (Wangsa et al., 2024).

PRELIMINARY STUDY REPORT

The researchers would like to report the final phase of this study using heuristic evaluation to test the developed STEM education administrative model in the first and second phases of the study. Wongsa et al. (2024) developed a STEM Education Administrative Model focusing on the effective administration and management of STEM programs in extra-large size secondary schools in Thailand. This model encompasses six factors and 18 indicators to ensure the successful implementation, sustainability, and continuous improvement of STEM education in terms of strategies, structure, and practices (Wongsa et al., 2024).

The findings derived from the first phase using document analysis have successfully identified six essential factors of STEM educational administration needed by extra-large sized schools in Thailand, namely (i) Setting STEM educational policies (PF); (ii) Teacher development in STEM education (TD); (iii) Development of an integrated learning curriculum (IL); (iv) Creation of a STEM educational cooperation network (CN); (v) Supervision and evaluation of STEM education (SE), and (vi) Innovative leadership (IL) (Wongsa et al., 2024). This was followed by the 11 experts to determine a cut-off point that was a mean score of more than 3.00, and less than 20 percent as the coefficient of scattering, to create the 18 indicators on the foundation of prevailing studies related to the STEM educational administration (Wongsa et al., 2024).

The 18 indicators were found in the first phase of the study: (i) Setting STEM educational policies (PF) factor has three indicators, namely setting objectives of STEM education policies (PF1), setting goals and guidelines of STEM educational policies (PF2), and supervising, monitoring, and evaluating of STEM educational policies (PF3). (ii) Teacher development in STEM education (TD) factor has three indicators, such as STEM education knowledge training (TD1), creating a professional learning community (TD2), and motivation (TD3). (iii) Development of an integrated learning curriculum (IL) factor provides three indicators, that are determining objectives of integrated curriculum (IL1), integrated curriculum design (IL2), and integrated curriculum evaluation (IL3). (iv) Creation of a STEM educational cooperation network (CN) factor specifies three indicators, namely cooperation between network partners (CN1), creating a platform for knowledge exchange (CN2), and publication of best practice results (CN3). (v) Supervision and evaluation of STEM education (SE) factor contributes three indicators such as administering supervisory planning on STEM education (SE1), administering supervisory process on STEM education (SE2), and evaluating STEM education supervision (SE3). (vi) Innovative leadership (IL) factor forms three indicators, namely vision of change (IL1), creative and innovative thinking (IL2), and creating an organizational atmosphere of innovation (IL3).

In the second phase of the study, Wongsa et al. (2024) utilized quantitative survey design to 480 respondents consisting of principals and teachers to develop a STEM education administrative model. This model used the identified six factors and 18 indicators by arranging them in a logical manner to reflect their interrelationships. As a result, this model has successfully provided a comprehensive and structured overview of the ethical considerations relevant to STEM educational administration within Wongsa et al.'s (2024) selected scope. The findings of Pearson correlation coefficients were used to assess the linear relationships between pairs of 18 indicators.

The Pearson correlation findings showed that the magnitude of the correlation coefficients ranged from 0.426 to 0.805 revealing the strengths of the relationships from moderate to strong, with values closer to 1 representing a stronger correlation and all the relationships are statistically significant at 0.01 level. Subsequently, findings indicated that the relationship between administering supervisory planning on STEM education (SE1) and publication of best practice results (CN3) ($r = .805$; $r<.01$) was the highest magnitude of the correlation coefficient. However, the lowest magnitude of the correlation coefficient was STEM education knowledge training (TD1) and integrated curriculum design (IL2) ($r = .426$; $p<0.01$) (Wongsa et al., 2024).

The ultimate findings of the second phase were to accomplish estimates of the parameters of the STEM education administrative model, the validity of the identified factors and their factor loading of the STEM educational administration. Factor loading means the 'relative importance' of the identified indicators that collectively form a specifically identified factor in the STEM education administrative model of extra-large size secondary school administrators that were considered. The co-variance with the STEM educational administration factors ranged from 71.30 to 98.40 percent while the factor loading of all the STEM educational administration factors were ranged from 0.844 to 0.992 and was statistically significant at 0.01. The factor with the highest factor loading value was development of an integrated learning curriculum. This was followed by teacher development in STEM education, supervision and evaluation of STEM education, setting STEM educational policies, and innovative leadership. The factor that has the least capacity factor loading value was creation of a STEM educational cooperation network. Consequently, the researchers concluded that all the identified factors are found to be important constructs of STEM educational administration for extra-large size secondary school administrators in northeast region of Thailand. The findings of goodness of fit indicated that the STEM education administrative model fits between the obtained values of collected data and the expected values as follows: $\chi^2 = 77.869$, $df = 63$, p-value = 0.098, CFI = 0.998, TLI = 0.995, RMSEA = 0.022, and SRMR = 0.022. After referring to the experts' (Byrne, 1998; Hu & Bentler, 1999; Ullman, 2001) rules of thumb and their recommended cut-off values, the researchers concluded that the associated real values are fitting to the expected values in the STEM education administrative model (Wongsa et al., 2024).

MATERIALS AND METHODS

Research Design

The researchers employed multi-case study research design to test the STEM education administrative model for extra-large sized secondary school model. This research design using fieldwork approach as an effective approach for testing the implementation and the impact of the model. The two cases were chosen because these extra-large sized secondary schools have selected as excellent schools under STEM Education Cooperation Project between Thailand and Singapore from 2020 to 2022. Therefore, these two cases could provide an in-depth analysis of its implementation and impact within a real-world context. Besides, the researchers intended to identify best practices, challenges, and outcomes associated with the model's use (Gay et al., 2011). Fieldwork was found effective because the researchers could observe and assess the practical implementation and outcomes of the STEM education administrative model.

Case and Fieldwork Site Selection

The researchers chose two extra-large sized schools from two provinces in northeastern region of Thailand, namely Surin and Sisaket provinces that are representative and particular relevant for this study due to these two schools were awarded as centers of excellence under STEM Education Cooperation Project from 2020 to 2022. The researchers also considered other factors such as school size, demographics, existing STEM programs, and their commitment to STEM education initiatives. The researchers chose multiple cases which allowed for comparisons and broader generalizations (Gay et al., 2011). A total of eight evaluators were selected consisting of a school director, a deputy director, an academic administrator, a head of academic administration, and four teachers who are responsible for STEM education practices in these two schools.

Research Tool and Data Analysis

Heuristic evaluation was employed by researchers to identify usability problems in a user interface design using a usability inspection method. It involved the eight evaluators to examine the interface and judge its compliance with recognized usability principles, so-called heuristics. This method was found valuable in this study as it could be applied to the evaluation of STEM education tools and resources while the practitioners in the two schools were utilizing the STEM education administrative model.

The researchers used a set of established usability principles, such as Nielsen's (1994) 10 heuristics, which including visibility of the model status, matched between model and real-world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency use, aesthetic and minimalist design, helped users recognized, diagnosed, and recovered from errors, and documentation. After the researchers revised the heuristic evaluation ideas of Stufflebeam (in Kanjanawasi, 2011) to evaluate the overall quality of the STEM education administrative model in three facets, namely suitability, possibility, and usefulness by eight evaluators. A five-point Likert scale assessment document was used as a tool to measure the evaluators' interpretations ranging from minimal to most appropriate levels. Table 1 presents the five appropriate levels which were clarified according to the mean score range.

Table 1: Clarification of Appropriate Level Based on the Average Score Range

Average Score Range	Interpretation
1.00 – 1.49	Minimal appropriate
1.50 – 2.49	Less appropriate
2.50 -3.49	Medium appropriate
3.50 – 4.49	Very appropriate
4.50 – 5.00	Most appropriate

The researchers established a set of heuristic based on best practices and standards in educational administration and STEM education. These might include principles like flexibility, scalability, user friendliness, alignment with educational goals, and effectiveness in resource management. Each evaluator reviewed the model independently against the predefined heuristics. They identified any areas where the model did not meet the criteria or could be improved. Finally, the researchers collected the eight evaluators' feedback, noting any recurring issues or suggestions as compilation of findings.

FINDINGS AND DISCUSSION

The heuristic evaluation findings are based on the quality of the STEM education administrative model in its suitability, possibility, and usefulness as reported by eight evaluators. The feedback was analyzed to identify common themes and critical areas for improvement. Based on this analysis, the model was refined and adjusted to better meet the heuristics.

Findings of Heuristic Evaluation in terms of Format for STEM Education Administrative Model

The eight evaluators reported that the STEM education administrative model for extra-large sized secondary school administrators was at the most appropriate levels in terms of its suitability, possibility, and usefulness for issues such as title, objective, and principles and concepts. Table 2 shows that all evaluators strongly agreed the title of the model in terms of its suitability, possibility, and usefulness. In addition, the findings indicated that the objective as well as principles and concepts are found at the same levels of appropriateness with mean score 4.86 and 4.71 respectively. However, the principles and concepts and objective of the model were evaluated as mean score 4.86 and 5.00 respectively. Table 2 illustrates the details of heuristic evaluation of format for STEM education administrative model.

Table 2: The Heuristic Evaluation of Format for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	**Title**: STEM Education Administrative Model for Extra-large Size Secondary Schools	Suitability	5.00	0.00	Most appropriate
		Possibility	5.00	0.00	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
2.	**Objective**: To serve as guidelines to develop quality learning management of STEM education for extra-large sized schools.	Suitability	4.86	0.38	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
3.	**Principles and Concepts**: Methods and practices to manage STEM education focusing on students possess the 21st Century skills.	Suitability	4.86	0.38	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	5.00	0.00	Most appropriate

Findings of Heuristic Evaluation in terms of Setting STEM Educational Policies Factor and its Indicators for STEM Education Administrative Model

The findings showed that usefulness of the setting STEM educational policies factor has highest mean scores for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. For example, the highest score was the usefulness (mean score = 5.00; *SD* = 0.00) for setting objectives of STEM educational policies (PF1) indicator compared to its possibility (mean score = 4.86; *SD* = 0.38) and suitability (mean score = 4.71; *SD* = 0.79) respectively and at the most appropriate level. On the other hand, supervising, monitoring, and evaluating of STEM educational policies (PF3) indicator was found having the same mean score (4.86) in terms of its suitability, possibility, and usefulness. The least capacity was setting goals and guidelines of STEM educational policies (PF2) indicator in terms of suitability and usefulness (mean score = 4.71; *SD* = 0.53) and possibility (mean score = 4.57; *SD* = 0.53). Table 3 demonstrates the details of heuristic evaluation of setting STEM educational policies (PF) factor and its indicators.

Table 3: The Heuristic Evaluation of Setting STEM Educational Policies (PF) for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	Setting objectives of STEM educational policies (PF1)	Suitability	4.71	0.79	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
2.	Setting goals and guidelines of STEM educational policies (PF2)	Suitability	4.71	0.53	Most appropriate
		Possibility	4.57	0.53	Most appropriate
		Usefulness	4.71	0.53	Most appropriate
3.	Supervising, monitoring, and evaluating of STEM educational policies (PF3)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate

		Usefulness	4.86	0.38	Most appropriate
	Total	Suitability	4.80	0.44	Most appropriate
		Possibility	4.77	0.42	Most appropriate
		Usefulness	4.93	0.26	Most appropriate

Findings of Heuristic Evaluation in terms of Teacher Development in STEM Education (TD) Factor and its Indicators for STEM Education Administrative Model

The findings showed that usefulness of the teacher development in STEM education (TD) factor has highest mean scores for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. Consequently, only creating a professional learning community (TD2) indicator possess maximum values for the three predefined heuristics, namely suitability, possibility, and usefulness (mean score = 5.00; *SD* = 0.00). On top of that, STEM education knowledge training (TD1) indicator was found having the same mean score (4.86) in terms of its suitability and possibility. The least capacity was motivation (TD3) indicator in terms of suitability and possibility (mean score = 4.71; *SD* = 0.49) but usefulness (mean score = 4.86; *SD* = 0.38). Table 4 presents the details of heuristic evaluation of teacher development in STEM education (TD) factor and its indicators.

Table 4: The Heuristic Evaluation of Teacher Development in STEM Education (TD) Factor for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	STEM education knowledge training (TD1)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
2.	Creating a professional learning community (TD2)	Suitability	5.00	0.00	Most appropriate
		Possibility	5.00	0.00	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
3.	Motivation (TD3)	Suitability	4.71	0.49	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
	Total	Suitability	4.84	0.37	Most appropriate
		Possibility	4.84	0.37	Most appropriate
		Usefulness	4.94	0.23	Most appropriate

Findings of Heuristic Evaluation in terms of Development of an Integrated Learning Curriculum (IL) Factor and its Indicators for STEM Education Administrative Model

The findings showed that usefulness of the development of an integrated learning curriculum (IL) factor has same mean scores (mean score = 4.86; *SD* = 0.38). for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. Consequently, integrated curriculum evaluation (IL3) and determining objectives of integrated curriculum (IL1) were found having the same mean scores 5.00 and 4.71 in terms of their suitability and possibility respectively. The least capacity was integrated curriculum design (IL2) indicator in terms of suitability and possibility (mean score = 4.57; *SD* =

0.53) respectively. Table 5 elucidates the details of heuristic evaluation of integrated learning curriculum (IL) factor and its indicators.

Table 5: The Heuristic Evaluation of Development of an Integrated Learning Curriculum (IL) Factor for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	Determining objectives of integrated curriculum (IL1)	Suitability	4.71	0.49	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
2.	Integrated curriculum design (IL2)	Suitability	4.57	0.53	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
3.	Integrated curriculum evaluation (IL3)	Suitability	5.00	0.00	Most appropriate
		Possibility	5.00	0.00	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
	Total	Suitability	4.73	0.47	Most appropriate
		Possibility	4.79	0.41	Most appropriate
		Usefulness	4.94	0.24	Most appropriate

Findings of Heuristic Evaluation in terms of Creation of a STEM Educational Cooperation (CN) Factor and its Indicators for STEM Education Administrative Model

The findings showed that the creation of a STEM educational cooperation (CN) factor has highest mean scores for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. Moreover, the other two indicators such as cooperation between network partners (CN1) indicator and creating a platform for knowledge exchange (CN2) indicators were found having the same mean score (4.86) and standard deviation (0.38) in terms of their suitability and possibility. Only publication of best practice results (CN3) indicator has been evaluated at mean score (4.71) and standard deviation (0.49). Table 6 demonstrates the details of heuristic evaluation of creation of a STEM educational cooperation (CN) factor and its indicators.

Table 6: The Heuristic Evaluation of Creation of a STEM Educational Cooperation (CN) Factor for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	Cooperation between network partners (CN1)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
2.	Creating a platform for knowledge exchange (CN2)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
3.	Publication of best practice results (CN3)	Suitability	5.00	0.00	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
	Total	Suitability	4.84	0.37	Most

					appropriate
		Possibility	4.84	0.37	Most appropriate
		Usefulness	4.98	0.13	Most appropriate

Findings of Heuristic Evaluation in terms of Supervision and Evaluation of STEM Education (SE) Factor and its Indicators for STEM Education Administrative Model

The findings showed that the supervision and evaluation of STEM education (SE) factor has highest mean scores for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. Moreover, the administering supervisory process on STEM education (SE2) and evaluating STEM education supervision (SE3) were found having the same mean score (4.86) in terms of its suitability and possibility at the most appropriate level. The least capacity was administering supervisory planning on STEM education (SE1) indicator in terms of suitability, possibility, and usefulness (mean score = 4.57; *SD* = 0.53), (mean score = 4.71; *SD* = 0.49), and (mean score = 4.86; *SD* = 0.38) respectively. Table 7 elucidates the details of heuristic evaluation of supervision and evaluation of STEM education (SE) factor and its indicators.

Table 7: The Heuristic Evaluation of Supervision and Evaluation of STEM Education (SE) Factor for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	Administering supervisory planning on STEM education (SE1)	Suitability	4.57	0.53	Most appropriate
		Possibility	4.71	0.49	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
2.	Administering supervisory process on STEM education (SE2)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	4.86	0.76	Most appropriate
3.	Evaluating STEM education supervision (SE3)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
	Total	Suitability	4.79	0.41	Most appropriate
		Possibility	4.84	0.37	Most appropriate
		Usefulness	4.93	0.26	Most appropriate

Findings of Heuristic Evaluation in terms of Innovative Leadership (IL) Factor and its Indicators for STEM Education Administrative Model

The findings showed that the innovative leadership (IL) factor has highest mean scores for all the three indicators in terms of usefulness compared to the other two predefined heuristics such as suitability and possibility. Moreover, the creating an organizational atmosphere of innovation (IL3) and creative and innovative thinking (IL2) indicators were found having the same mean score as (4.86) and (4.71) in terms of its suitability and possibility at the most appropriate level respectively. Table 8 elucidates the details of heuristic evaluation of innovative leadership (IL) factor and its indicators.

Table 8: The Heuristic Evaluation of Innovative Leadership (IL) Factor for STEM Education Administrative Model

No.	Issues	Assessment	$\bar{x}$	*SD*	Interpret
1.	Vision of change (IL1)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.71	0.38	Most appropriate
		Usefulness	4.86	0.38	Most appropriate
2.	Creative and innovative thinking (IL2)	Suitability	4.71	0.38	Most appropriate
		Possibility	4.71	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
3.	Creating an organizational atmosphere of innovation (IL3)	Suitability	4.86	0.38	Most appropriate
		Possibility	4.86	0.38	Most appropriate
		Usefulness	5.00	0.00	Most appropriate
	Total	Suitability	4.84	0.37	Most appropriate
		Possibility	4.89	0.32	Most appropriate
		Usefulness	4.95	0.21	Most appropriate

CONCLUSION

According to the findings, the researchers concluded that there are several benefits of practicing this STEM education administrative model in extra-large sized secondary schools in Thailand such as enhanced student engagement, improved academic performance, preparation for future careers, and increased innovation. Students are found more engaged and motivated by integrating STEM into the curriculum and providing hands-on learning experiences. Moreover, students often perform better academically when they are actively engaged in STEM learning activities. Furthermore, a strong STEM education prepares students for careers in high demand fields such as technology, engineering, and healthcare. Finally, promoting a culture of innovation within schools can lead to new ideas and approaches that benefit both students and educators.

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