



Student Engagement in Medical Research Curriculum Development Strategies: A Comprehensive Approach Utilizing Mixed-Methods Study and SWOT-TOWS-AHP Analysis

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Abstract

Introduction Student engagement in medical curriculum development has become increasingly important, yet structured frameworks for decision-making and prioritizing strategies remain limited. This study demonstrates an approach integrating student representatives into strategy development to enhance engagement in medical research (MR) curriculum design and highlights students' perspectives on MR.

Methods A mixed-methods study was conducted with 262 clinical year medical students and intern doctors. Participants completed a questionnaire on practices, perceptions, attitudes, motivations, and barriers related to MR. Focused group discussions evaluated beliefs towards MR and the faculty's strengths, weaknesses, opportunities, and threats. Thematic analysis was performed. Strategies were developed using the TOWS matrix, and student representatives ranked the strategies using the analytic hierarchy process (AHP).

Results MR is perceived as complex and nonessential, yet its benefits in career development, patient care, and knowledge advancement are well-recognized. The chance to pursue research on personally interesting topics motivates student engagement in MR. However, curriculum overload has emerged as a significant barrier. The opportunity-strength strategy received the highest priority score of 0.33. The preferred sub-strategy involves establishing a centralized communication and coordination system to connect expert professors in both pre-clinical and clinical medical fields, both within and outside the institution, thereby enhancing the diversity of available mentors (priority score = 0.12).

Conclusion To address curriculum overload, a centralized communication system and coordination between students and experts are necessary. Additionally, cultivating time management skills is essential. Involving students in curriculum development ensures that their perspectives and needs are considered, leading to the creation of insightful strategies.

Keywords Student engagement · SWOT · Analytic hierarchy process · Medical research · Curriculum development

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Abbreviations

| | |
|-----|-------------------------------------|
| MR | Medical research |
| IQR | Interquartile range |
| PCM | Phramongkutklao College of Medicine |
| AHP | Analytic hierarchy process |

Introduction

“Student Engagement in Schools” is a key aspect of the ASPIRE-to-Excellence initiative, initiated by the Association for Medical Education in Europe (AMEE) since 2012 to acknowledge and reward exceptional teaching practices [1]. Students could collaborate with faculty members across all academic domains, including research, teaching,

governance, and curriculum development [2]. Moreover, actively incorporating student voices and involving student representatives in curriculum design and development offers valuable insights into student thinking, learning, and decision-making processes [3]. This input can guide the ongoing enhancement of teaching methods and materials, tailoring them to each medical school's specific context [4].

Health-related research has consistently gained significance and has been widely promoted [5, 6]. However, there continues to be a global shortage of medical researchers despite the growing demand for them [7]. Over the past three decades, the proportion of medical researchers has sharply declined [8, 9]. Thus, the AMEE produced a guide titled "Developing Research Skills in Medical Students," which recommends that every medical student understand research methods and the research benefits to address this challenge [9, 10]. This guide concluded that encouraging students' active participation in research activities can greatly enhance their understanding of research [10].

Various studies have explored the attitudes, practices, knowledge levels, perceptions, motivations, and barriers related to research among medical and science students [11–18]. These factors are known to mediate engagement, as researchers are motivated to conduct studies based on their beliefs [19, 20]. This aligns with Self-Determination Theory, which posits that individuals are more likely to sustain behavior when driven by internal sources of motivation, such as their attitudes and perceptions, rather than external incentives [21]. Self-Determination Theory emphasizes fostering three core psychological needs—autonomy, competence, and a sense of belonging—for optimal motivation. Involving students in curriculum development for medical research (MR) enhances these needs, empowering them to take ownership of the process, build their skills, and deepen their engagement in MR activities [22, 23].

Previous frameworks often view students as customers or external stakeholders in university education rather than as team members [22]. Studies have shown that involving students in curriculum renewal teams and expanding their roles beyond traditional feedback—such as conducting literature reviews, writing reports, and proposing new courses—fosters their professional growth. This collaborative approach not only enhances students' development but also creates a more inclusive and comprehensive curriculum design process [24, 25]. This is supported by previous research that successfully incorporated students as a primary stakeholder in program renewal [26], as well as medical curriculum development and evaluation [27]. Additionally, structured platforms for student engagement in curriculum evaluation and design enhance their awareness of academic medicine and interest in research careers [28]. Nevertheless, previous strategies and frameworks may lack detailed rankings of feedback strengths and weaknesses, making it challenging

to prioritize new curriculum designs from the student's perspective [22].

Identifying the curriculum's strengths and weaknesses necessitates using an appropriate educational evaluation tool. Program evaluation frameworks have traditionally been categorized into systematic or naturalistic and decision-oriented or value-oriented approaches [29]. The Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis, known for its structured, systematic, and decision-oriented methodology, is remarkably adaptable for including student engagement in decision-making [30]. Furthermore, utilizing the TOWS matrix helps develop strategies to address weaknesses and threats while enhancing strengths and opportunities. This process aligns with Transformative Learning theory, enabling students to critically reflect on past learning challenges and contribute to meaningful curriculum development [31]. However, prioritizing the strategy derived from the SWOT analysis remains a challenge.

The analytic hierarchy process (AHP), initially introduced by Thomas L. Saaty for decision-making and ranking strategies with multiple options, has gained widespread recognition [32–35]. This approach has been effectively incorporated into the SWOT matrix across diverse industries, providing significant advantages in prioritizing strategies derived from SWOT analysis [34–36]. These tools have proven valuable in strategic planning for managers and executives, enhancing strategic decision-making [36, 37]. However, to our knowledge, the tool has been limitedly applied in the context of medical education. Thus, engaging students in both strategy development and the prioritization of newly developed strategies through the AHP could enhance their sense of belonging, competence, and autonomy, consistent with Self-Determination Theory [38]. This approach fosters long-term engagement with the strategies and enables students to gain deeper insights into the decision-making process. Moreover, by allowing students to monitor the implementation of these strategies, the co-creation process is further strengthened for future iterations [25, 38].

When developing curriculum strategies, it is crucial to incorporate key aspects such as student-centered, problem-based, integrated, clinically authentic, elective-driven, and systematic approaches in alignment with the SPICES model [39]. This study employed an explanatory mixed-methods design to explore the mediators of medical research engagement from the students' perspective and enhance strategies for promoting research participation and publication among medical students. The objective was to examine the practices, attitudes, perceptions, barriers, and motivations of clinical year medical students and intern doctors who graduated from Phramongkutklao College of Medicine (PCM) toward conducting medical research. Furthermore, consistent with the SPICES model, the study aimed to leverage student-driven strategies to maximize medical research

improvement policies' effectiveness and clinical authenticity [4]. This was achieved through focus group interviews to assess the curriculum's SWOT. Finally, the SWOT-TOWS-AHP analysis incorporated input from both medical students and intern doctors, facilitating problem-based critical reflection and yielding deeper insights. Given that PCM students enter directly from high school and may lack prior research experience, this systematic and structured framework is adaptable and well-suited to encourage and integrate student contributions effectively. The insights from this study could inform the development of a student-driven research curriculum framework and enhance the understanding of students' mediators of research engagement within medical schools of similar contexts.

Methods

Study Design and Subjects

The authors conducted an explanatory mixed-methods design and performed a SWOT-TOWS-AHP analysis to develop a student-driven strategy to improve further medical students' involvement in medical research at PCM. The flow of this study is illustrated in Fig. 1.

Quantitative Phase

A cross-sectional study was conducted at PCM, Bangkok, Thailand, using a self-administered survey. The survey was distributed to clinical year medical students, including

fourth-, fifth-, and sixth-year students and intern doctors who had graduated from PCM. The total number of clinical year medical students was 292, with approximately 250 interns. Both groups were enrolled in the same curriculum paradigm and could present and publish their research findings voluntarily. Notably, many publications emerged from projects conducted during their fourth and sixth years as medical students and internships.

Qualitative Phase

A focused group discussion (FGD) was conducted using purposive sampling to select clinical medical students and interns with previous extracurricular research experience. Eight groups, totaling 27 participants, were enrolled in the FGD, and semi-structured interviews were conducted. Each group consisted of 3–5 participants from the same year of education, with four groups of clinical year students and the remaining four groups of interns.

SWOT-TOWS-AHP Analysis

Twenty-seven representatives were invited, and 18 (66.7%) representatives with prior MR experiences, including poster presentations, oral presentations, or MR publications, responded to the survey regarding pairwise comparison of the strategies. The student representatives included in the study were chosen based on their experiences as student year leaders, cadet commanders, MR group leaders, or presidents of academic or research clubs. These positions were determined through voting by the medical

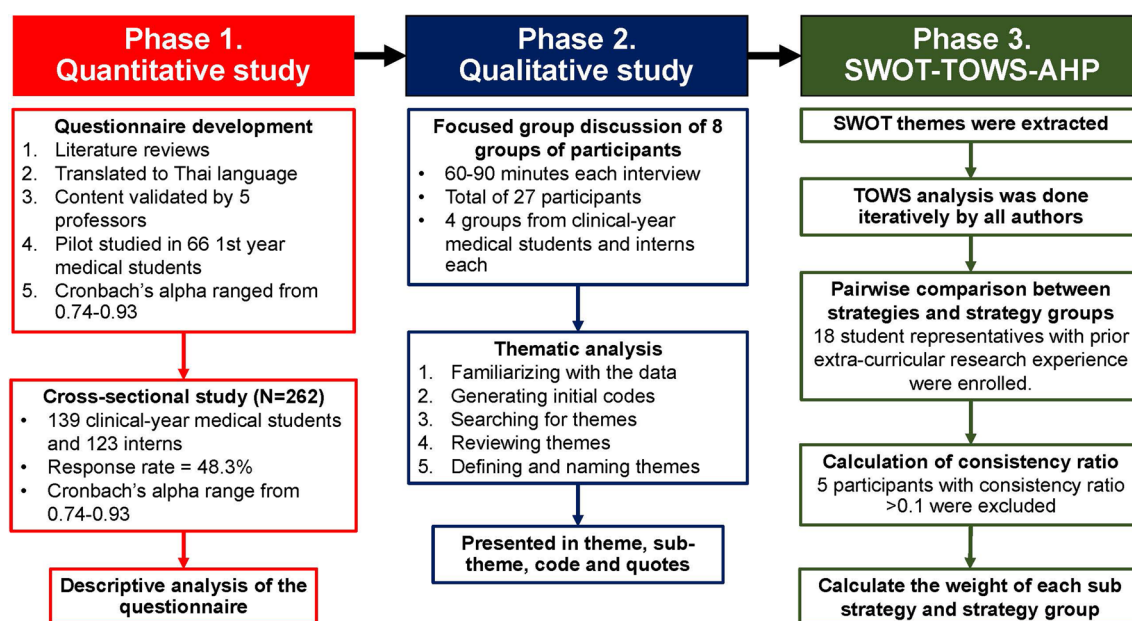


Fig. 1 The flow of study process

students, approved by the deans, and involved direct communication with the program director [40].

Phramongkutklao College of Medicine Medical Research Curriculum

The PCM curriculum spans 6 years: 3 pre-clinical years dedicated to studying basic sciences and 3 clinical years focused on developing clinical experiences. In three specific years of the curriculum (the third, fourth, and sixth years of medical school), an introductory module on MR is mandatory.

In the third year, medical students learn the fundamentals of MR, including basic study designs focusing on quantitative methods, data analysis, and research proposal development. Additionally, students gain insights into aspects of public health, including community participation. Moving on to the fourth year, students delve deeper into advanced study designs and focus on conducting their own research study. Fourth-year students are divided into eight groups, each consisting of approximately 12, to develop and finalize a community-based research proposal, which is then presented as a report. Finally, in the sixth year, medical students are organized into pairs or groups of three to conduct medical research to improve medical care in a community hospital setting. Their research findings are presented, and a manuscript report is submitted.

Data Collection

Quantitative Phase

We employed an electronic standardized questionnaire consisting of six parts—the first part comprised short-answer questions to collect demographic data. The rest consisted of a Likert scale questionnaire with five scores, addressing practices, perceptions, attitudes, barriers, and motivation toward MR. The questionnaire was based on relevant published works and the experience and context of PCM investigators. The detailed development, including the validity and reliability of the questionnaire, was published elsewhere [6].

Five expert professors reviewed the questionnaire to ensure content validity and reliability. Pilot testing was conducted among 66 first-year medical students, resulting in Cronbach's alpha scores ranging from 0.74 to 0.93. Subsequently, the questionnaire was distributed to the study population. The final Cronbach's alphas for practices, perceptions, attitudes, barriers, motivation, and overall questions were 0.83, 0.84, 0.74, 0.89, 0.88, and 0.93, respectively. Furthermore, the construct validity of the questionnaire revealed proper construct through confirmatory factor analysis [6].

Qualitative Phase

After analyzing the quantitative data, FGDs by SL and PS were conducted using a semi-structured interview format. Purposive sampling was employed to select clinical medical students and interns with prior extracurricular research experience, such as previous publications or international research presentations. This method enabled the collection of accurate, in-depth responses, as participants were able to provide comprehensive insights, ranging from attitudes toward research to the barriers they encountered [6]. The authors invited eligible participants to participate. The interviews included questions and probes to explore participants' perceptions of MR, their previous experiences in MR, and the SWOT of PCM related to MR during their medical student years. Before conducting the qualitative research, interviewers received training at PCM. Informed consent was obtained from participants before the survey. Each interview lasted approximately 60 to 90 min and was conducted in Thai. Conversations were recorded and transcribed using the Zoom application. Before the analysis, two researchers (SL and AK) reviewed the transcriptions to identify any errors. The interviews were coded iteratively throughout the data collection process by SL, PS, and AK. Data collection continued until content saturation was achieved, indicated by the absence of new emerging codes in the final two groups of participants [41].

SWOT-TOWS-AHP Analysis

A pairwise comparison survey was designed to evaluate each sub-strategy within the TOWS matrix and compare them among the four types of strategy groups: SO, WO, ST, and WT. The survey utilized a nine-point importance scale [42]. The authors explained the details of the survey, and it was administered through a self-answered online questionnaire.

Statistical Analysis

Quantitative Phase

All data were downloaded from Google Forms and analyzed using SPSS 29 (IBM, Armonk, NY, USA). Frequency distribution of demographic characteristics was performed. Categorical data were presented as percentages, and the Likert scale was presented as the median and interquartile range (IQR).

Qualitative Phase

A thematic analysis strategy focused on examining themes or patterns of meaning within data. This method can emphasize organization and detailed description of the dataset and

theoretically informed interpretation of meaning [43]. The investigators (SL and AK) transcribed and proofread the interview recordings word for word. SL, PS, and KT followed a six-step guide for conducting thematic analysis [41]. First, we familiarized ourselves with the data and generated initial codes individually. Both inductive and deductive coding approaches were used, and the researchers discussed observed patterns and identified key themes. The themes of the students' mediators toward conducting MR and SWOT were reviewed iteratively, and all authors assembled to define and name them. The final findings were presented as codes, subthemes, themes, and quotations.

SWOT-TOWS-AHP Analysis

The combined strategies were formed by all authors using a TOWS matrix, incorporating the SWOT related to MR promotion in PCM, the students' beliefs regarding conducting MR and a literature review. The AHP process consists of four steps. (1) Building the AHP hierarchical model to improve medical research participation and outcomes for medical students. (2) Conducting a pairwise comparison matrix to compare each sub-strategy and each strategic domain. The geometric mean consolidated the opinions since the participants' rankings carried equal weight [44]. (3) The consistency ratio (CR) calculation was performed, and participants with a CR over 0.1 were excluded. The CR is used to assess the consistency of judgments in the AHP, derived through the eigenvalue method for prioritization. It is calculated by dividing the consistency index (CI) by the random index (RI). The CI is defined as: " $CI = (\lambda_{\max} - n) / (n - 1)$ " where λ_{\max} is the maximum eigenvalue and n is the size of the comparison matrix. A perfectly consistent matrix will have λ_{\max} equal to n , with any deviation indicating inconsistency. The random index (RI) is a pre-calculated value representing the average consistency index of randomly generated pairwise comparison matrices based on the matrix size. For example, for size 3, 4, or 5 matrices, the RI values are 0.58, 0.90, and 1.12, respectively. The RI values increase as the matrix size grows, reflecting the increased likelihood of random inconsistency in larger matrices. The CR ensures that only judgments with an acceptable level of consistency ($CR < 0.1$) are used in the analysis [33]. (4) The overall weight of the components is calculated by multiplying the weight of each component within the component group.

Results

Quantitative Phase

Overall, 139 clinical year medical students and 123 interns participated in the study. The response rate was 47.6% and 49.2% for clinical year medical students and interns,

respectively. 59.5% of the participants were male, and 22.1% had previously published an MR. The clinical year students and interns believe that MR enhances one's career prospects, improves knowledge, and is valuable and complex, with a median Likert scale of four or higher. However, only the interns believe that MR promotes critical thinking and is essential for the medical profession, with a median Likert scale of four or higher.

Regarding the barriers, both groups hold the view that the lack of rewards or motivation and curriculum overload is the most problematic, with a median (IQR) Likert scale of 4 (3–4) and 4 (4–5), respectively. On the other hand, extrinsic motivations, such as the focus on pursuing higher degrees and the pursuit of further education, received a median Likert scale of 4 (3–4) (Table 1).

Qualitative Phase

Table 2 demonstrates the theme, sub-theme, and codes of the thematic analysis of eight focus groups (FGD01 to FGD04 are groups consisting of clinical year students; FGD05 to FGD08 are interns).

Perceptions and Attitudes Although some participants enjoyed conducting medical research, a prevalent belief among all groups was that MR is unnecessary for medical students, describing it as a complex and demanding task. A participant articulated, "It's like a top-level subject, complex even after trying to learn it" (FGD02). Many argued that existing treatment guidelines suffice, negating the need for new research: "Traditional methods cure diseases; there's no need to create new knowledge" (FGD07). However, several acknowledged MR's role in enhancing patient care and advancing medical knowledge, asserting doctors' importance in being well-versed in research fundamentals: "Clinic practices and treatments are all based on research" (FGD04).

Barriers Participants cited significant barriers, including high workloads that deter research activities, especially near exams: "If it's close to the exam...I won't do any research" (FGD08). They also expressed a lack of necessary skills and resources to initiate research, with one noting the challenge of tackling advanced topics like drug resistance (FGD06). The absence of personal research ownership and insufficient understanding of research topics led by instructors were further highlighted as impediments.

Motivations Despite mentors receiving low ratings in the quantitative analysis, those with prior research experience stressed the value of having a supportive and consistent mentor, particularly in overcoming complex challenges: "The professor helps us manage complex issues" (FGD08). The autonomy to explore personally interesting topics was

Table 1 Practices, perceptions, attitude, barriers, and motivation Likert-score stratified by educational level ($N=262$)

| Questions | Clinical year ($n=139$) Median (IQR) | Intern ($n=123$) Median (IQR) |
|--|---|------------------------------------|
| Practice | | |
| Willingness to take part in any research related task | 3 (3–3) | 3 (3–4) |
| To spend more than 2 months on a research project | 3 (2–3) | 3 (2–3) |
| To devote the same time for medical research as their university studies | 3 (3–4) | 3 (2–3) |
| Perception | | |
| Medical research promoting critical thinking | 3 (3–4) | 4 (3–4) |
| Enhancing one's career prospect | 4 (3–4) | 4 (4–5) |
| Enhances knowledge | 4 (3–4) | 4 (3–4) |
| Research/publication should be mandatory | 3 (2–3) | 3 (2–4) |
| Research is important | 3 (3–4) | 4 (3–4) |
| Research experience should be a criterion for residency training | 3 (2–3) | 3 (2–3) |
| Attitude | | |
| Medical research is valuable | 4 (3–4) | 4 (3–4) |
| Medical research is exciting | 3 (2–3) | 3 (2–3) |
| Medical research is enjoyable | 3 (2–3) | 3 (2–3) |
| Medical research is complicated | 4 (3–5) | 4 (3–5) |
| Medical research is time consuming | 3 (3–4) | 3 (2–3) |
| Medical research is essential for medical profession | 3 (3–4) | 4 (3–4) |
| Barrier | | |
| Lack of allotted time | 3 (3–4) | 3 (3–4) |
| Lack of exposure and opportunities | 3 (3–4) | 3 (3–4) |
| Lack of training and support | 3 (3–4) | 3 (3–3) |
| Lack of mentoring and guidance | 3 (2–4) | 3 (2–3) |
| Lack of funding | 3 (3–4) | 3 (2–4) |
| Lack of personal knowledge of research process | 3 (3–4) | 3 (3–4) |
| Lack of statistical support | 3 (3–4) | 3 (3–4) |
| Lack of rewards or motivations | 4 (3–5) | 4 (3–4) |
| Curriculum overload | 4 (3–5) | 4 (3–5) |
| Motivation | | |
| Focus on pursuing higher degrees | 4 (3–4) | 4 (3–4) |
| Formal recognition by university | 4 (3–4) | 3 (3–4) |
| Pursuit of further education | 4 (3–4) | 4 (3–4) |
| Pursuit of personal interest | 3 (2–3) | 3 (2–4) |
| Improving their potential in research skill | 3 (2–4) | 3 (3–4) |
| Having mentor guidance/role model | 3 (2–4) | 3 (3–4) |
| To be a part of help in solving medical problems in society | 3 (2–4) | 3 (3–4) |

QR interquartile range

a key motivator, with participants feeling more passionate and engaged: “Pursuing personal interests leads to research driven by enthusiasm” (FGD04). Curiosity about knowledge gaps in existing guidelines also spurred interest: “Exploring guidelines continuously reveals gaps” (FGD07).

Furthermore, participants recognized MR as beneficial for further education and professional development, viewing it as a profile enhancer demonstrating expertise and genuine interest in a specialized field: “It serves as supporting

evidence for further studies or specialization” (FGD01). Collaborative research with teachers was seen as a way to deepen knowledge and strengthen faculty relationships.

SWOT-TOWS-AHP Analysis

The SWOT-TOWS matrix containing the strategies derived from the SWOT analysis, mixed-methods studies, and literature review is presented in Table 3. For the AHP analysis, 18 participants with prior experience in research and a student

Table 2 Thematic analysis of focused group discussion involving 8 groups of clinical year medical students and interns

| Theme | Sub-theme | Code | N ^a |
|---------------------------|---|--|----------------|
| Perceptions and attitudes | View medical research as unimportant for medical student | Distant matter; do not need to engage in research; no desire to seek new knowledge beyond clinical practice; prefer patient care; further education tends to prioritize grades over research work; burdensome | 8 |
| | Medical research involves complexity and requires significant effort | Overly complex for medical students; time consuming; reading research articles is challenging; tired; requires a specialist level of expertise; high level of ability is required | 8 |
| | Research has benefits in terms of patient care and advancing knowledge | Beneficial for patients; necessary; generating new knowledge; doctors should engage in research to update their knowledge | 4 |
| | Research helps develop skills and is something that doctors should be knowledgeable about | Development of knowledge; enhance skills in various domains; basic statistical analysis is important; evidence-based medicine is important; research process knowledge is mandatory; research experience is mandatory | 4 |
| | Happiness in the process of conducting research | Enjoyable feeling during research discussions; joy when significant research findings emerge; enjoyment in data collection and statistical analysis | 3 |
| Barrier | Lacking skills in initiating and conducting research | Lacking confidence; initiating research topics independently is challenging; limited clinical experience; lack statistical analysis skills; lack skills to gather secondary data; limited proficiency in essential software tools; lack English language proficiency | 8 |
| | High workload and numerous responsibilities to fulfill | Too many extracurricular activities; too much workload throughout the day; too much homework; difficult time management | 8 |
| | Not being the owner of one's own research or being compelled to conduct it | Not feel a sense of ownership over the research work; not conducting research on a topic of personal interest; compelled to conduct research | 7 |
| | The lengthy and complex documentation process drains one's energy | Research ethics necessitate extensive documentation; document-related tasks are time-consuming and complex; delayed ethical approvals impede progress | 6 |
| | Lack of knowledge in accessing organizational resources and personnel | Unaware of professors who share similar interests; unaware of the capabilities of faculty laboratory equipment; unaware of the diverse research practices within the faculty | 5 |
| | Fear of disappointment and pressure from mentors, co-researchers or team members | Fear of criticism and rejection; fear of failure; fear of pressure and judgment from mentors; seniority culture; lack of collaborative teamwork; coordinating research with many individuals causes stress | 5 |
| | Lack of financial resources hinders research endeavors | Lack of financial resources; expensive open access publication fees; funding retrieval system access difficulty | 2 |

Table 2 (continued)

| Theme | Sub-theme | Code | N ^a |
|------------|--|--|----------------|
| Motivation | Having a close and consistent mentor/role model who constantly supports and nurtures | Good mentor/role model; examples from peers; senior/alumni as advisors; mentor with a flexible schedule; encouraging mentor; approachable and friendly mentors; mentor who motivates to engage in research | 8 |
| | Having the opportunity to conduct research on a topic of personal interest and being the project initiator | Sense of ownership; personal interest and curiosity; recognizing the significance of the engaged research work; to help a real-life case; newly founded gap of knowledge | 7 |
| | To use as a supplement for further education and professional advancement | Help establish valuable connections; research profile for further academic pursuits; professional advancement; academic ranks; enhance one's application for further education | 6 |
| | To enhance skills and expand one's knowledge | To learn the research process; acquire new knowledge; develop one's own skills; challenge oneself in research endeavors; deepen specialized knowledge | 5 |
| | Having a positive research experience in the past | Prior experience as a research collaborator; non-stressful working environment; sense of accomplishment and pride; success in presenting or publishing | 5 |
| | Participating in the academic presentation and building connections | Participating in academic conferences; opportunities and allows for networking with like-minded individuals; present research internationally | 3 |

^aThe number of groups that provided responses related to the subtheme

representative (10 clinical year students and 8 interns) successfully engaged in pairwise comparisons of the strategies to determine the most ideal one. Five participants with a CR above 0.1 were excluded. Table 4 displays that the Opportunity-Strength (SO) strategy group is the most important, with a priority score of 0.33. Figure 2 illustrates the priorities of each strategy group. The sub-strategy “Developing a centralized communication and coordination system that connects expert professors in pre-clinical and clinical medical fields, both within and outside the institution” (SO1) is the most preferred, followed by the “Develop a faculty database system that provides information on their respective areas of expertise, the needs of medical students for research collaboration in various topics, the potential of resources, and funding sources available to support research work” (WO1) strategy. The priority scores for each sub-strategy are shown in Fig. 3.

Discussion

This study successfully employed a mixed-methods approach to determine the mediators of research engagement among medical students and interns. Although previous studies have provided strategies to foster faculty research for students [45–48], the present study stands out for its comprehensive design, which utilizes SWOT-TOWS-AHP analysis to integrate student engagement and develop and prioritize strategies. Students with previous experience in

medical research were requested to provide their perspectives on the faculty’s strengths, weaknesses, opportunities, and threats. Additionally, student representatives were formally invited to rank the strategies formulated through the SWOT-TOWS analysis. Implementing a well-defined framework that delineates students’ roles and responsibilities could enhance their engagement in shaping the educational curriculum [49]. Thus, this study demonstrates the involvement of student representatives as co-creators in curriculum design, which offers the advantage of direct interaction with students, allowing for a deeper understanding of their thoughts and viewpoints [2, 3].

Various strategies have been implemented to enhance medical research engagement, including electives, mandatory courses, and summer research programs [50]. Similar to the student’s expectations in the present study, a pilot research training network for undergraduate students was established in 2015. This network facilitated collaboration between medical students, junior trainees, and senior staff members in medical education research [51]. Establishing a robust collaboration network to enhance staff accessibility would significantly benefit student engagement, as a major barrier to engagement is the perceived inaccessibility of staff [52].

Comprehensive reviews of effective strategies for enhancing research capacity have recommended various approaches [47]. These include recruiting new faculty research assistants, implementing mentoring programs, supporting local mentors, expanding and diversifying the mentor pool,

Table 3 SWOT-TOWS analysis

| SWOT analysis | | | |
|---|---|---|--|
| Strengths (S) | | Weaknesses (W) | |
| What do you do well? What resources do you have within your control? | | What needs to be enhanced to increase program success? What intrinsic factors place your program at a disadvantage? | |
| Opportunities (O) | What external factors could benefit your program? | S1. Teachers are knowledgeable, kind-hearted, and ready to provide guidance | W1. Lack of promotion regarding the research potential of both faculty and resources |
| | | S2. Organizations and resources provide strong support for research endeavors | W2. Lack of collaboration from various disciplines in conducting research among medical students |
| | | S3. High potential in the field of community medicine | W3. The research curriculum lacks flexibility and requires excessive time for course management |
| | | S4. A rigorous and high-quality research and statistical analysis curriculum | W4. The funding system for medical students is difficult to access |
| | | S5. Frequent conferences for presenting diverse research studies | W5. Not aware of the potential of community hospitals for conducting research in the curriculum |
| Opportunity-Strength Strategy (SO) | | Opportunity-Weakness Strategy (WO) | |
| How can strengths be used to take advantage of opportunities? | | How can you minimize/overcome weaknesses by using opportunities? | |
| O1. Professors with diverse expertise who have not yet promoted research among medical students | SO1. Developing a centralized communication and coordination system that connects expert professors in pre-clinical and clinical medical fields, both within and outside the institution (S1/S2/O1/O2/O3) | WO1. Develop a faculty database system that provides information on their respective areas of expertise, the needs of medical students for research collaboration in various topics, the potential of resources and funding sources available to support research work (W1/W2/O1/O2/O3) | WO2. Simplify the expense reimbursement system for medical students conducting research, both within and outside the curriculum, with the support of faculty advisors, resident or fellow physicians as mentors (O1/O2/W1/W2/W4) |
| O2. Resident and fellow physicians who engage in research work and continue to advance | SO2. Support collaborative research in community medicine between medical students, resident and fellow physicians, and external individuals from diverse fields, fostering cooperation and knowledge exchange (S3/S4/O1/O2/O3) | WO3. Allow for the utilization of research from other disciplines beyond the coursework-specific research for the purpose of credit transfer and evaluation in relevant subjects (O1/O2/O3/O4/W1/W2/W3/W5) | WO4. Establish a Memorandum of Understanding (MOU) for collaborative research between medical students and institutions, promoting data collection and collaboration to obtain representative samples on a larger scale (O3/O4/W1/W2/W4) |
| O3. Connections with both local and international universities | SO3. Expand the scope of research to encompass a broader range of population groups, such as military hospitals or associate hospitals in various other areas, to include a larger and more diverse population (S3/S4/O4) | Threat-Weakness Strategy (WT) | |
| O4. Databases and accessibility on diverse population groups | SO4. Organize conferences to present collaborative research findings conducted jointly by medical students and resident physicians or fellow physicians (S2/S5/O2) | How can you use threats to minimize weaknesses and use weaknesses to avoid threats? | |
| Threats (T) | Threat-Strength Strategy (ST) | Threat-Weakness Strategy (WT) | |
| What factors beyond your control place the program "at risk?" | | How can you use threats to minimize weaknesses and use weaknesses to avoid threats? | |

Table 3 (continued)

| | | |
|--|---|--|
| T1. Requesting research ethical use of extensive, lengthy, and complex documents | ST1. Develop a centralized system for documenting and addressing common ethical issues encountered in research, providing guidelines and solutions based on the experiences of experienced faculty members or senior peers (T1/T2/T3/S1/S2) | WT1. Enhance flexibility in medical student research within the curriculum by allowing the use of secondary data, reducing complexities in ethical considerations, and addressing time and budget constraints (T1/T2/W3/W4) |
| | ST2. Develop an extended mentoring system for encouraging medical students to engage in research (S1/S4/T1/T3) | WT2. Support research continuity and expansion by leveraging previous research proposals and addressing research issues while simplifying the ethical approval process and reducing the workload (T1/T2/T3/W1/W2/W4/W5) |
| | ST3. Promote medical student research presentations at conferences and encourage publication in national and international journals while fostering innovation and creativity (S1/S2/S5/T1/T2) | WT3. Reduce curriculum workload to allow for more time to study important research issues and areas of interest in advance at community hospitals while assessing research capabilities of personnel and necessary resources (T1/T2/W3/W5) |
| T2. The workload in the medical graduate program is substantial | | |
| T3. Seniority culture | | |

The SWOT-TOWS matrix is adapted from Topor et al.

actively engaging faculty mentors as stakeholders, and establishing a campus-wide resource [46, 47]. However, despite mentors' significant role in these strategies, a systematic framework to fully leverage their potential remains unfulfilled [53]. Hence, it is strongly recommended that a well-structured system be established to drive the effective implementation of these strategies.

Regarding perception, previous literature from various countries has shown that research is often perceived as important and mandatory among undergraduate and post-graduate students and teaching staff [12, 15, 54]. Consistent with these findings, the current study also uncovered that participants perceive medical research as carrying multiple benefits. However, some participants may perceive medical research as overly complex, time-consuming, and unnecessary for all medical students. Additionally, certain individuals may prioritize dedicating their time to learning and memorizing practice guidelines, possibly due to a lack of awareness among many medical students regarding the importance of research in healthcare [12, 50]. Consequently, providing medical students with opportunities to conduct medical research is crucial.

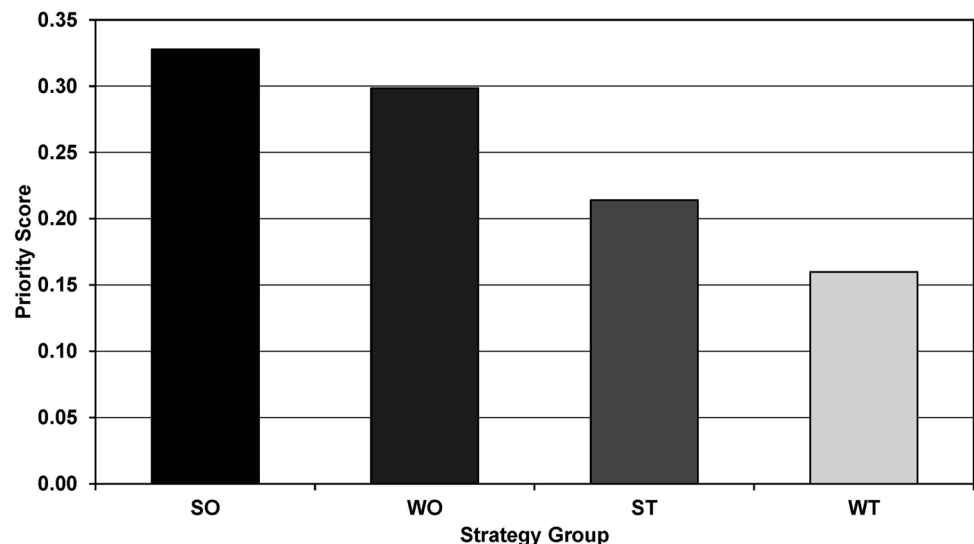
Published research frequently identifies the shortage of time as a significant obstacle to conducting medical research, resulting in a decline in the number of medical students interested in research endeavors. However, it is imperative to acknowledge that time is an uncontrollable constraint, necessitating the provision of time management strategies for undergraduate researchers. For instance, implementing techniques such as establishing attainable objectives, prioritizing tasks based on their significance, and refining the planning process can assist in maintaining focus on a research project [55]. Additionally, involving a team, employing creative problem-solving strategies to overcome obstacles, and proactively managing potential distractions can aid in sustaining concentration [56]. Moreover, to address this barrier, speeding up medical research undertaken by students, as exemplified by the WT2 strategy, "Support research continuity and expansion by leveraging previous research proposals and addressing research issues, while simplifying the ethical approval process and reducing workload," may prove beneficial.

In the present study, extrinsic motivation is the main driving force behind participants' engagement in medical research. Extrinsic motivations originate externally through incentives, bonuses, promotions, and rewards [57]. Similar studies have also yielded comparable findings, highlighting that extrinsic motivation is significant in motivating researchers, including career advancement, pursuit of further education, and recognition [58, 59]. However, according to the Self-Determination Theory, focusing excessively on extrinsic motivation can potentially hamper performance by negatively impacting intrinsic motivation [60].

Table 4 Priority of each strategy and sub strategy in TOWS matrix by analytic hierarchy process analysis

| Strategy group | Strategy group's priority | Sub strategy | Sub strategy's priority | Overall priority | Ranking of strategy |
|----------------|---------------------------|--------------|-------------------------|------------------|---------------------|
| SO | 0.33 | SO1 | 0.35 | 0.1156 | 1 |
| | | SO2 | 0.23 | 0.0749 | 5 |
| | | SO3 | 0.24 | 0.0775 | 4 |
| | | SO4 | 0.18 | 0.0597 | 10 |
| WO | 0.30 | WO1 | 0.37 | 0.1111 | 2 |
| | | WO2 | 0.23 | 0.0691 | 6 |
| | | WO3 | 0.21 | 0.0620 | 9 |
| | | WO4 | 0.19 | 0.0563 | 11 |
| ST | 0.21 | ST1 | 0.32 | 0.0690 | 7 |
| | | ST2 | 0.21 | 0.0452 | 13 |
| | | ST3 | 0.47 | 0.0998 | 3 |
| WT | 0.16 | WT1 | 0.28 | 0.0441 | 14 |
| | | WT2 | 0.39 | 0.0621 | 8 |
| | | WT3 | 0.34 | 0.0536 | 12 |

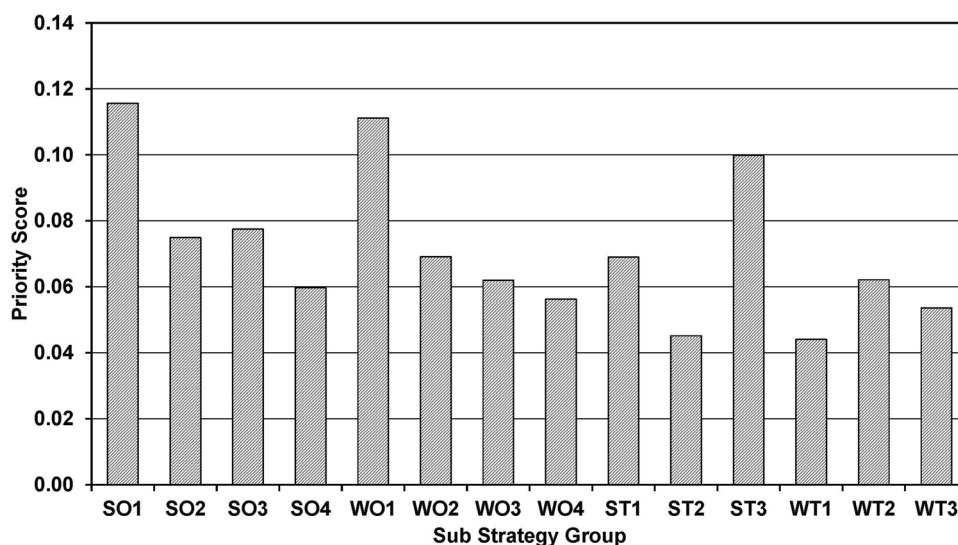
SO Opportunity-Strength, WO Opportunity-Weakness, ST Threat-Strength, WT Threat-Weakness

Fig. 2 Priority score of each strategy group in the TOWS matrix: SO, Opportunity-Strength; WO, Opportunity-Weakness; ST, Threat-Strength; WT, Threat-Weakness

Three fundamental needs must be fulfilled to empower motivation and encourage students' engagement in medical research: autonomy, competence, and a sense of belonging [60]. Faculty members can support these needs by offering extracurricular research time, allowing students to choose their research topics and mentors, and, when feasible, hiring students as research assistants to enhance their autonomy [21]. To foster competence, it is beneficial to introduce research skills early on and provide practical training [21]. Additionally, participants in this study expressed that the opportunity to conduct research on a personally interesting topic and take the initiative in a project greatly motivates them to engage in medical research, thus promoting their sense of belonging.

Unlike Western medical programs, Thailand's 6-year medical curriculum allows direct entry from high school, often leaving students with limited research experience [61, 62]. While the Medical Research Curriculum at PCM has led to successful student publications and international presentations, it is perceived as contributing to curriculum overload [6]. This study highlights that students may prioritize grades over research due to the heavy curriculum and lack of experience. To alleviate these burdens, barriers to research engagement must be identified and addressed, tailored to each institution [22]. Aligning with the SPICES model, medical research engagement should be student-centered, elective-driven, and systematic [39]. The newly developed strategies aim to foster a supportive

Fig. 3 Priority score of each sub-strategy in the TOWS matrix: SO, Opportunity-Strength; WO, Opportunity-Weakness; ST, Threat-Strength; WT, Threat-Weakness. The codes for the sub-strategy groups are detailed as the strategy group followed by the strategy number. For example, “SO1” refers to sub-strategy number 1 from the Opportunity-Strength group



ecosystem for medical research, integrating diverse topics, interprofessional collaboration, extracurricular activities, and centralized systems that connect students with experts, offering guidance on ethical proposal writing, especially for those new to research.

The present study has encountered several limitations. Firstly, the study focused exclusively on medical students and interns from PCM, which may limit the generalizability of the findings to other universities with different curricula. Therefore, differences in the ranking of strategies may occur, and external validation is needed. Secondly, since participation in the study was voluntary, selection bias could be a significant limitation. Only those who chose to participate were included, potentially influencing the results. Furthermore, the participants primarily consisted of experienced students, which may limit the applicability of these strategies to less skilled individuals. However, these strategies should promote further engagement in medical research and create valuable opportunities. Thirdly, although student engagement is emphasized, the study does not explicitly mention the involvement of other key stakeholders, such as faculty members or administrative staff, in developing the strategies. Broader stakeholder involvement would ensure the strategy addresses student needs and the institutional capacity to implement them effectively. Collaboration with faculty and administrative representatives could enhance the feasibility and sustainability of the proposed strategies. Lastly, when ranking the TOWS strategy, only a limited number of participants were involved, which may not fully represent the entire population. However, it is worth noting that selecting experienced and knowledgeable judges is more crucial than having many judges. Their expertise ensures accurate judgments without diluting the quality by involving individuals who may be less appropriate [63]. In the current study, student representatives with prior experience in medical

research were selected, leading to more comprehensive opinions on ranking medical research strategies.

Despite these limitations, the present study also has notable strengths. It outlines a comprehensive framework for student engagement in the design of medical research curricula and identifies the support that faculty should provide. Furthermore, the study employs a comprehensive approach to understanding participants' perceptions, barriers, and motivations toward medical research.

Conclusion

The research utilized a mixed-methods study to demonstrate medical students' and interns' perceptions, attitudes, barriers, and motivations toward medical research. While medical research is considered complex and unnecessary for all students, it is also recognized as beneficial for enhancing career paths, improving patient care, and advancing knowledge. The opportunity to research a personally interesting topic motivates the participants to engage in medical research, but lacking the skills to initiate their own research is a significant barrier. Therefore, gradual and close support from mentors is needed. Moreover, the SWOT-TOWS-AHP analysis provided a strategic framework to prioritize and develop strategies for student engagement in medical research. The study offers valuable insights and a comprehensive framework for integrating student representatives into the design of medical research curricula.

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Author Contribution The concept for study was developed by SL, PS, KT, KJ, AK, and BS. SL and PS collected the data. SL and AK analyzed the data. SL, PS, and AK wrote the first draft. All authors contributed and approved the final version.

Data Availability The datasets used and/or analyzed during the current study available from the author on reasonable request (contact Sethapong Lertsakulbunlue via Sethapong.ler@pcm.ac.th).

Declarations

Ethics Approval and Consent to Participate This study was approved by the Medical Department Ethics Review Committee for Research in Human Subjects, Institutional Review Board, Royal Thai Army (RTA) (approval no. S060q/65_Exp), following international guidelines such as the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines, and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use – Good Clinical Practice. Informed consent documentation was obtained from all subjects with permission from the Institutional Review Board, RTA Medical Department.

Consent for Publication Not applicable.

Competing Interests The authors declare no competing interests.

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