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Factors Influencing STEM Career Interest among Malaysian Secondary School Students: A Systematic Review (2020-2025)

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Abstract: Science, Technology, Engineering, and Mathematics (STEM) career interest among Malaysian secondary school students has become an important concern, as participation in STEM pathways remains uneven despite continuing policy support and workforce demand. This systematic literature review examined the factors influencing STEM career interest among Malaysian secondary school students through a synthesis of empirical studies published between 2020 and 2025. Following PRISMA 2020 guidelines, records were retrieved from Scopus, Web of Science, and Google Scholar, and systematic screening resulted in 20 studies being included in the qualitative synthesis. The findings were organised into four themes: social and environmental influences on STEM interest and career choice; psychological and motivational determinants of STEM aspiration, interest, and persistence; gender and differential patterns in STEM career orientation; and STEM education implementation, learning context, exposure, and student readiness. Across the reviewed studies, STEM career interest was consistently associated with parental and peer support, self-efficacy, motivation, career outcome expectations, gender-related experiences, and the quality of STEM learning exposure in school settings. Overall, STEM career interest appears to develop through the interaction of contextual, psychological, and educational factors rather than through a single determinant. The review also highlights methodological gaps in the current Malaysian evidence base and suggests the need for more longitudinal, intervention-based, and contextually diverse research to strengthen future STEM-related policy and practice.

Keywords: STEM Career Interest, Malaysian Secondary School Students, Systematic Literature Review, Influencing Factors.

1. Introduction

Global demand for a highly skilled STEM workforce has intensified as nations pursue innovation-driven and knowledge-based economies. However, many countries continue to report insufficient STEM graduates, persistent gender imbalances, and declining interest in STEM pathways among youth, particularly at the secondary school level where career aspirations begin to crystallize (Kayan-Fadlelmula *et al.,* 2022; López *et al.,* 2023). Research consistently shows that students' STEM career aspirations and choices are shaped by personal factors, social influences, and environmental or structural conditions, including self-efficacy, motivation, family support, school experiences, and access to STEM-related opportunities (Ali & Anwar, 2025; Kozan *et al.,* 2023; López *et al.,* 2023; Zhou & Shirazi, 2025). Systematic reviews and mappings have highlighted the central role of self-efficacy, outcome expectations, personal utility, and positive STEM experiences in sustaining interest in STEM careers, while also pointing to the influence of gender stereotypes, cultural norms, and unequal access to supportive learning environments (López *et al.,* 2023; Msambwa *et al.,* 2023).

In Malaysia, STEM education policies position schools as a key pipeline for national human capital development, yet women and other underrepresented groups remain markedly underrepresented in many STEM fields. A Malaysian systematic review on young women's intention to pursue STEM identified both personal and external factors as important determinants of participation, while also highlighting key gaps in the local evidence base (Sajid *et al.,* 2020). At the same time, international evidence suggests that integrated STEM curricula, inquiry-based and project-based learning, and out-of-school programs can enhance students' STEM interest and

career aspirations, particularly when they provide hands-on, relevant experiences and sustained engagement (Le *et al.*, 2023; López *et al.,* 2023; Neher-Asylbekov & Wagner, 2022; Prieto-Rodriguez *et al.,* 2020).

Despite the growing global literature, there is still no systematic synthesis focused specifically on factors influencing STEM career interest among Malaysian secondary school students in the post-2020 context, shaped by rapid technological change and the educational disruptions of COVID-19. Existing reviews are either global or regional, focus on general STEM participation, or centre mainly on female students or higher education cohorts (Kayan-Fadlelmula *et al.,* 2022; Msambwa *et al.,* 2023; Nabi *et al.,* 2024; Sajid *et al.,* 2020). The present systematic review (2020–2025) addresses this gap by collating and critically analysing empirical studies related to Malaysian secondary students' STEM career interest. The review aims to (i) map the range of personal, social, school, and broader contextual factors associated with STEM career interest; (ii) identify gendered and sociocultural patterns specific to the Malaysian context; and (iii) highlight conceptual, methodological, and thematic gaps to inform the design of future interventions and policies that more effectively cultivate and sustain STEM career aspirations among Malaysian youth (Kozan *et al.,* 2023; López *et al.,* 2023; Sajid *et al.,* 2020).

To guide the scope and analytical direction of this review, the research questions were developed using the PICo framework, which emphasises Population, Interest, and Context (Kitchenham & Charters, 2007; Lockwood *et al.,* 2015). This framework enabled a structured formulation of questions aligned with the focus on Malaysian secondary school students and STEM career interest. The research questions for this study are as follows:

1. What social and environmental factors influence STEM career interest and career choice among Malaysian secondary school students?
2. What psychological and motivational determinants influence STEM aspiration, interest, and persistence among Malaysian secondary school students?
3. What gender-based differences are evident in STEM career orientation among Malaysian secondary school students?
4. How do STEM education implementation, learning context, exposure, and student readiness contribute to STEM career interest among Malaysian secondary school students?

2. Literature Review

Interest in science, technology, engineering, and mathematics (STEM) careers among secondary school students has become an important concern across education systems, particularly as many countries continue to face shortages of STEM talent despite sustained policy attention and labour market demand. Existing research indicates that STEM career interest is shaped by multiple interrelated factors rather than by a single influence. These include personal characteristics such as self-efficacy, motivation, and career expectations, as well as social and environmental influences such as family support, peer interaction, teacher encouragement, school experiences, and broader cultural messages about STEM pathways (Zhou & Shirazi, 2025).

In Malaysia, STEM education is regarded as an important component of national human capital development, especially at the secondary school level where academic orientation and career preferences begin to take shape more clearly. However, participation in STEM pathways remains uneven, and the literature suggests that this pattern is influenced by both psychological and contextual factors. Previous studies indicate that students' interest in STEM careers is shaped by parental support, confidence in STEM-related ability, motivation to learn science, perceptions of career value, learning exposure, and the quality of school-based STEM experiences (Chen *et al.*, 2022; Razali *et al.,* 2020a). Gender-related patterns, school context, and access to meaningful STEM learning opportunities may also affect how students perceive the attractiveness and feasibility of STEM careers (Balta *et al.,* 2023; Mansour, 2025; Sellami *et al.,* 2023).

The wider literature further suggests that students' STEM aspirations are influenced by both social-contextual and psychological processes. Parental expectations, cultural capital, and perceptions of STEM professionals have been linked to student aspirations, while self-efficacy, outcome expectations, and motivational beliefs appear to mediate these influences (Amalina *et al.,* 2025; Chen *et al.,* 2022). Meaningful STEM exposure through mentoring, informal learning, and programme-based experiences has also been associated with stronger engagement and

interest in STEM pathways (Noah & Asiahwati Awi, 2022; Huang *et al.*, 2022; Zhou & Shirazi, 2025). Despite this growing literature, limited systematic synthesis has focused specifically on Malaysian secondary school students.

3. Method

As recommended by Page *et al.* (2021) this review followed the PRISMA 2020 guidelines in identifying eligible studies for analysis. Four stages of study selection were employed, namely identification, screening, eligibility, and inclusion. Data from the included studies were then extracted and analysed based on the established approach. The description of each stage is presented below.

3.1 Identification

Initially, 243 records were identified through database searching, comprising 8 records from Scopus, 102 from Web of Science, and 133 from Google Scholar. After applying the inclusion criteria related to publication year (2020–2025), document type (journal article), and language (English), 85 records were excluded. As a result, 158 records remained for the screening stage. Table 1 presents the search string used, while Table 2 summarises the inclusion and exclusion criteria.

Table 1. The Search String

Database	Search items
Scopus Web of Science Google Scholar	("STEM career interest" OR "interest in STEM careers" OR "STEM career aspiration*" OR "STEM career intention*" OR "STEM career choice*" OR "science technology engineering mathematics career*") AND (factor* OR influenc* OR determinant* OR predictor* OR motivat* OR barrier* OR perception* OR attitude* OR "self-efficacy" OR "parental support" OR "teacher support") AND (Malaysia* OR Malaysian*) AND ("secondary school student*" OR "secondary student*" OR "high school student*" OR adolescen* OR teen* OR youth) **Date of Access: August 2025**

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020 – 2025	< 2020
Document type	Journal (Article)	Conference papers, books, reviews, in-press articles

3.2 Screening

The screening stage involved the removal of duplicate records, followed by title and abstract screening to determine the relevance of each study to the review objectives. After removing 2 duplicate records, 156 records remained for screening. Subsequently, 73 records were excluded because their titles or abstracts were not relevant to the scope of the review. This resulted in 83 articles being retained for full-text eligibility assessment.

3.3 Eligibility

During the eligibility stage, the full-text articles were assessed against the review criteria. Studies were excluded if they did not focus on factors related to STEM career interest, STEM career aspiration, STEM career choice, or Malaysian secondary school student samples. Articles were also excluded when full-text access was unavailable. As a result, 63 articles were removed during this stage.

3.4 Inclusion

A total of 20 studies met all inclusion criteria and were retained for qualitative thematic synthesis. The study selection process is presented in Figure 1.

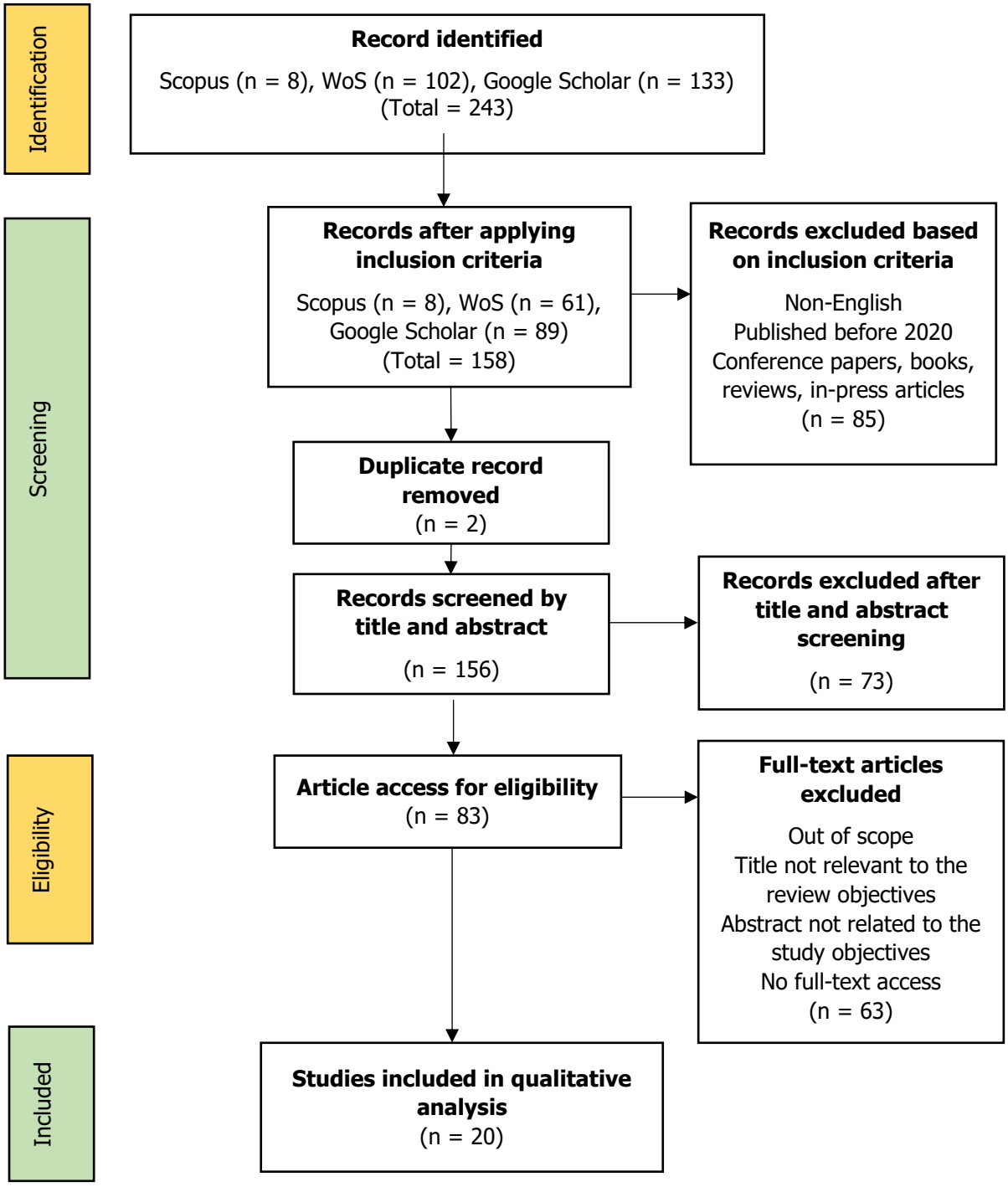

Figure 1. PRISMA 2020 flow diagram of the study selection process

3.5 Data Extraction and Analysis

The 20 included studies were analysed using an integrative thematic synthesis with a hybrid inductive–deductive approach. Key findings, contextual information, and factors related to STEM career interest among Malaysian secondary school students were systematically extracted and coded into themes. Although the research questions guided the scope of the review, the final thematic structure was refined through repeated engagement with the extracted data, ensuring conceptual coherence and evidence-based rigour. This process produced a stable

thematic structure across the included studies and indicated that the selected sample was sufficient to address the review questions.

4. Results

The included studies were assessed using a quality appraisal method adapted from Abouzahra *et al.* (2020) and Kitchenham (2007). Six criteria were applied, and three experts independently scored all studies based on the established scoring system. Each criterion was assigned a score of 1 if fully met, 0.5 if partially met, and 0 if not met. Only studies scoring above 3.0 were retained for synthesis and analysis. All included studies scored above the minimum threshold and were therefore retained for thematic synthesis.

Discrepancies among the experts were resolved through consensus before the final scores were calculated. This procedure helped ensure the reliability of the appraisal process and minimise potential scoring bias. The six quality appraisal criteria were as follows:

1. Clarity of the study's purpose: Assesses whether the research aims are clearly stated and well defined.
2. Presentation of interest and usefulness: Assesses whether the study clearly communicates its significance and potential contributions.
3. Establishment of methodology: Assesses whether the study design, data collection, and analysis are appropriate and well executed.
4. Definition of key concepts: Assesses whether the procedures and methods are described in sufficient detail to support replication.
5. Comparison with similar work: Assesses whether the study is adequately situated within existing research and theory.
6. Acknowledgment of limitations: Assesses whether the study clearly reports its constraints and weaknesses.

The quality assessment results of the selected primary studies are presented in Table 3.

Table 3. Result of Assessment Performance for Selected Primary Studies.

Author	Title	QA1	QA2	QA3	QA4	QA5	QA6	Total Mark	Percentage (%)
Alam *et al.* (2021)	Factors that Influence High School Female Students' Intentions to Pursue Science, Technology, Engineering and Mathematics (STEM) Education in Malaysia	1	1	1	1	1	1	6.0	100.0
Bakar and Mahmud (2020)	The Profiling of Aspiration and Interest towards STEM and TVET Careers among Malaysian School Students	1	1	1	1	0.5	0	4.5	75.0
Fridict *et al.* (2023)	Factors Influencing Secondary Students' Intention to Study STEM	1	1	1	1	1	0	5.0	83.3
Halim *et al.* (2023)	Effect of Environmental Factors on Students' Interest in STEM Careers: The Mediating Role of Self-Efficacy	1	1	1	1	1	0.5	5.5	91.7

Ismail and Asrah (2025)	Survey on Exploring STEM Enthusiasm Among Secondary School Students in Muar	1	1	1	1	0.5	0	4.5	75.0
Mahmud *et al.* (2022)	The Relationship between Career Interests and STEM Careers of Secondary School Students	1	1	1	1	1	0	5.0	83.3
Mohd Farid & Othman (2025)	Investigating STEM Interest and Its Relationship with Academic Success among Urban Secondary School Students	1	1	1	1	1	0	5.0	83.3
Mustapa *et al.* (2023)	The Exposure of Electrical Engineering Field as a STEM Branch towards Technical School's Students in Malaysia	1	1	1	0.5	0.5	0	4.0	66.7
Nor Huzir *et al.* (2025)	Factors Affecting Students' Persistence to Enrol in STEM Education	1	1	1	1	1	0	5.0	83.3
Rahman and Halim (2022)	STEM Career Interest: The Effect of Gender	1	1	1	1	1	0.5	5.5	91.7
Razali (2021)	Exploring Crucial Factors of an Interest in STEM Career Model among Secondary School Students	1	1	1	1	1	0	5.0	83.3
Razali *et al.* (2020a)	Motivation to Learn Science as a Mediator between Attitude towards STEM and the Development of STEM Career Aspiration among Secondary School Students	1	1	1	1	1	1	6.0	100.0
Razali *et al.* (2020b)	STEM Education in Malaysia towards Developing a Human Capital through Motivating Science Subject	1	1	1	1	1	0	5.0	83.3
Razali *et al.* (2022)	The Effects of Parental Autonomy on the Creation of STEM Career Interests	1	1	1	1	0.5	0	4.5	75.0
Riduan and Othman (2024)	Examining Challenges and Strategies in Implementing STEM Education in Malaysian Secondary Schools: Perspectives of Teachers and Students	1	1	1	0.5	1	0	4.5	75.0
Shamsuddin *et al.* (2025)	Profiling Students' Readiness for the Future: Cluster Analysis of 21st-Century Competencies and Career Interests Among Secondary Students	1	1	1	1	1	0.5	5.5	91.7

Sulong and Mahfar (2025)	The Influence of Career Outcome Expectations and Career Interests on Career Readiness among Secondary School Students in Johor, Malaysia	1	1	1	1	1	1	6.0	100.0
Tey *et al.* (2020)	Teacher, Parental and Friend Influences on STEM Interest and Career Choice Intention	1	1	1	1	1	1	6.0	100.0
Tey *et al.* (2024)	The Influence of Gender on STEM Career Choice: A Partial Least Squares Analysis	1	1	1	1	1	1	6.0	100.0
Zainal Abidin *et al.* (2025)	Rural High School Students' Interest and Perception Towards STEM Education	1	1	1	1	1	0	5.0	83.3

4.1 Summary of Quality Assessment

Overall, the methodological quality of the included studies was moderate to high. Alam *et al.* (2021), Sulong and Mahfar (2025), Razali *et al.* (2020a), Tey *et al.* (2020)and Tey *et al.* (2024) achieved the highest quality score of 100%, indicating that they clearly articulated their research purpose, established the relevance and value of the work, presented well-defined methodological and conceptual frameworks, situated their findings in relation to existing literature, and explicitly acknowledged study limitations. A second group, comprising Halim *et al.* (2023), Rahman and Halim (2022) and Shamsuddin *et al.* (2025) attained 91.7%, reflecting strong overall quality with only minor weaknesses, primarily in the partial reporting of limitations. Fridict et al. (2023), Razali (2021), Mahmud *et al.* (2022), (Mohd Farid & Othman, 2025), Nor Huzir *et al.* (2025), Zainal Abidin *et al.* (2025) and Razali et al. (2020b) scored 83.3%, suggesting generally robust methodological quality despite some shortcomings, particularly the lack of explicit discussion of limitations. Bakar and Mahmud (2020), Razali *et al.* (2022), Riduan and Othman (2024) and Ismail and Asrah (2025) obtained 75.0%, largely due to weaknesses in conceptual clarity, limited engagement with prior studies, or insufficient reporting of limitations. Mustapa *et al.* (2023) recorded the lowest score, 66.7%, primarily because of weaker conceptual development, less rigorous comparison with previous research, and the absence of a clearly articulated limitations section.

4.2 Characteristics of the Included Studies

The 20 studies included in this systematic review were analysed across several methodological and empirical characteristics. To provide an overview of the included evidence, an analysis was conducted based on research design, participant characteristics, geographical and school contexts, and the variables and constructs examined in the reviewed studies.

Figure 2 presents the distribution of research designs reported in the studies included in this systematic review. The findings show that the most frequently used research design was survey/correlational/descriptive studies (n = 10), followed closely by SEM/PLS-SEM model-based studies (n = 9). Only a small number of studies employed intervention/outreach evaluation (n = 1) and cluster analysis/profiling (n = 1). Overall, the distribution indicates that research on factors influencing STEM career interest among Malaysian secondary school students has been dominated by quantitative, non-experimental approaches, with a particularly strong emphasis on survey-based analysis and structural modelling techniques, while relatively fewer studies have adopted intervention-based or profiling-oriented designs.

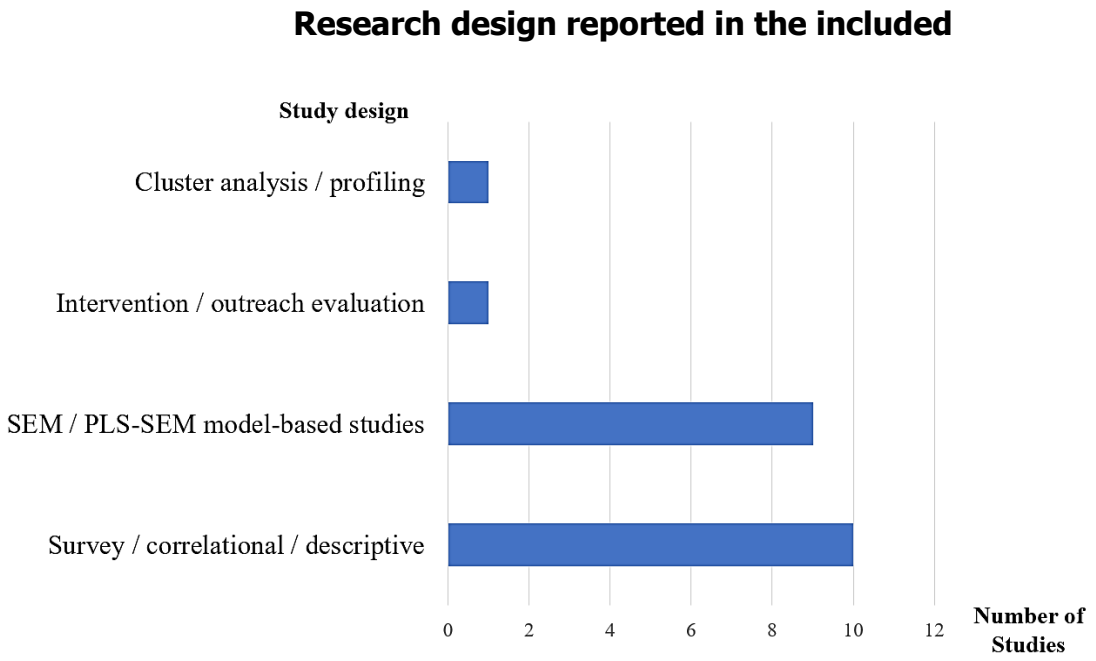

Figure 2. Distribution of study design across the included studies (n = 20)

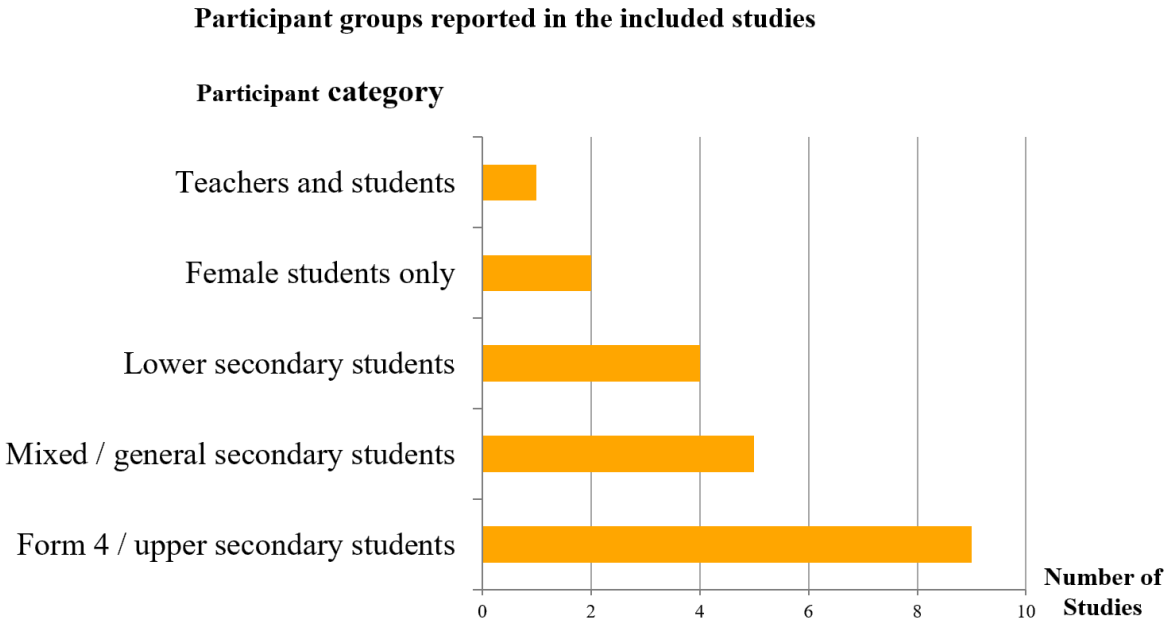

Figure 3. Distribution of participant groups across the included studies (n = 20)

Figure 3 presents the distribution of participant groups reported in the studies included in this systematic review. The findings show that the largest proportion of studies focused on Form 4 / upper secondary students (n = 9), followed by studies involving mixed / general secondary students (n = 5). A smaller number of studies examined lower secondary students (n = 4) and female students only (n = 2), while only one study involved both teachers and students (n = 1). In general, the distribution suggests that research on factors influencing STEM career interest among Malaysian secondary school students has been concentrated mainly on upper secondary student populations, with comparatively fewer studies focusing on lower secondary students, female-specific samples, or multi-participant perspectives involving both students and teachers.

Figure 4 presents the geographical context and school type reported in the studies included in this systematic review. In terms of geographical context, the largest number of studies were conducted across multiple or unspecified Malaysian locations (n = 10), followed by Selangor (n = 6). A smaller number of studies were conducted in Johor (n = 2) and the central region/Klang Valley (n = 2), while only one study was conducted in Sabah (n = 1). Regarding school type, most studies were carried out in national or regular secondary schools (n = 12), followed by studies involving science stream students (n = 5). Only a limited number of studies focused on rural or remote high school contexts (n = 2), technical school contexts (n = 1), and school-based perspectives involving teachers and students (n = 1). Collectively, the distribution indicates that the reviewed literature has been concentrated mainly in regular secondary school settings and in broader or more accessible Malaysian contexts, with comparatively fewer studies focusing on region-specific or specialised school environments.

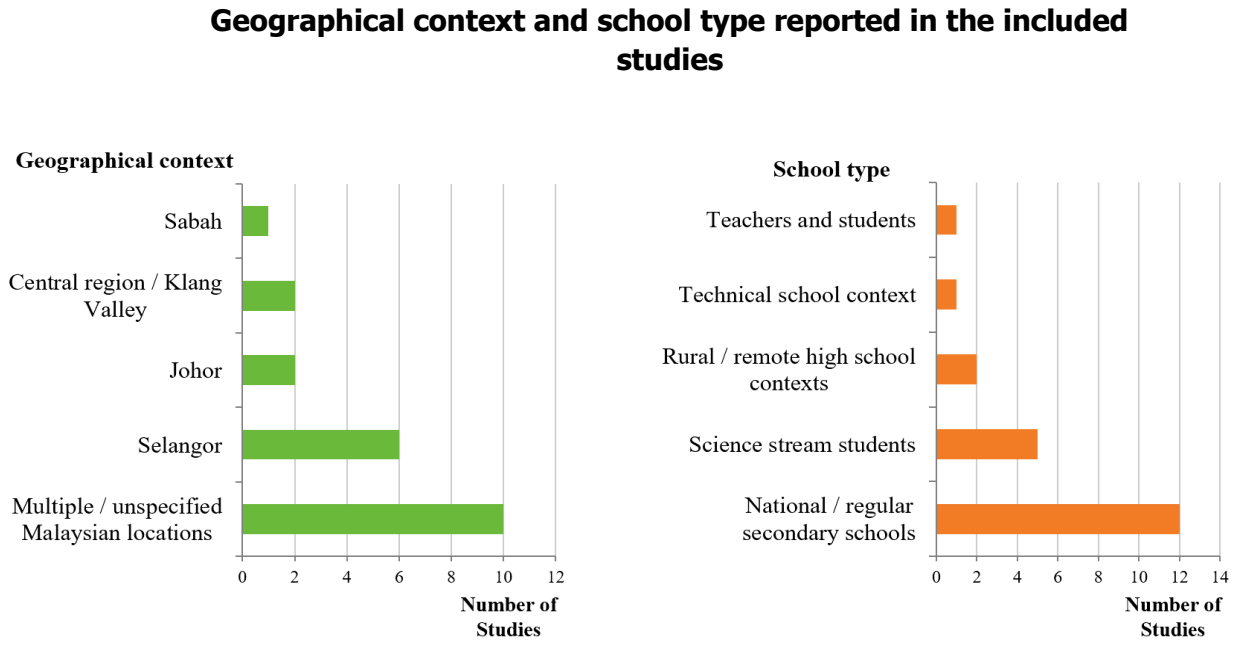

Figure 4. Geographical context and school type of the included studies (n = 20)

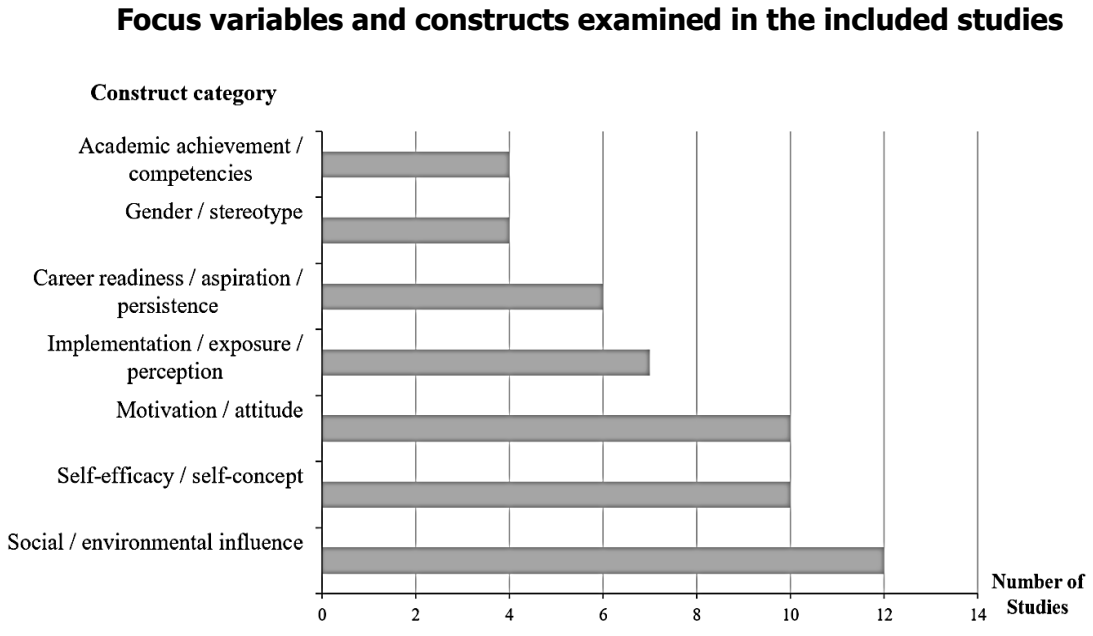

Figure 5. Frequency of focus variables and constructs across the included studies (n = 20)

Figure 5 presents the frequency of focus variables and constructs examined in the studies included in this systematic review. The findings show that the most frequently examined construct category was social / environmental influence (n = 12), followed by self-efficacy / self-concept (n = 10) and motivation / attitude (n = 10). A moderate number of studies focused on implementation / exposure / perception (n = 7) and career readiness / aspiration / persistence (n = 6). In contrast, fewer studies examined academic achievement / competencies (n = 4) and gender / stereotype (n = 4). Overall, the distribution suggests that the reviewed literature has primarily concentrated on social-contextual and psychological constructs in explaining STEM career interest among Malaysian secondary school students, while comparatively less attention has been given to gender-related factors and academic competency-based variables.

Across the included studies, several consistent patterns were identified in relation to research design, participant groups, geographical context, school setting, and focus constructs. Most studies employed quantitative, non-experimental designs, particularly survey, correlational, descriptive, and SEM-based approaches. The reviewed evidence also focused mainly on upper secondary students, especially Form Four students, with fewer studies involving lower secondary students, female-only samples, or both teachers and students. In terms of context, the studies were conducted largely across regular secondary school settings and broader Malaysian locations, with Selangor emerging as the most frequently specified state. Across the reviewed studies, the most frequently examined constructs were social and environmental influence, self-efficacy, self-concept, motivation, and attitude, while fewer studies focused on academic achievement, competencies, gender, and stereotype. Overall, the included studies suggest that research on STEM career interest among Malaysian secondary school students has been shaped mainly by quantitative evidence and has placed stronger emphasis on psychological and social-contextual determinants than on demographic or performance-based factors.

4.3 Thematic Synthesis of the Selected Studies

The thematic synthesis of the 20 included studies identified four major themes explaining the factors influencing STEM career interest among Malaysian secondary school students. The themes were generated using a hybrid inductive-deductive coding approach. All studies contributed to at least one theme, and several informed multiple themes depending on the factors examined.

The four themes were:

1. Social and Environmental Influences on STEM Interest and Career Choice
2. Psychological and Motivational Determinants of STEM Aspiration, Interest, and Persistence
3. Gender and Differential Patterns in STEM Career Orientation
4. STEM Education Implementation, Learning Context, Exposure, and Student Readiness

Collectively, these themes demonstrate that STEM career interest among Malaysian secondary school students is shaped by the interaction of social influences, psychological factors, gender-related experiences, and educational contexts. The findings indicate that students' interest in STEM-related careers develops not only through personal motivation and self-belief, but also through environmental support, learning experiences, and exposure to STEM pathways.

To provide a clearer overview of how the included studies contributed to the thematic synthesis, the distribution of studies across the identified themes was mapped. Table 4 presents the alignment between each included study and the themes identified through the thematic analysis. The table indicates which studies contributed to each theme, illustrating how the empirical evidence supporting the thematic findings is distributed across the reviewed literature.

As shown in Table 4, each included study was aligned with its primary theme based on the dominant focus of the study. This thematic classification indicates that the factors influencing STEM career interest among Malaysian secondary school students can be organised into four interrelated areas, namely social and environmental influences, psychological and motivational determinants, gender-related patterns, and STEM education implementation and learning context. The thematic mapping presented in Table 4 therefore provides a structured overview of how the

empirical evidence from the included studies supports the themes identified in this systematic review. The following sections discuss each theme in greater detail.

4.3.1 Theme 1: Social and Environmental Influences on STEM Interest and Career Choice

Across the five studies, social and environmental influences emerged as major determinants of STEM interest and career orientation among Malaysian secondary school students. A consistent pattern across the literature is the central role of the family environment, particularly parental influence, in shaping both STEM interest and career intention. Tey *et al.* (2020) showed that parental influence significantly predicted both STEM interest and STEM career choice intention, whereas teacher influence was not statistically significant and friend influence was limited to career choice intention. Razali *et al.* (2022) similarly found that parental autonomy had a direct and significant effect on STEM career interest, suggesting that supportive parental involvement acts as an enabling condition for longer-term STEM aspiration. Halim *et al.* (2023) likewise reported that family influence was one of the strongest contextual variables, although its effect operated through self-efficacy rather than through a simple direct pathway.

Table 4. Distribution of Included Studies Across the Identified Themes

No.	Studies	Theme 1: Social and Environmental Influences on STEM Interest and Career Choice	Theme 2: Psychological and Motivational Determinants of STEM Aspiration, Interest, and Persistence	Theme 3: Gender and Differential Patterns in STEM Career Orientation	Theme 4: STEM Education Implementation, Learning Context, Exposure, and Student Readiness
1.	Alam *et al.* (2021)			✓	
2.	Bakar and Mahmud (2020)		✓		
3.	Fridict *et al.* (2023)	✓			
4.	Halim *et al.* (2023)	✓			
5.	Ismail and Asrah (2025)	✓			
6.	Mahmud *et al.* (2022)		✓		
7.	Mohd Farid and Othman, 2025)				✓
8.	Mustapa *et al.* (2023)				✓
9.	Nor Huzir *et al.* (2025)		✓		
10.	Rahman and Halim (2022)			✓	
11.	Razali (2021)		✓		
12.	Razali *et al.* (2020a)		✓		
13.	Razali *et al.* (2020b)		✓		
14.	Razali *et al.* (2022)	✓			
15.	Riduan and Othman (2024)				✓
16.	Shamsuddin *et al.* (2025)				✓

17.	Sulong and Mahfar (2025)		✓		
18.	Tey *et al.* (2020)	✓			
19.	Tey *et al.* (2024)			✓	
20.	Zainal Abidin *et al.* (2025)				✓

Another recurring pattern concerns the interaction between social context and students' perceived capability. Environmental support appears most meaningful when it strengthens confidence, self-belief, and perceived competence. Halim *et al.* (2023) demonstrated that family influence and out-of-school learning experiences affected STEM career interest through self-efficacy, while media exposure influenced interest both directly and indirectly. Fridict *et al.* (2023) similarly identified self-efficacy, attitude, and normative social influence as central determinants of the intention to study STEM. Ismail and Asrah (2025) reinforced this pattern by showing that students with low confidence in their ability to succeed in STEM, weak family encouragement, or limited role model exposure were more likely to disengage from STEM pathways. These findings suggest that social influence is strongest when it reinforces competence beliefs rather than merely transmitting advice or expectations.

The studies also indicate that not all social agents and educational environments exert equal influence. Tey *et al.* (2020) found that teachers did not significantly influence either STEM interest or STEM career choice intention, a finding that contrasts with conventional expectations about teachers as major school-based role models. Halim *et al.* (2023) likewise found that in-school learning experiences did not significantly affect self-efficacy or STEM career interest, whereas out-of-school learning experiences were more influential. Fridict *et al.* (2023) adds an important contextual layer through an outreach setting in Tongod District, where STEM exposure was intended to raise awareness among students with more limited access to science and technology. These findings suggest that formal classroom exposure alone may be insufficient, whereas informal, outreach-based, and socially reinforced experiences may exert a stronger influence on STEM engagement.

Within this theme, STEM career interest appears to develop within a layered social ecology. Family influence emerges as the most consistent factor, while peer influence is more selective and teacher influence appears weaker than commonly assumed. Media exposure, out-of-school learning opportunities, and visible role models also appear to strengthen students' confidence and enhance the perceived relevance of STEM for their future lives. These findings suggest that STEM career development is shaped not by academic exposure alone, but by the combined influence of supportive relationships, perceived competence, and socially meaningful images of STEM careers.

4.3.2 Theme 2: Psychological and Motivational Determinants of STEM Aspiration, Interest, and Persistence

The studies under this theme consistently show that STEM career development among Malaysian secondary school students is strongly associated with psychological readiness rather than exposure alone. Bakar and Mahmud (2020) framed aspiration and career interest as psychosocial constructs that explain how students move toward STEM and TVET pathways, while Razali *et al.* (2020a) argued that a positive attitude towards STEM is insufficient without the reinforcing role of science motivation. A similar pattern appears in Razali *et al.* (2020b) where science motivation was treated as a central mechanism in developing STEM career interest, and in Razali (2021) where STEM career interest was modelled as the result of several learner-related factors operating together. These studies suggest that students' beliefs, motives, and aspirations form a key foundation for STEM orientation at the secondary school stage.

A major point of convergence across the studies is the role of motivation and self-efficacy as proximal drivers of STEM aspiration and persistence. Razali *et al.* (2020a) found that motivation to learn science mediated the relationship between attitude towards STEM and STEM career interest, indicating that favourable attitudes become effective when translated into sustained motivational energy. Razali *et al.* (2020b) extended this argument by

identifying self-efficacy, self-determination, intrinsic motivation, grade motivation, and career motivation as important components of science motivation with strong explanatory value for STEM career interest. Nor Huzir *et al.* (2025) reinforced the importance of self-efficacy by showing that students with stronger self-belief were more likely to remain in STEM education after enrolment, while Sulong and Mahfar (2025) showed that career outcome expectations were the strongest predictor of career readiness. These findings suggest that STEM aspiration is supported by two closely related processes, confidence in present capability and belief in future benefit.

Another pattern concerns the relationship between career interest structure, aspiration alignment, and STEM-related decision quality. Bakar and Mahmud (2020) found high congruency between aspiration and interest in the Social, Investigative, and Realistic dimensions, suggesting that students are more likely to make coherent educational choices when personal orientation aligns with career imagery. Mahmud *et al.* (2022) reached a similar conclusion, reporting that career interests were significantly related to STEM careers among Form Three students. Sulong and Mahfar (2025) further showed that not all interest dimensions contributed equally to future readiness, with Investigative and Conventional interests showing stronger positive effects than other RIASEC dimensions.

The studies also indicate that STEM career interest is best understood as a multifactor construct rather than a single-variable outcome. Razali (2021) showed that attitudes towards STEM, 21st-century skills, science motivation, and parental authority jointly explained a substantial proportion of the variance in STEM career interest. Razali *et al.* (2020a) and Razali *et al.* (2020b) similarly suggested that motivational mechanisms do not operate independently, but are connected to broader learning experiences and future career intention. Bakar and Mahmud (2020), Mahmud *et al.* (2022), Nor Huzir *et al.* (2025) and Sulong and Mahfar (2025) further indicate that these psychological determinants shape not only initial interest, but also persistence, readiness, and longer-term STEM orientation. Within this theme, psychological readiness appears to provide a strong explanatory base for STEM aspiration, interest, persistence, and career preparedness.

4.3.3 Theme 3: Gender and Differential Patterns in STEM Career Orientation

The studies under this theme indicate that gender remains a relevant factor in STEM career orientation, although its influence is neither simple nor consistently direct. Alam *et al.* (2021) highlighted the continued underrepresentation of girls in STEM education, particularly in technology- and engineering-related pathways, and argued that female participation must be understood through a combination of cognitive and contextual influences rather than gender alone. Rahman and Halim (2022) also identified gender disparity as an ongoing issue, but reported a more moderate pattern in which STEM career interest was generally at a medium-high level, with boys showing only slightly higher interest than girls. Tey *et al.* (2024) further showed that gender did not dominate the overall decision structure, as it moderated only one pathway in the proposed model. These findings suggest that gender functions less as an isolated cause and more as a background condition interacting with other mechanisms that shape STEM orientation.

A key point of convergence across the studies is the close relationship between gendered STEM orientation and psychological factors, particularly self-efficacy, attitudes, and stereotype-related beliefs. Alam et al. (2021) found that attitude, motivation, and career outcome expectancy positively influenced STEM self-efficacy, whereas gender stereotype and teacher stereotype had negative effects, with self-efficacy subsequently predicting intention to pursue STEM education. Rahman and Halim (2022) similarly examined intrinsic and extrinsic factors, including self-efficacy, social influence, media influence, and perception, indicating that gender differences in STEM interest should be understood within a broader motivational structure. Tey *et al.* (2024) reached a comparable conclusion by showing that students' attitudes significantly influenced career choice intention and that media exposure and attitude mediated the effects of social norms. Together, these findings indicate that gender-based variation in STEM orientation is often shaped through confidence beliefs, evaluative attitudes, and exposure to gendered messages in the learning environment.

The studies also show that the strength of gender effects varies across contexts. Rahman and Halim (2022) reported that boys tended to show higher STEM career interest, yet also found minimal differences between male and female students across several intrinsic and extrinsic factors. Tey *et al.* (2024) likewise found only a marginal moderating effect of gender, suggesting that it may not fully explain career intentions when broader social and

psychological variables are considered. In contrast, Alam *et al.* (2021) showed that stereotype-related factors continue to constrain female participation. This variation suggests that gender disparities become more visible when examined through stereotype and self-efficacy pathways than when treated as a simple demographic difference.

Within this theme, gender differences in STEM orientation appear to reflect differences in experience, perception, and support rather than fixed preferences. The evidence suggests that strengthening self-efficacy, reducing stereotype pressure, and expanding access to meaningful STEM experiences may be more important than focusing on gender alone.

4.3.4 Theme 4: STEM Education Implementation, Learning Context, Exposure, and Student Readiness

The studies under this theme show that STEM career interest is closely linked to how STEM is implemented in schools and how students experience the learning environment. Riduan and Othman (2024) reported that implementation in Malaysian secondary schools remains constrained by incomplete teaching equipment, limited internet access, insufficient infrastructure, and heavy syllabus demands. Zainal Abidin *et al.* (2025) similarly indicated that student interest is shaped by everyday classroom experiences, particularly when lessons are engaging, relevant, and supported by clear teaching. Mohd Farid and Othman (2025) found that students in urban settings showed more positive STEM interest when instructional methods were effective and connected to real-world applications. These findings suggest that implementation quality influences interest through concrete learning conditions, pedagogical delivery, and students' perceptions of whether STEM is understandable and meaningful.

A second pattern concerns the relationship between learning context and student engagement, particularly the distinction between structural access and actual experience. Mohd Farid and Othman (2025) showed that even in resource-rich urban schools, gaps in student confidence persisted and the relationship between interest and academic performance was weak. Zainal Abidin *et al.* (2025) in a rural context, reported generally positive attitudes toward STEM but emphasised that interest was shaped more by perceived relevance, teacher clarity, and collaborative learning than by resource availability alone. Riduan and Othman (2024) support this interpretation by identifying resource shortages and infrastructure limitations as continuing barriers. These findings suggest that differences in STEM interest cannot be explained solely by location, as both urban and rural contexts highlight the importance of how students interpret the quality and relevance of their learning experiences.

The theme also highlights the role of exposure-based interventions in strengthening STEM orientation. Mustapa *et al.* (2023) showed that targeted exposure, such as webinars on electrical engineering careers and overseas study experiences, was associated with strong post-programme interest. Zainal Abidin *et al.* (2025) similarly found that students responded positively to engaging and discussion-based STEM learning, while Riduan and Othman (2024) reported favourable responses toward technology-integrated teaching approaches. These findings suggest that exposure is most effective when STEM is presented as a meaningful and accessible pathway rather than as a purely academic subject.

Another important issue is student readiness for future STEM participation. Shamsuddin *et al.* (2025) identified distinct student profiles based on self-perceived competencies and career preferences, showing variation in confidence, leadership, and focus across STEM-related fields. Mohd Farid and Othman (2025) further indicated that positive interest does not necessarily translate into strong academic performance, while Riduan and Othman (2024) emphasised that implementation barriers may limit opportunities to develop deeper competencies. These findings suggest that readiness should be understood as a layered construct involving confidence, skill development, career focus, and institutional support.

Within this theme, STEM career interest appears to develop through the interaction of implementation quality, meaningful exposure, and contextual relevance, which together shape students' readiness for future pathways.

5. Discussion

The findings of this review indicate that STEM career interest among Malaysian secondary school students is shaped by the interaction of social, psychological, gender-related, and educational factors rather than by any single determinant. This suggests that STEM career interest should be understood as a developmental and context-sensitive construct, rather than as a fixed outcome of curriculum exposure alone. Across the reviewed studies, interest appears to strengthen when students encounter consistent reinforcement across home, school, and future career expectations. In this sense, the reviewed evidence points to an important connection between students' immediate learning experiences and their longer-term perceptions of whether STEM is relevant, attainable, and worthwhile.

One clear implication is that social and psychological factors do not operate independently, but reinforce one another. Family support, parental expectations, peer interaction, and role models appear to shape the social meaning of STEM, while self-efficacy, science motivation, and career outcome expectations influence how students interpret these external signals in relation to their own capability and future prospects (Tey *et al.*, 2020; Razali *et al.,* 2022; Razali *et al.,* 2020a; Razali *et al.,* 2020b; Sulong & Mahfar, 2025). This helps explain why exposure alone is often insufficient. Students are more likely to sustain interest in STEM when support from parents, schools, and learning environments is translated into personal confidence and perceived future value (Nor Huzir *et al.,* 2025; Mahmud *et al.,* 2022). The themes therefore connect through a shared mechanism: contextual encouragement becomes influential when it is internalised as competence, motivation, and aspiration.

The review also suggests that gender and school context are best interpreted as conditions that shape access to confidence-building and meaningful STEM experiences, rather than as isolated explanatory variables. Gender-related differences appear to reflect unequal exposure to stereotype pressure, expectations, and supportive opportunities rather than simple differences in preference (Alam *et al.,* 2021; Rahman & Halim, 2022; Tey *et al.,* 2024). Similarly, school implementation matters because students' interest is strengthened when STEM is experienced through engaging teaching, relevant examples, and practical exposure, but weakened when infrastructure, resources, or instructional support are limited (Riduan & Othman, 2024; Mustapa *et al.,* 2023; Zainal Abidin *et al.,* 2025; Shamsuddin *et al.,* 2025). Taken together, these findings suggest that stronger STEM career interest is most likely to develop when social support, psychological readiness, gender-sensitive encouragement, and high-quality educational experiences are aligned. At the same time, the reviewed evidence remains dominated by quantitative and cross-sectional designs, indicating a need for more longitudinal and contextually diverse research to clarify how STEM career interest develops over time.

6. Implications and Contributions

This review contributes to the literature on STEM career interest among Malaysian secondary school students in several important ways. Theoretically, it shows that STEM career interest is shaped not by a single determinant, but by the interaction of four interrelated domains: social and environmental influences, psychological and motivational determinants, gender-related patterns, and STEM education implementation and learning context. This synthesis offers a more integrated understanding of STEM career interest as a developmental and multidimensional construct within the Malaysian secondary school context.

Practically, the findings suggest that efforts to strengthen STEM career interest should extend beyond curriculum content and academic performance alone. More effective support requires coordinated involvement from schools, families, counsellors, and policymakers. Parental encouragement, meaningful exposure to STEM careers, confidence-building learning experiences, and gender-sensitive support appear particularly important in sustaining students' interest in STEM pathways.

Methodologically, this review maps the dominant characteristics of the Malaysian literature published between 2020 and 2025. The evidence is largely shaped by quantitative and cross-sectional studies, with a stronger focus on upper secondary students, regular school settings, and social-contextual and psychological constructs. This pattern highlights important gaps, including the limited use of longitudinal and intervention-based designs and the lack of more diverse school and student contexts. The review also proposes a conceptual framework showing how these four domains interact to shape STEM career interest and related outcomes, including aspiration, career choice, persistence, and readiness for future pathways.

Figure 6 presents the proposed conceptual framework derived from the thematic synthesis of the reviewed studies. The framework illustrates that STEM career interest among Malaysian secondary school students is shaped by the interaction of four main domains, namely social and environmental influences, psychological and motivational determinants, gender-related patterns, and STEM education implementation, learning context, exposure, and student readiness. These domains interact in shaping students' interest in STEM pathways, which may subsequently influence broader outcomes such as aspiration, career choice, persistence, and readiness for future STEM-related directions.

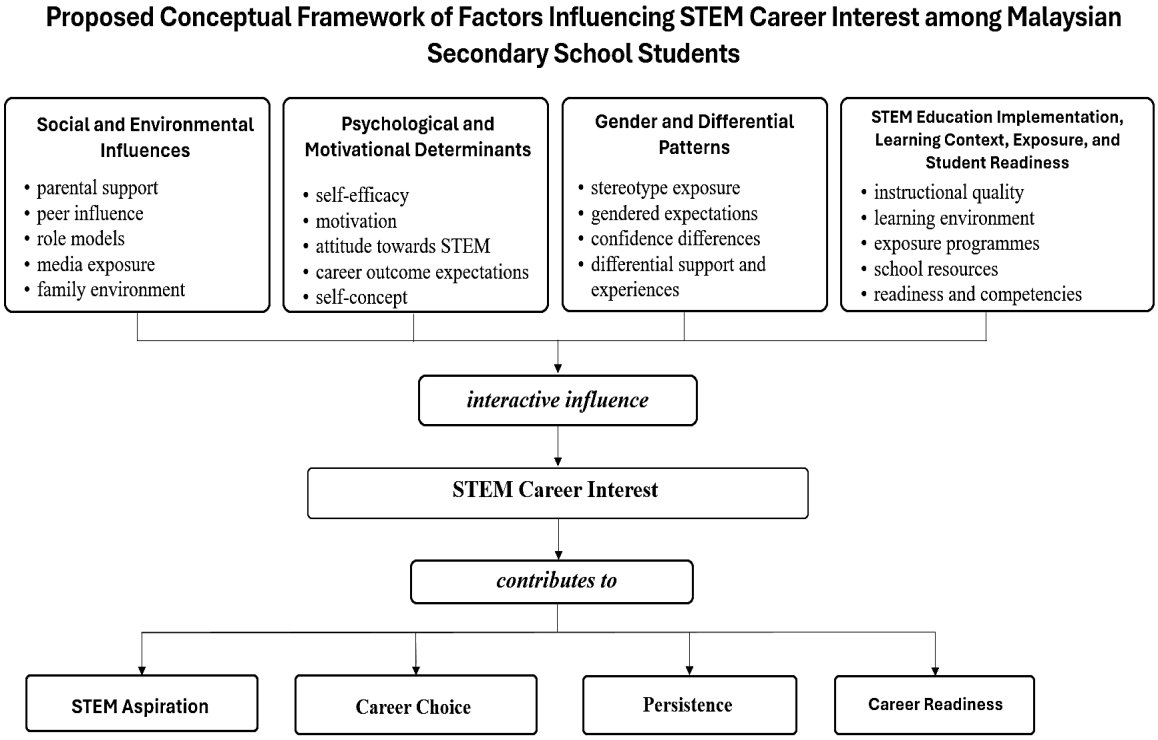

Figure 6. Proposed conceptual framework of factors influencing STEM career interest among Malaysian secondary school students

7. Conclusion

This systematic literature review examined the factors influencing STEM career interest among Malaysian secondary school students based on empirical studies published between 2020 and 2025. Four major themes were identified: social and environmental influences, psychological and motivational determinants, gender-related patterns, and STEM education implementation, learning context, exposure, and student readiness. Together, these themes show that STEM career interest develops through the interaction of contextual support, internal motivation, gendered experiences, and the quality of school-based learning environments.

The findings indicate that STEM career interest is shaped not by a single factor, but by a combination of parental support, role model exposure, self-efficacy, science motivation, career outcome expectations, stereotype-related experiences, and meaningful STEM learning opportunities. The review further suggests that strengthening STEM interest requires support beyond academic instruction alone. More effective outcomes are likely when students are supported by families and schools, exposed to relevant STEM experiences, and guided through learning environments that build confidence, relevance, and future orientation. Future research should include more diverse contexts, student groups, and longer-term perspectives on STEM career development.

8. Limitation

Several limitations should be acknowledged. First, this review was restricted to studies published between 2020 and 2025, which may have excluded relevant earlier or later work. Second, the search process included Google Scholar in addition to Scopus and Web of Science to capture locally relevant and context-specific studies on Malaysian secondary school students. Although this broadened coverage, it may also have introduced variation in indexing standards, publication type, and reporting quality across the included studies. Third, the findings depend on the

methodological characteristics of the selected studies. Differences in sample characteristics, school settings, instruments, and analytical procedures may have affected the consistency of the reported results. Accordingly, the synthesis reflects recurring patterns in the literature rather than direct causal relationships. In addition, the dominance of quantitative studies may have limited deeper interpretation of how STEM career interest develops across different student experiences and educational contexts. Finally, because the review focused specifically on Malaysian secondary school students, the findings may not be directly generalisable to other educational levels or national contexts.

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Author contribution statement

Kamarnisa Abd Rahim: Conceptualization, methodology, literature search, data extraction, formal analysis, writing original draft, and technical/material support. Mohd Izwan Mahmud: Supervision, validation, writing review and editing, and final approval of the manuscript. Ku Suhaila Ku Johari: Supervision, validation, and writing review and editing. All authors have read and agreed to the published version of the manuscript.

Does this article screen for similarity?

Yes

Conflict of Interest

The authors have no conflicts of interest to declare. There is also no financial interest to report. The author certifies that the submission is original work and is not under review at any other publication.

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