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Enhancing STEM education through peeragogy: Exploring the impact of demographics factor

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Abstract: Despite the growing recognition of the peeragogy learning approach, which emphasizes students' active participation and responsibility in their learning, there is still a gap in understanding how demographic factors influence its effectiveness in Science, Technology, Engineering and Mathematics (STEM) education. While pedagogy aims to harness the individual potential to promote independence, collaboration, and deep understanding, few studies have been conducted on how different demographic factors impact the success of this approach. This study aims to identify the trends in the peeragogy learning approach among students for STEM subjects in the Upper Secondary Vocational Program (PVMA) stream based on demographic factors such as gender, STEM subjects and socioeconomic status (SES). The design of this study is survey research that employs a quantitative approach, and a modified set of questionnaires derived from past studies was used as the research instrument. A total of 158 students enrolled in STEM subjects under the PVMA stream at secondary schools were randomly selected as the study samples. The results indicate that most students in STEM subjects under the PVMA stream prefer a goal-oriented peeragogy learning approach, a consistent trend across both genders. Socioeconomic status also plays a role, with students from varying household income levels generally preferring the self-directed peeragogy learning approach. Different STEM subjects and SES affect PVMA students' choice of peeragogy learning approaches. In conclusion, educational institutions can improve the effectiveness of peeragogy in STEM education for PVMA students by promoting equitable learning opportunities for different SES and developing peeragogy strategies based on different STEM subjects.

Keywords: Peeragogy; Vocational education; Quality education; STEM gender, Socioeconomic Status (SES)

1. Introduction

As the education landscape evolves in response to technological advancements and globalization, it is crucial to address the effectiveness of current teaching methods, particularly in STEM education. STEM subject is emphasized as one of the crucial components of implementing 21st-century learning skills (Khalil & Osman, 2017). It focuses on elective subjects based on Pure Science and Additional Mathematics, Applied Science and Technology and PVMA (Muhammad & Noor Ibrahim, 2021). Through this learning, students can practice concepts, practical skills, and industry experience related to the STEM field (Ravi & Mahmud, 2021). Integrating STEM education also helps generate critical thinking skills and improve problem-solving skills among students (Davidi et al., 2021).

This study seeks to bridge gaps in conventional educational practices by examining how peeragogy

approaches vary in STEM education based on students' demographic factors such as gender, STEM subjects, and SES. Conventional teaching methods such as lecture-based instruction, textbook-centric learning, and standardized testing that do not prioritize a goal-oriented learning may inadvertently neglect to inspire students or align learning with their interests and aspirations (Herpi et al., 2024). This oversight has significant implications as it can erode students' motivation and diminish the perceived relevance of educational content, resulting in decreased enthusiasm and engagement (Gumartifa et al., 2023).

Additionally, an excessive dependence on teacher direction within these teaching methods can hinder the cultivation of independent learning skills. When students passively receive ingestion rather than actively engage in their learning, it can lead to superficial understanding and inadequate development of critical thinking abilities (Widana et al., 2023). Consequently, this approach may restrict students' capacity to apply knowledge beyond structured classroom environments. Based on Burt et al. (2023), the absence of active participation and goal setting in the learning process poses challenges for long-term retention of information. Without a personal investment in their learning objectives, students may struggle to see the enduring significance and relevance of the material they are studying, potentially diminishing their overall educational experience and outcomes.

Therefore, integrating peeragogy learning approaches is crucial for fostering deeper engagement and critical thinking and enhancing students' ability to retain and apply knowledge effectively. Peeragogy is a peer-based learning approach where students interact with other students to achieve the same educational goals (Amiruddin et al., 2023). Peeragogy is characterised by collaborative, two-way communication, and learner-centred strategies (Purwantini et al., 2022; Suhaimi et al., 2021). It is an active learning which is able to strengthen the 21st-century learning skills (Prasetya et al., 2022). It encourages students to increase knowledge by sharing information, fostering active engagement, problem-solving and critical thinking skills (Shet, 2024), thus improving communication skills (Ramesh et al., 2023) and academic achievement, especially in STEM subjects (Kizito & Telephore, 2019).

Peeragogy offers a flexible framework that can be adapted to accommodate diverse learning needs and preferences (Eden et al., 2024). This is particularly relevant when considering how peeragogy benefits both male and female students and can vary based on demographic factors. Study indicates that engagement with peeragogy may differ by gender, and its effectiveness can also vary across different STEM subjects within the PVMA stream. Additionally, peeragogy offers a means to address socioeconomic disparities by providing more inclusive and supportive learning opportunities. Thus, peeragogy's adaptability to diverse learning contexts underscores its potential to improve educational outcomes across varying demographic and subject-specific needs.

By analyzing these trends, this study aims to enhance the inclusivity and effectiveness of STEM education, ensuring that peeragogy can effectively address diverse student needs and support their development in a rapidly evolving technological world. Therefore, this study aims to:

(1) identify the tendency of peeragogy learning approach among STEM students based on demographic factors.
(2) analyse the difference in peeragogy learning approach among STEM students based on gender.
(3) analyse the difference in peeragogy learning approach among STEM students based on STEM subjects.
(4) analyse the difference in peeragogy learning approach among STEM students based on SES.

2. Methods

This study is survey research that employs a quantitative approach. The population comprises 166 first-year students enrolled in PVMA subjects at secondary schools in Batu Pahat, Johor. The rationale for selecting the schools is based on the issue of a decline in student achievement in PVMA subjects. The subjects include Cooling and Air Conditioning Equipment Services, Furniture Manufacturing, Food Crops, Landscape and Nursery, and Food Preparation. The sample size distribution for the study is based on the population, as outlined in Table 1. Samples from each secondary school were chosen using a random sampling technique based on Krejcie & Morgan (1970) Table, resulting in a study sample of 158 students. The conduct of student involvement as the respondents in this study is in accordance with the Declaration of Helsinki.

Table 1. Population and sample size of the study

Secondary schools	Population	Samples
SMK Tun Ismail	19	18
SMK Datuk Menteri	22	21
SMK Seri Medan	18	17
SMK Permata Jaya	25	24
SMK Senggarang	22	21
SMK Penghulu Saat	21	20
SMK Tunku Putra	19	18
SMK Dato Onn	20	19
Total	**166**	**158**

A set of questionnaires was used as the research instrument. The questionnaire consists of two sections, Section A and Section B. In Section A, respondents were required to provide information related to their gender, family income level, and the type of elective STEM subjects they were taking. There are 48 items in Section B. All the items were modified from Mohamad et al. (2022) questionnaire and related to the pedagogy learning approach consisting of five constructs, called student-centered, self-directed, consensus-based, sharing-based, and goal-oriented peeragogy learning approaches. The respondents in this research have voluntarily agreed to complete the questionnaire, and their data has been approved for publication.

Content validation of questionnaire was carried out by three lecturers from the Faculty of Technical and Vocational Education (FPTV), who are experts in STEM fields, critical thinking skills, and peeragogy learning approaches. For the pilot study, the questionnaire was randomly distributed to 30 students in PVMA subjects. The Cronbach's Alpha value was used to obtain reliability scores for the analysed variables. The alpha value for the peeragogy learning approach items is .93. The Cronbach's alpha value exceeding 0.80 up to 1.0 indicates an excellent and effective alpha value with a high level of reliability (Bond et al., 2020). Therefore, the items in the questionnaire are appropriate to use.

All collected data was analysed using SPSS version 29. The research utilized descriptive statistical methods to determine the percentage and frequency of agreement for each tendency pattern in pedagogy learning approaches based on demographic factors. However, the inferential statistical methods were used to analyse the difference in the peeragogy approach based on students' gender, STEM subjects, and SES. Due to the type of data for the dependent variable, the peeragogy learning approach is nominal data that uses a dichotomous scale: agree and disagree, the non-parametric test, Kruskal-Wallis H, was used to find the mean difference in the five constructs of the peeragogy learning approach based on gender, STEM subjects, and SES.

3. Results and discussion

Tendecy of peeragogy learning approach among STEM students based on demographics

The findings in Table 2 show that most students (70.3%) tend to practice a goal-oriented peeragogy learning approach. It is followed by a student-centred, self-directed sharing, and consensus-based peeragogy learning approach (Table 3).

Table 2. Tendency of peeragogy learning approach among STEM students

Peeragogy learning approach	Disagree		Agree	
	f	%	*F*	%
Student-centered	53	33.5	105	66.5
Self-directed	57	36.0	101	64.0
Consensus-based	50	31.6	108	68.4
Sharing	57	36.1	101	63.9
Goal-oriented	47	29.7	111	70.3

The findings were influenced by students who take STEM subjects in the PVMA stream are trained to work in groups to complete assignments given by teachers, especially in teaching and learning sessions. Students will work together to learn and solve problems collaboratively (Bakhmat et al., 2023). Directly, it enhances students' performance by encouraging deeper understanding and retention of knowledge and cultivates essential skills such as critical thinking, teamwork, and communication. By setting and achieving shared goals, students become more motivated and take greater responsibility for their learning journey, ultimately leading to a more enriching educational experience that positively impacts their overall development (Kimmel, 2024). This is closely related to the goal-based peeragogy learning approach, which has characteristics that emphasize the active involvement of students in achieving shared learning objectives (Rozali & Halim, 2020).

Table 3. Descending order pattern of peeragogy learning approach tendencies among STEM students

Peeragogy learning approach	*f*	Descending order
Goal-oriented	111	
Student-centred	105	
Self-directed	101	
Sharing	101	
Consensus-based	108	

The goal-oriented peeragogy learning approach is often used by male and female students (Table 4). Male and female STEM students have almost the same tendencies in terms of the peeragogy learning approach (Table 5). This is because every student, regardless of gender, needs to communicate, collaborate, share opinions, and actively engage in group work to solve problems and achieve task goals and learning objectives together (Karnan & Marimuthu, 2021).

Table 4. Tendency of peeragogy learning approach based on students'gender

Peeragogy learning approach	Male				Female			
	Disagree		Agree		Disagree		Agree	
	F	%	*f*	%	*f*	%	*f*	%
Student-centred	38	33.0	77	67.0	15	34.9	28	65.1
Self-directed	41	35.7	74	64.3	16	37.2	27	62.8
Consensus-based	35	30.4	80	69.6	15	34.9	28	65.1
Sharing	40	34.8	75	65.2	17	39.5	26	60.5
Goal-oriented	33	28.7	82	71.3	14	32.6	29	67.4

Table 5. Descending order pattern of peeragogy learning approach tendencies based on students' gender

Male		Female		Descending order
Peeragogy learning approach	*f*	Peeragogy learning approach	*f*	
Goal-oriented	82	Goal-oriented	29	↓
Consensus-based	80	Consensus-based	28	
Student-centred	77	Student-centred	28	
Sharing	75	Self-directed	27	
Self-directed	74	Sharing	26	

Table 6. Tendency of peeragogy learning approach based on STEM subjects

STEM subjects			Student-centred	Self-directed	Consensus-based	Sharing	Goal-oriented
Landscape and Nursery	Disagree	*f*	18	18	14	16	14
		%	40.9	40.9	31.8	36.4	31.8
	Agree	*f*	26	26	30	28	30
		%	59.1	59.1	68.2	63.6	68.2
Food Preparation	Disagree	*f*	15	14	15	17	15
		%	37.5	35	37.5	42.5	37.5
	Agree	*f*	25	26	25	23	25
		%	62.5	65	62.5	57.5	62.5
Food Crops	Disagree	*f*	11	13	11	14	12
		%	31.4	38.2	31.4	40	34.3
	Agree	*f*	24	21	24	21	23
		%	68.6	61.8	68.6	60	65.7
Furniture Manufacturing	Disagree	*f*	5	6	6	6	5
		%	23.8	28.6	28.6	28.6	23.8
	Agree	*f*	16	15	15	15	16
		%	76.2	71.4	71.4	71.4	76.2
Cooling and Air Conditioning Equipment Services	Disagree	*f*	3	5	4	5	2
		%	16.7	26.3	22.2	27.8	11.1
	Agree	*f*	15	14	14	13	16
		%	83.3	73.7	77.8	72.2	88.9

Table 7. Descending order pattern of peeragogy learning approach tendencies based on STEM subjects

Landscape and Nursery		Food Preparation		Food Crops		Furniture Manufacturing		Cooling and Air Conditioning Equipment Services		Descending Order
Peeragogy Learning Approach	***f***	**Peeragogy Learning Approach**	***f***	**Peeragogy Learning Approach**	***f***	**Peeragogy Learning Approach**	***f***	**Peeragogy Learning Approach**	***f***	
Consensus-based	30	Self-directed	26	Student-centred	24	Student-centred	16	Goal-oriented	16	
Goal-oriented	30	Consensus-based	25	Consensus-based	24	Goal-oriented	16	Student-centred	15	
Sharing	28	Goal-oriented	25	Goal-oriented	23	Self-directed	15	Self-directed	14	
Student-centred	26	Student-centred	25	Self-directed	21	Consensus-based	15	Consensus-based	14	
Self-directed	26	Sharing	23	Sharing	21	Sharing	15	Sharing	13	

Based on Table 6 and Table 7, most students taking the subjects of Landscape and Nursery, Furniture Manufacturing, and Cooling and Air Conditioning Equipment Service practice a goal-oriented peeragogy learning approach. For the subject of Food Preparation, most students tend to practice a self-directed learning approach, while students taking the subject of Food Crops tend to use a consensus-based peeragogy learning approach.

Adopting a goal-oriented peeragogy learning approach among students in fields such as Landscape and Nursery, Furniture Manufacturing, and Cooling and Air Conditioning Equipment Service significantly contributes to their development (Omar et al., 2020). In Landscape and Nursery, students are trained to plan and execute landscape projects (Hersperger et al., 2020), which enhances their ability to achieve desired outcomes through strategic planning and resource management (Szeidl & Aubert, 2021). This hands-on training in selecting plants, designing layouts, and managing resources equips students with essential skills for executing successful projects, fostering creativity and technical expertise (Li & Pilz, 2023).

In Furniture Manufacturing, students' strong interest in the subject drives them to produce quality work within specified timeframes, highlighting the motivational impact of a goal-oriented approach (Rafiola et al., 2020). Similarly, in Cooling and Air Conditioning Equipment Service, practical tasks encourage students to collaborate effectively, reinforcing the importance of teamwork in achieving educational objectives (Paurine et al., 2021). This approach provides students with practical skills relevant to their fields and cultivates their ability to work collaboratively towards common goals, preparing them for future professional challenges.

The use of a self-directed peeragogy approach in Food Preparation significantly positively impacts student development. This approach encourages students to take the initiative in their learning process by independently researching and understanding the concepts behind various dishes (Rodés-Paragarino et al., 2024). By engaging in self-directed learning, students develop critical skills such as time management, resourcefulness, self-motivation, gathering information on ingredients, cooking techniques, and food presentation (Prayag et al., 2020). The collaborative aspect of peeragogy allows students to enhance their interpersonal and communication skills as they share ideas and insights with classmates. This process not only fosters creativity and innovation in food preparation but also builds confidence and autonomy in learners (Oliveira et al., 2022), preparing them for future challenges in education and their careers. Ultimately, this approach cultivates a

well-rounded skill set, enabling students to become more effective and adaptive learners.

The consensus-based peeragogy approach used in the study of Food Crops significantly contributes to student development by fostering practical and interpersonal skills (Daud et al., 2024). In this learning model, students work collaboratively, guided by teachers, to manage and care for food crops. The need for group consensus in decision-making, such as selecting plant types and scheduling care, teaches students the value of cooperation and collective problem-solving (Tiwari, 2008). This approach enhances students' gardening skills and develops essential social skills, as they must communicate effectively and negotiate with peers to reach agreements. Additionally, students cultivate leadership abilities by taking initiative and guiding group discussions and activities. As a result, this educational strategy prepares students with hands-on agricultural knowledge and equips them with the teamwork and leadership skills necessary for success in various future endeavours (Khoshnodifar et al., 2020).

Table 8 shows that students with varying household income levels tend to practice a self-directed learning approach. It was found that students with household incomes between RM3971 and RM4850 also practice a student-centred peeragogy learning approach (4.9%). Meanwhile, 45.6% of students with household incomes below RM2500 are less likely to practice a sharing-based peeragogy learning approach. This is followed by students with household incomes between RM2501 and RM3170 (10.4%) and between RM3171 and RM3970 (3.8%).

Table 8. Tendency of peeragogy learning approach based on SES

Peeragogy Learning Approach	Below RM2500				RM2501-RM3170				RM3171-RM3970				RM3971-RM4850			
	Disagree		Agree		Disagree		Agree		Disagree		Agree		Disagree		Agree	
	f	%	*f*	%	*f*	%	*f*	%	*F*	%	*f*	%	*F*	%	*f*	%
Student-centred	36	32.4	75	67.6	10	37	17	63	4	36.4	7	63.6	2	22.2	7	77.8
Self-directed	33	29.7	78	70.3	5	18.5	22	81.5	3	27.3	8	72.7	1	11.1	8	88.9
Consensus-based	34	30.6	77	69.4	9	33.3	18	66.7	4	36.4	7	63.6	3	33.3	6	66.7
Sharing	39	35.1	72	64.9	10	37	17	63	5	45.5	6	54.5	3	33.3	6	66.7
Goal-oriented	32	28.8	79	71.2	9	33.3	18	66.7	5	45.5	6	54.5	2	22.2	7	77.8

Adopting a self-directed peeragogy learning approach by students from diverse SES fosters several positive impacts on their development. By engaging in group activities, students are encouraged to independently explore various resources and bring their insights to the group. This practice enhances their teamwork skills, as they must collaborate and communicate effectively with peers. Additionally, the requirement to independently investigate learning materials promotes critical thinking and self-motivation, as students take responsibility for their learning journey. By exploring knowledge through multiple sources, students gain a broader and deeper understanding of the subjects studied, which enriches their academic experience. This approach prepares students for academic success and equips them with essential skills for lifelong learning and adaptability in diverse environments (Morgan et al., 2022).

Table 9. Descending order pattern of peeragogy learning approach tendencies

Below RM2500		RM2501-RM3170		RM3171-RM3970		RM3971-RM4850		Descending order
Peeragogy Learning Approach	*F*	Peeragogy Learning Approach	*f*	Peeragogy Learning Approach	*f*	Peeragogy Learning Approach	*f*	
Goal-oriented	79	Self-directed	22	Self-directed	8	Self-directed	8	
Self-directed	78	Consensus-based	18	Student-centred	7	Student-centred	7	
Consensus-based	77	Goal-oriented	18	Consensus-based	7	Goal-oriented	7	
Student-centred	75	Student-centred	17	Sharing	6	Consensus-based	6	
Sharing	72	Sharing	17	Consensus-based	6	Sharing	6	

Difference in peeragogy learning approach based on gender

Kruskal-Wallis H test indicates that gender does not significantly influence the peeragogy learning approach (Table 10). Peeragogy, which emphasizes collaborative learning and peer interactions, provides an inclusive environment where male and female students can thrive equally. Such an approach fosters a sense of community and belonging, enhancing motivation and engagement in learning (Triantafyllou et al., 2024). By working towards specific goals (Sides & Cuevas, 2020), students develop critical thinking and problem-solving skills as they navigate challenges and devise strategies for success. Ultimately, the goal-oriented peeragogy approach, which aligns with the outcome-based education (OBE) system, empowers students to take ownership of their learning (Marín et al., 2020), increasing confidence and preparation for future academic and professional endeavours.

Table 10. Kruskal-Wallis H test for differences in peeragogy learning approach based on gender

Gender		Peeragogy Learning Approach				
		Student-centred	Self-directed	Consensus-based	Sharing	Goal-oriented
Male	N	115	115	115	115	115
	Mean Rank	78.54	79.22	81.97	82.79	82.49
Female	N	43	43	43	43	43
	Mean Rank	82.07	80.26	72.88	70.70	71.51
Kruskal-Wallis H		0.19	0.02	1.24	2.20	1.81
p		0.67	0.90	0.27	0.14	0.18

*Significant differences at $p < .05$

The mean rank of male students is higher than female students. This shows that male students are more likely to use the peeragogy learning approach in their learning compared to female students. Male students prefer to work together, share knowledge, and support each other's learning, fostering community and mutual respect. Male students have higher team identification, which lead to lower freeriding behaviour and thus more cooperation, while women were nevertheless more tempted not to contribute their fair share of work (Gomez-Ruiz & Sánchez-Expósito, 2020).

Difference in peeragogy learning approach based on STEM subjects

Kruskal-Wallis H test indicates that there is a significant difference between STEM subjects and Student-centred, Sharing, and Goal-oriented peeragogy learning approaches. STEM subjects traditionally focus on acquiring specific technical knowledge and skills (Sumarni et al., 2019), emphasizing structured learning, problem-solving (Ravi & Mahmud, 2021), and mastery of complex concepts (Yusof et al., 2021), through direct instruction and standardized curricula. Each subject has a unique and meaningful learning approach (Suhaimi et al., 2021). Understanding these differences will provide valuable learning experiences to students and help them master the subject better.

In contrast, a student-centred peeragogy approach prioritizes collaborative learning, critical thinking, and the co-creation of knowledge through peer interaction and shared experiences (Beukman, 2021). This approach fosters a more personalized and adaptive learning environment, encouraging students to take ownership of their education, explore interdisciplinary connections, and develop skills such as communication, teamwork, and self-directed learning. The significant difference lies in the shift from a teacher-directed, content-focused model to a learner-driven, and process-oriented framework, which can lead to a deeper understanding of the material through active engagement and mutual support among peers.

Table 11. Kruskal-Wallis H test for differences in peeragogy learning approach based on STEM subjects

STEM Subjects		Peeragogy learning Approach				
		Student-centred	Self-learning	Consensus-based	Sharing	Goal-oriented
Food Crops	N	35	35	35	35	35
	Mean Rank	76.04	75.60	77.96	75.39	73.57
Landscape and Nursery	N	44	44	44	44	44
	Mean Rank	67.34	72.11	80.02	77.38	78.58
Furniture Manufacturing	N	21	21	21	21	21
	Mean Rank	89.86	81.02	80.50	93.50	86.38
Cooling and Air Conditioning Equipment Services	N	18	18	18	18	18
	Mean Rank	106.9	103.00	105.72	103.9	113.67
Food Preparation	N	40	40	40	40	40
	Mean Rank	78.10	79.66	67.95	67.10	66.75
Kruskal-Wallis H		11.00	6.21	8.56	10.47	14.30
P		*0.03	0.18	0.07	*0.03	*0.01

*Significant differences at $p < .05$

There is a significant difference between STEM subjects and sharing-based peeragogy learning approach due to the distinct nature and objectives of each. STEM subjects focus on developing and implementing critical thinking, problem-solving, and analytical skills through a structured and quantitative approach (Topsakal et al., 2022). They involve understanding complex theories,

conducting experiments, and using mathematical models to explain natural phenomena and create technological advancements. Sharing-based peeragogy learning approach pertains to the interpersonal and social process of distributing information, resources, or experiences among individuals or groups. It emphasizes communication, collaboration, and cultivating relationships, which are more qualitative and subjective.

For a goal-oriented peeragogy learning approach, each of these subjects which is Food Crops, Landscape and Nursery, Furniture Making, Cooling and Air Conditioning Equipment Services, and Food Preparation inherently demands a strong focus on practical, outcome-driven tasks that require students to work towards specific objectives or goals (Mora et al., 2020). For example, in Food Crops, students engage in activities that involve planning, cultivating, and managing various crops, which necessitates a clear understanding of the desired outcomes, such as maximizing yield or improving crop quality.

Similarly, Landscape and Nursery involves planning and executing landscape projects, where students must select appropriate plants, design spatial layouts, and manage resources efficiently to achieve the intended aesthetic and functional goals. On the other hand, furniture-making requires students to focus on creating well-crafted, functional pieces of furniture, which involves meticulous planning, precise execution, and problem-solving skills to meet specific design and structural requirements. In Cooling and Air Conditioning Equipment Services, students are required to do tasks dealing with maintaining or improving system efficiency, which involves diagnosing issues, implementing solutions, and achieving energy efficiency goals, aligning with a goal-oriented approach. Lastly, Food Preparation demands that students understand the principles of cooking and nutrition and execute recipes and meal plans that meet specific dietary and presentation goals.

The goal-oriented peeragogy approach is effective in these STEM subjects because it encourages students to actively engage in problem-solving, collaborate in groups, and implement theoretical knowledge to practical tasks, ultimately leading to a deeper understanding and mastery of the subject matter (Shchedrina et al., 2020). This approach is particularly suited to these disciplines as it mirrors real-world professional scenarios where students achieve specific and essential measurable outcomes, preparing them for future careers.

Difference in peeragogy learning approach based on SES

Kruskal-Wallis H analysis indicates that there is a significant difference between STEM students with various socioeconomic statuses and goal-oriented peeragogy learning approaches. The significant differences between STEM students from various SES and their adoption of a goal-oriented peeragogy learning approach can be attributed to several interconnected factors.

Students from lower SES backgrounds, such as those with household incomes below RM1000, may face challenges such as limited access to educational resources, less academic support at home, and fewer opportunities for extracurricular enrichment (Mamat & Abdul Wahab, 2022). These constraints can impact their ability to fully engage in a goal-oriented peeragogy approach, which typically requires active participation, collaboration, and access to independent and group learning resources. In contrast, students from higher SES backgrounds, for example, those with household incomes ranging from RM3971 to RM4850 often have better access to learning materials, technology, and academic support, which can facilitate their engagement in a goal-oriented learning.

Table 12. Kruskal-Wallis H test for differences in peeragogy learning approach among STEM students based on socio economic status

Socio Economic Status		Peeragogy Learning Approach				
		Student-centred	Self-learning	Consensus-based	Sharing	Goal-oriented
Below RM 1000	N	40	40	40	40	40
	Mean Rank	79.26	82.40	79.95	86.84	82.05
RM1001-RM2500	N	71	71	71	71	71
	Mean Rank	82.90	77.06	82.33	79.87	80.10
RM2501-RM3170	N	27	27	27	27	27
	Mean Rank	72.98	79.20	74.96	69.17	71.04
RM3171-RM3970	N	11	11	11	11	11
	Mean Rank	67.55	75.55	64.05	59.82	55.77
RM3971-RM4850	N	9	9	9	9	9
	Mean Rank	87.89	91.56	87.67	99.06	117.83
Kruskal-Wallis H		2.01	1.08	2.09	6.12	10.39
p		0.73	0.90	0.72	0.19	*0.03

*Significant differences at $p < .05$

This disparity in access and support can make these students more adept at setting and achieving academic goals through peeragogy, as they will likely have the resources and environments conducive to this learning approach. Moreover, higher SES students may also have more opportunities to develop soft skills such as teamwork, leadership, and communication, which are crucial for successful participation in a goal-oriented peer learning (Green-weir et al., 2021). Consequently, the variation in SES influences the degree to which students can participate effectively in a peeragogy learning approach, with higher SES students often being better positioned to benefit from this collaborative, goal-driven educational strategy. These dynamics highlight the broader impact of SES factors on educational outcomes, where students from more advantaged backgrounds may have a distinct edge in leveraging peeragogy for their academic success, leading to significant differences in learning experiences and outcomes across different SES groups.

4. Conclusion

As a result of these research findings, teachers can identify patterns in students' tendencies toward peeragogy learning approaches, enabling them to implement teaching and learning methods better suited to their students' needs. The insights gained from this study are crucial for educators, as they provide deeper understanding of student behaviour and learning preferences, allowing for more targeted and effective teaching strategies. Moreover, by aligning teaching methods with students' learning tendencies based on demographic factors, educators can enhance the overall quality of education, leading to improved school excellence and reputation. This benefits the students and the school and contributes significantly to the broader development of education in Malaysia, reinforcing the country's commitment to cultivating a more knowledgeable and capable generation.

Author contribution

Nur Nadia Binti Md Arsad prepared the literature review, collected and analyzed the research data, while Yee Mei Heong conceptualized the research, interpreted and discussed the research findings

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Conflict of interest

There are no competing interests for all authors.

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