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Implementation of Educational Robotics in Inclusive Classroom from the Lenses of Pre-service Teachers

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ABSTRACT

Integrating Educational Robotics (ER) into inclusive classrooms offers a transformative path toward equitable learning. This study examines pre-service teachers' attitudes and perceptions regarding ER implementation at the Institute of Teacher Education, Technical Education Campus (IPGKPT), Malaysia. Aligned with global frameworks like the OECD Learning Compass 2030 and Malaysia's Digital Education Policy 2023–2030, the research evaluates ER's role in modernising inclusive pedagogy. Employing a descriptive quantitative design, data were collected from 61 pre-service teachers via a validated questionnaire. The results indicate a very high positive attitude towards educational technology (M = 4.32) and a strong belief in ER's potential to enrich inclusive teaching (M = 4.12). Respondents particularly highlighted ER's ability to foster digital literacy, creativity, and problem-solving skills in students with Special Educational Needs (SEN) (M = 4.30). Despite this optimism, the study identifies significant barriers, including insufficient technical expertise and infrastructural gaps. These findings underscore an urgent need for targeted professional development and pedagogical training. The research concludes that while ER effectively supports differentiated instruction and learner engagement, its success depends on enhancing teacher education curricula and strategic policy alignment. This study provides a foundation for future research and curriculum reform, ensuring pre-service teachers are equipped to bridge the gap between technological potential and inclusive classroom practice.

1.0 Introduction

The emergence of Educational Robotics (ER) as a pedagogical innovation offers transformative potential for fostering inclusive, equitable and future-ready education. There is evidence that ER plays a crucial role in regulating differentiated and adaptive learning for students with diverse needs, aligning with both global and national efforts to reimagine education for the 21st century in inclusive classrooms. Recent developments in OECD Learning Compass 2030 have heightened the need for transformative competencies such as creating new value, reconciling tensions, and taking responsibility as ER serves as a meaningful platform for student-centred classroom and inclusive learning (OECD, 2019). This vision is further reinforced by Sustainable Development Goal 4, which advocates for inclusive and equitable quality education, preparing for future challenges and lifelong learning opportunities for all (UNESCO, 2016).

In further, these findings complement with Malaysia's Digital Education Policy (DEPM 2023) which identifies robotics and automation as key drivers of digital transformation in teaching and learning, emphasizing the need for accessible and adaptive digital tools for all learners to improve engagement and learning experiences (Ministry of Education Malaysia, 2023). Similarly, the Malaysia TVET Policy 2030 also highlights the integration of advanced technologies like robotics to modernize curricula and promote inclusion, particularly in Industry 4.0-aligned sectors (Ministry of Human Resources Malaysia, 2024). Meanwhile, at regional level, the ASEAN Secretariat's initiatives to promote business engagement in upskilling and reskilling underscore robotics as a strategic skill for workforce resilience, advocating cross-sector collaboration and inclusive education pathways (ASEAN Secretariat, 2025). In general, ER supports lifelong learning by continuously developing digital competencies and problem-solving skills, which are crucial for adapting to evolving job markets (Kaliappan et al., 2025; Razli et al., 2025).

In essence, the published literature provides a robust evidence base supporting the claim that ER, in its various forms, serves as a powerful catalyst for developing the multifaceted skills required for success in the digital age. The consensus across numerous studies is that these approaches move beyond traditional rote learning to foster a more dynamic and empowering educational experience. These studies consistently point to a strong connection between engagement with ER and the development of skills such as critical thinking, problem-solving, creativity, collaboration, and computational thinking. (Nazirbek et al., 2025; Khoyratty & Bheekharry, 2024; Tzagkaraki et al., 2021; Eguchi & Uribe, 2017). Several studies have indicated that educational robotics effectively bridges the gap between theoretical knowledge and practical applications, thereby enhancing students' understanding and preparedness. Additionally, it equips learners with essential skills required to thrive in increasingly technology-driven career pathways. (Nazirbek et al., 2025; Maciel et al., 2023).

On a broader perspective, this has intensified the call for renewed efforts to integrate Educational Robotics (ER) into Inclusive Education, as it offers underprivileged and at-risk children meaningful opportunities to acquire essential skills for the modern workforce regardless of their future academic or career paths (Alimisis, 2021). Through its emphasis on interactive, hands-on tasks, Educational Robotics (ER) dismantles learning barriers. This approach is believed to foster an inclusive atmosphere where every student, including those with disabilities or unique learning requirements, is an engaged participant (Castaneda Rincon et al., 2024; Schiavo et al., 2024; Canet et al., 2022). These activities not only encourage participation but also significantly enhance students' social interactions, cognitive abilities, and emotional development (Paulino et al., 2024). Additionally, ER supports differentiated instruction, providing personalized learning experiences that accommodate various learning styles, thereby empowering all students to participate equally and achieve success in inclusive educational settings.

More recently, literature has emerged that offers contradictory findings despite its benefits, ER faces challenges such as limited teacher knowledge and technical difficulties (Tzagkaraki et al., 2021). Many educators do not have formal training in Educational Robotics (ER), which can result in uncertainty and ineffective implementation in the classroom. This lack of expertise may hinder their ability to integrate ER effectively into their teaching practices (Screpanti et al., 2021). Additionally, technical difficulties such as insufficient infrastructure, lack of access to appropriate tools, and compatibility issues further complicate the adoption process (Canet et al., 2022; Zabala et al., 2021; Scaradozzi et al., 2019). These challenges highlight the need for targeted professional development and improved resources to facilitate the effective integration of Educational Robotics in educational settings especially among pre-service teachers.

These challenges are particularly pronounced in inclusive education settings, where the diverse needs of learners require careful adaptation and support especially from teachers. Integration of Educational Robotics (ER) into inclusive educational settings especially represents a groundbreaking pedagogical paradigm that effectively utilizes technological advancements to significantly serve as powerful catalyst for fostering student engagement and intrinsic motivation (Mobo et al., 2025; Ribeiro et al., 2025; Grubisic & Crnokic, 2024). Additionally, this pedagogical innovation demonstrates significant potential for fostering engagement within heterogeneous student populations by effectively accommodating their varied learning profiles (Hanssen & Khitruk, 2021). It closely aligns with the principles outlined in the Salamanca Statement and Framework for Action on Special Needs Education (UNESCO, 1994), which advocates for inclusive education systems that support all learners, especially those with special educational needs (Kanyopa, 2023). However, the successful realization of ER's potential is contingent upon teachers acquiring not only technical proficiency but also pedagogical fluency in deploying robotics meaningfully within diverse classroom settings. Building teacher capacity in ER is therefore essential, as it equips educators with the necessary competencies to create adaptive, inclusive, and technologically enriched learning environments that align with 21st-century educational demands.

2.0 Objectives and Research Questions

The specific objective of this study is to investigate the implementation of educational robotics in inclusive classroom among pre-service teachers in Institute of Teacher Education, Technical Education Campus. Information gained on pre-service teachers' attitude and views pertaining to implementation of educational robotics in inclusive classroom is fundamental as it underscores their professional responsibility to develop the necessary competencies for effective robotics instruction. Moreover, the information obtained from this study could be useful for policymakers, Design and Technology learning program designers and lecturers. In order to address the aforementioned research objective, this paper attempts to answer the following research questions:

i. What is the level of attitude towards technology in education among pre-service teachers in Institute of Teacher Education, Technical Education Campus?

ii. What is the view of pre-service teachers in Institute of Teacher Education, Technical Education Campus on educational robotics?

iii. What is the view of pre-service teachers in Institute of Teacher Education, Technical Education Campus on the potential of educational robotics in education?

iv. What is the view of pre-service teachers in Institute of Teacher Education, Technical Education Campus on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN)?

2.1 Conceptual Framework

The conceptual framework established in this study aims to analyze the potential for integrating educational robotics in inclusive classrooms among pre-service teachers at the Institute of Teacher Education, Technical Education Campus. The conceptual framework as illustrated in Figure 1 comprises of independent variables (IV) which consist of attitude and views meanwhile dependent variable (DV) measures implementation of educational robotics among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT). This conceptual framework aims to clarify key concepts and illustrate the anticipated relationships between variables in this study.

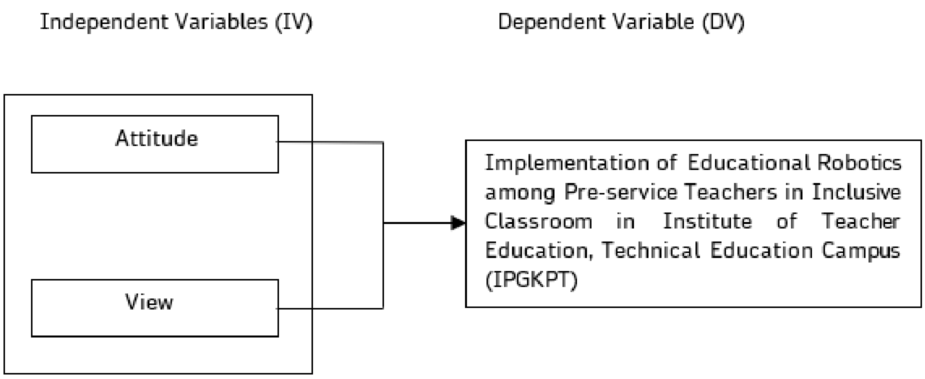

Fig. 1: Conceptual Framework

3.0 Methodology

The study adopts a quantitative research design focusing on a descriptive approach, as the researchers aim to pose specific, focused questions to investigate attitudes and views in implementation of educational robotics in inclusive classroom among pre-service teachers at Institute of Teacher Education, Technical Education Campus (Creswell, 2008). Consequently, a survey was employed to collect quantifiable data from respondents. As highlighted in various studies, surveys are one of the most practical methods for distributing questionnaires to a small sample to identify trends in attitudes, opinions, behaviours, or characteristics representative of a larger population (Ghazali & Sufean, 2018; Creswell, 2008; Wiersma, 1991). Moreover, surveys are advantageous due to their cost-effectiveness and reduced workload compared to studying an entire population (Malhotra & Birks, 2007). The data gathered through the survey was then analysed statistically in an objective and unbiased manner.

Therefore, a survey is administered to observe the attitude and views of pre-service teachers at Institute of Teacher Education, Technical Education Campus (IPGKPT) in implementation of educational robotics in inclusive classroom. The population of this study comprised of 73 pre-service teachers from Bachelor of Teaching Degree Program (PISMP) (June 2022 Intake, Year 3, Semester II) enrolled in RBTS3392 Inclusive Education majoring in Design and Technology (RBT). The sample size in this study was determined using Krejie and Morgan (1970) sample size determiner with a 5% margin of error and a 95% confidence level to achieve statistical significance (Bukhari, 2021). Therefore, 61 respondents were selected using simple random sampling to ensure every individual in the population had an equal chance of selection to participate in this study. A set of questionnaires was then administered to 61 respondents, and the survey was conducted online using Google Forms. This is based on the fact that digitally collected data has been shown to be more efficient than pen-and-paper methods in the matter of speedy data handling, less lost or incorrect data and general feasibility (Drummond et al.,1995).

Data collection was conducted through a structured questionnaire administered online via Google Forms. According to Christopher and Bruce (1985), questionnaires are the easiest way to obtain information from a big group of respondents and are able to collect valid and reliable data for analysing a research problem to obtain computable information. Respondents received an email, phone messages and social media invitation containing a link to the questionnaire. The whole questionnaire took approximately 10–15 minutes to complete. Follow-up reminders were sent to respondents to ensure a high response rate and the anonymity of responses was maintained to encourage honest feedback. The questionnaire consisted of sections on demographic information, pre-service teachers' attitude towards technology in education (8 items), pre-service teachers' views on educational robotics (2 items), pre-service teachers' views on the potential of educational robotics in education (6 items) and pre-service teachers' views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN) (11 items) aligning with the objectives of the study. Total items administered in this questionnaire was 20 items altogether.

Table 1: Cronbach Alpha's reliability according to construct

Construct	Number of items	Cronbach Alpha	Interpretation
Pre-service teachers' attitudes	8	0.91	Excellent
Pre-service teachers' views on ER	2	0.86	Good
Pre-service teachers' views on the potential of ER	6	0.92	Excellent
Pre-service teachers' views on the competencies	11	0.92	Excellent
Total	27	0.90	Excellent

The questionnaire underwent pre-testing with a pilot group of 30 pre-service teachers to ensure clarity, reliability, and validity. Feedback from the pilot phase led to minor adjustments, enhancing the quality of the final instrument. The reliability of the questionnaire was assessed using Cronbach's Alpha as shown in Table 1 above, which yielded values exceeding 0.80 for all constructs, indicating acceptable internal consistency. The validity was ensured through content validation by two experts in the field of Special Education and Design and Technology. Feedback from these experts helped refine the phrasing and relevance of the items to align with the study objectives. The questionnaire was evaluated using 5-point Likert Scale as it is established that the accuracy of statistics calculated is not compromised (Rasmussen, 1989). The interpretation of mean score by Tschannen-Moran and Gareis (2004), was used to determine level of attitude and views in implementation of educational robotics in inclusive classroom among pre-service teachers at Institute of Teacher Education, Technical Education Campus (IPGKPT) in Table 2 below. Thenceforth, data were analysed by descriptive statistics namely mean and standard deviation (SD) using Statistical Package for Social Science (SPSS) version 30. Responses were analysed using statistical techniques, including descriptive analysis. The structured design of the questionnaire and rigorous testing ensured the accuracy and applicability of the data collected for this research. In general, this study was conducted with a focus on obtaining descriptive information to answer aforementioned research questions.

Table 2: Interpretation of mean value

Mean Value	Interpretation of Mean Value
1.00 - 1.80	Very Low
1.81 - 2.60	Low
2.61 - 3.40	Average
3.41 - 4.20	High
4.21 - 5.00	Very High

4.0 Discussion of analysis and findings

This study was conducted among 61 pre-service teachers from Bachelor of Teaching Degree Program (PISMP) (June 2022 Intake, Year 3, Semester II) majoring in Design and Technology (RBT) at Institute of Teacher Education, Technical Education Campus (IPGKPT). The respondents of this study were selected randomly. Table 3 lists the information on the respondents' background with 14 (23%) respondents are male meanwhile 47 (77%) are female. Based on the analysis of the respondents' demographic, it can be established that most of the respondents were predominantly female. The distribution of respondents was balanced across three classes, with each class consisting of 21, 20, and 20 respondents, respectively, ensuring a relatively equal representation across the study groups.

Table 3: Respondents' demographic information (n=61)

Profile	Category	Frequency	Percentage (%)
Gender	Male	14	23
	Female	47	77
Class	RBT1	21	34
	RBT2	20	33
	RBT3	20	33

4.1 Attitude towards technology in education among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT)

Table 4 demonstrates the mean value and level of pre-service teachers' attitude towards technology in education in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at very high level (M=4.32, SD=0.64). Based on normality test conducted using Kolmogorov-Smirnov test, the data of attitude towards technology in education (df = 61, sig.> 0.05) were not significant. Hence, this indicates that the data is normally distributed. Findings revealed, most respondents agreed that they view that technology has a beneficial impact on teaching (M=4.57). The lowest mean recorded in item B04 as technology has solved problems of access to learning for pupils with mental disabilities (M=4.07). Based on Table 4 as shown below, the descriptive analysis found that the overall mean of pre-service teachers' level of attitude towards technology in education is very high. Therefore, this finding suggests that the level of attitude towards technology in education among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at very high level.

Table 4: Pre-service teachers' attitudes towards technology in education

	Item	Mean	SD	Level
B01	Technology has solved problems of access to learning for pupils with motor disabilities.	4.26	0.68	Very High
B02	Technology has solved problems of access to learning for pupils with hearing and/or visual sensory disabilities.	4.26	0.60	Very High
B03	Technology has solved problems of access to learning for pupils with intellectual disabilities.	4.21	0.70	Very High
B04	Technology has solved problems of access to learning for pupils with mental disabilities.	4.07	0.74	High
B05	The view that technology has a beneficial impact on teaching is correct.	4.57	0.59	Very High
B06	In my personal experience, I have found that the impact of technology on teaching is appreciable.	4.31	0.62	Very High
B07	Technology is used to support programmes to individualize education according to the individual needs of students.	4.28	0.63	Very High
B08	Learning is enhanced when text and images are integrated in a multimedia environment.	4.56	0.56	Very High
		4.32	0.64	Very High

4.2 Views On Educational Robotics Among Pre-Service Teachers In Institute Of Teacher Education, Technical Education Campus (IPGKPT)

Table 5 demonstrates the mean value and level of pre-service teachers' views on educational robotics in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at high level (M=4.14, SD=0.66). Based on normality test conducted using Kolmogorov-Smirnov test, the data of views on educational robotics (df = 61, sig.> 0.05) were not significant. Hence, this indicates that the data is normally distributed. Findings revealed, most respondents agreed that educational robotics can have a very high overall impact on students with Special Educational Needs (SEN) (M=4.16). The lowest mean recorded in item C10 Educational robotics is possible to reduce the problems of access to learning for students with Special Educational Needs (SEN) (M=4.11). Based on Table 5 as shown below, the descriptive analysis found that the overall mean of pre-service teachers' level of views on educational robotics is high. Therefore, this finding suggests that the level of views on educational robotics among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at high level.

Table 5: Pre-service teachers' views on educational robotics

	Item	Mean	SD	Level
C09	Educational robotics can have a very high overall impact on students with Special Educational Needs (SEN).	4.16	0.66	High
C10	Educational robotics is possible to reduce the problems of access to learning for students with Special Educational Needs (SEN).	4.11	0.66	High
		4.14	**0.66**	**High**

4.3 Views On The Potential Of Educational Robotics In Education Among Pre-Service Teachers In Institute Of Teacher Education, Technical Education Campus (IPGKPT)

Table 6 demonstrates the mean value and level of pre-service teachers' views on the potential of educational robotics in education in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at high level (M=4.12, SD=0.68). Based on normality test conducted using Kolmogorov-Smirnov test, the data of views on the potential of educational robotics in education (df = 61, sig.> 0.05) were not significant. Hence, this indicates that the data is normally distributed. Findings revealed, most respondents agreed the most on item D16 'generalising and transferring what has been learnt to other areas' (M=4.23). The lowest mean recorded in item D12 as 'designing, organising and planning' (M=4.03). Based on Table 6 as shown below, the descriptive analysis found that the overall mean of pre-service teachers' level of views on the potential of educational robotics is high. Therefore, this finding suggests that the level of views on the potential of educational robotics among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at high level.

Table 6: Pre-service teachers' views on the potential of educational robotics in education

	Item	Mean	SD	Level
D11	Problem solving and making decisions	4.07	0.70	High
D12	Designing, organising and planning	4.03	0.70	High
D13	Analysing, discriminating and thinking critically	4.05	0.69	High
D14	Collaborating, evaluating, co-operating and sharing	4.16	0.66	High
D15	Understanding and handling errors	4.15	0.67	High
D16	Generalising and transferring what has been learnt to other areas	4.23	0.64	Very High
		4.12	0.68	High

4.4 Views On The Competencies Enhanced By Educational Robotics On Students With Special Educational Needs (SEN) Among Pre-Service Teachers In Institute Of Teacher Education, Technical Education Campus (IPGKPT)

Table 7 demonstrates the mean value and level of pre-service teachers' views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN) in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at very high level (M=4.30, SD=0.67). Based on normality test conducted using Kolmogorov-Smirnov test, the data of views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN) (df = 61, sig.> 0.05) were not significant. Hence, this indicates that the data is normally distributed. Findings revealed, most respondents agreed that digital competence is the most important competency (M=4.62) meanwhile the lowest mean recorded in item E17 'social, empathy, relational and affective' seemed to less important competency (M=4.08). Based on Table 7 as shown below, the descriptive analysis found that the overall mean of pre-service teachers' views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN) is very high. Therefore, this finding suggests that the level of views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN) among pre-service teachers in Institute of Teacher Education, Technical Education Campus (IPGKPT) is at very high level.

Table 7: Pre-service teachers' views on the competencies enhanced by educational robotics on students with Special Educational Needs (SEN)

	Item	Mean	SD	Level
E17	Social, empathy, relational and affective	4.08	0.68	High
E18	Motivational (involvement, interest and participation)	4.38	0.66	Very High
E19	Expressive, creative and divergent thinking	4.51	0.56	Very High
E20	Functional literacy	4.25	0.67	Very High
E21	Multilingual competence	4.26	0.74	Very High
E22	Competence in Mathematics, Science, Technology and Engineering	4.46	0.62	Very High
E23	Digital competence	4.62	0.52	Very High
E24	Personal, social and learning to learn competence	4.23	0.64	Very High
E25	Citizenship competence	4.15	0.79	High
E26	Entrepreneurial competence	4.16	0.73	High
E27	Cultural awareness and expression competence	4.11	0.77	High
		4.30	0.67	Very High

5.0 Conclusion and Future Research

In conclusion, this study highlights Educational Robotics (ER) as an innovative and effective pedagogical approach to fostering inclusivity and enhancing learning outcomes among students with diverse educational needs. The overwhelmingly positive perceptions and high attitudes of pre-service teachers towards ER underscore its potential to significantly advance inclusive educational practices. Respondents particularly emphasized ER's role in cultivating critical 21st-century competencies such as digital literacy, creativity, and problem-solving skills, essential for students with Special Educational Needs (SEN).

Nevertheless, the implementation of ER is not without challenges. This study identified significant barriers, including insufficient technical proficiency among educators and infrastructural limitations such as inadequate technological resources and facilities. Addressing these barriers is essential for maximizing the potential benefits of ER integration. Consistent with previous research (Grubisic & Crnokic, 2024; Schiavo et al., 2024; Alimisis, 2021), successful integration of ER necessitates continuous professional development, targeted training programs, and robust institutional support mechanisms.

The future of inclusive education intertwined with Educational Robotics (ER) is promising, driven by ongoing advancements in technology and evolving educational frameworks. ER has the potential to revolutionize inclusive classrooms by creating personalized, interactive, and engaging learning experiences tailored to diverse learner needs. Future research should explore emerging technologies such as artificial intelligence and adaptive learning systems integrated with robotics to further enhance personalization and accessibility in education. Additionally, collaboration between policymakers, educators, and technology developers is vital for cultivating innovative, inclusive, and sustainable educational environments. Ultimately, harnessing ER's full potential could lead to significant strides in educational equity, preparing all learners for meaningful participation in an increasingly digital and inclusive global society.

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Author Contributions

Kaliappan A.: Conceptualization, Methodology, Formal analysis, Data curation, Investigation, Writing – original draft; **Adil A.:** Methodology, Formal analysis, Data curation, Writing – original draft; **Saad S.:** Literature review, Writing – original draft; **Zul Azmi. M.:** Literature review, Data curation, Writing – review & editing; **Abdul Aziz M. A.:** Literature review, Validation, Writing – review & editing. **Meidelfi M.:** - Data curation

Conflicts of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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