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THE ACCEPTANCE LEVEL OF STEM TEACHERS TOWARDS BLENDED LEARNING IN A GREEN IT APPROACH ENVIRONMENT: A NEEDS ANALYSIS

Norraihan Rosman[1*], Haslinda Hashim[2], Jamilah Hamid[3]

[1] Department of Computer Science and Digital Technology, Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, Perak, Malaysia
Email: reyyhann_83@yahoo.com
[2] Department of Computer Science and Digital Technology, Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, Perak, Malaysia
Email: haslinda@meta.upsi.edu.my
[3] Department of Computer Science and Digital Technology, Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, Perak, Malaysia
Email: hjamilahmalabar@gmail.com
[*] Corresponding Author

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Abstract:

The adoption of cloud computing technology, a key strategy within Green IT and a central element of Industry 5.0, is regarded as a significant step towards promoting sustainable educational development. This technology delivers systematic computing services, including database management, software applications, smart analytics, and networking capabilities. It facilitates student-centered blended learning by enabling learners to regulate their own learning pace and select resources that align with their individual needs, thereby enhancing their conceptual understanding. This study aimed to examine the levels of knowledge and acceptance among Science, Technology, Engineering, and Mathematics (STEM) teachers regarding the blended learning approach. Employing a descriptive survey design, data were collected through a questionnaire administered to 161 teachers participating in the STEM Teacher Ambassador Program across the northern, central, eastern, and southern regions of Malaysia. The questionnaire was adapted from the Unified Theory of Acceptance and Use of Technology (UTAUT) model, incorporating constructs such as performance expectancy, effort expectancy, attitude towards technology use in learning, social influence, facilitating conditions, self-efficacy, and behavioral intention. The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0 to obtain percentages, mean scores, and standard deviations. The findings revealed that the participating STEM teachers possessed high levels of knowledge and

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acceptance towards blended learning within a Green IT framework (Mean = 3.85, SD = 0.75). In conclusion, this study provides valuable insights into the readiness of STEM educators to adopt blended learning approaches, which have the potential to enhance students' performance in STEM subjects at the secondary school level in Malaysia.

Keywords:

Blended Learning, STEM, Cloud Computing, Green IT

Introduction

The continuous transformations in the globalized world necessitate the reassessment of existing frameworks and the development of new strategies to achieve sustainable development. According to Pizzutilo and Venezia (2021), these changes demand a more profound understanding of sustainable lifestyles and concerted efforts to preserve the environment. In this context, the efficient and responsible management of technology has emerged as a priority, particularly in advancing environmental sustainability.

The advent of the Fifth Industrial Revolution (Industry 5.0) further reinforces this necessity by emphasizing the integration of advanced digital technologies with sustainable development principles (Kamarudin et al., 2022). One of the key approaches emphasized in Industry 5.0 is Green Information Technology (Green IT). As defined by Bridget O (2018) and Kamarudin et al. (2022), Green IT refers to the environmentally responsible and sustainable use of computer technologies and ICT resources. This approach aims to reduce pollution and minimize resource wastage through more efficient energy and data management.

An increasingly prominent application of Green IT in the education sector is cloud computing (Ahmed, 2016). This technology provides secure data storage, rapid access to applications, and online collaboration tools, making it a strategic asset for educational institutions. Cloud computing enables both teachers and students to engage in flexible, collaborative teaching and learning, especially in today's increasingly digital learning environment (Navaneethakrishnan, 2021; Yudantoko, 2020).

The integration of Green IT through cloud computing into blended learning (BL) environments constitutes a relevant and timely strategy in the current educational landscape. Blended learning combines traditional face-to-face instruction with online components, enhancing flexibility, interactivity, and student engagement. This pedagogical model supports the sustainable development agenda while fostering inclusive and effective educational practices, particularly in the post-COVID-19 context (Su & Wang, 2017).

Recent developments highlight the growing adoption of ICT-based innovations across various sectors, including green technologies such as cloud computing. According to Singh and Sharma (2023), the latest ICT innovations contribute to the reduction of carbon emissions and the minimization of resource wastage, thereby aligning with the global sustainability agenda. While Green IT has demonstrated substantial potential in supporting sustainable development in sectors such as industry and agriculture (Li et al., 2023; Landum et al., 2023), its implementation within the education sector especially at the secondary school level remains limited (Ramli et al., 2021).

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Zhao et al. (2023) emphasize that all sectors, including education, must actively contribute to promoting green innovation to fully harness the potential of green technologies within the digital economy. However, the lack of systematic studies and structured implementation strategies has rendered Green IT an underutilized approach in education, particularly among secondary school teachers in Malaysia.

In this regard, there is a pressing need to introduce teaching methods that not only support sustainable development but also address the challenges of climate change. Blended learning has emerged as a promising alternative, offering pedagogical flexibility that can be adapted to the needs of both educators and learners (Chin et al., 2019; Sivapalan, 2017). Nonetheless, the COVID-19 pandemic revealed several limitations within the digital learning system. Mahalingam and Khairul Azhar (2021) reported that many teachers faced difficulties in designing learning materials appropriate to students' abilities during remote learning (PdPR). In addition, the integration of online and face-to-face teaching strategies proved challenging (Yang & Rao, 2022), which negatively impacted student motivation (Platonova et al., 2022).

The absence of clear guidelines for implementing contemporary pedagogical approaches such as cybergogy which integrates digital elements with learning psychology further exacerbates these challenges (Bizami et al., 2022). Mahalingam and Khairul Azhar (2021) also noted that the existing curriculum lacks explicit direction on the effective implementation of such methods. While higher education institutions have increasingly adopted blended learning, its application at the secondary school level, particularly in STEM education, remains underexplored.

In light of these issues, this study aims to investigate the level of knowledge and acceptance of blended learning among STEM teachers within a Green IT framework. This research is essential to identify the training and support mechanisms required to enhance teachers' preparedness for implementing sustainable and technology-driven educational practices.

Literature Review

The continuous transformations in the globalized world necessitate the reassessment of existing frameworks and the development of new strategies to achieve sustainable development. According to Pizzutilo and Venezia (2021), these changes demand a more profound understanding of sustainable lifestyles and concerted efforts to preserve the environment. In this context, the efficient and responsible management of technology has emerged as a priority, particularly in advancing environmental sustainability.

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Additionally, the current curriculum framework in Malaysia does not provide any clear guidelines on how to effectively utilize this pedagogy (Mahalingam & Khairul Azhar, 2021).

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Problem Statement

Despite the recognized potential of Green IT and blended learning in advancing sustainable education, there is still limited empirical evidence on teachers' readiness—particularly STEM teachers at the secondary school level in Malaysia. While higher education institutions have made significant progress in adopting blended learning, secondary schools face unique challenges such as curriculum rigidity, limited training, and the absence of clear implementation guidelines.

Moreover, integrating Green IT principles into blended learning presents additional challenges, including:

- **Low awareness and knowledge** among teachers regarding environmentally sustainable ICT practices.
- **Insufficient infrastructure** to support energy-efficient technologies and cloud-based solutions.
- **Lack of policies and guidelines** linking digital pedagogy with sustainability goals.
- **Pedagogical difficulties** in balancing effective teaching with Green IT considerations, such as minimizing digital waste and promoting eco-friendly practices in online learning.

This lack of systematic studies leaves a gap in understanding how prepared and willing STEM teachers are to embrace blended learning within a Green IT framework. Addressing this gap is essential, as STEM education plays a pivotal role in shaping students' digital competencies, environmental awareness, and problem-solving skills aligned with the sustainability agenda.

Therefore, this study seeks to investigate the level of knowledge and acceptance of blended learning among STEM teachers within the Green IT framework. By addressing this gap, the research aims to provide insights into the training and support mechanisms required to equip teachers with sustainable and technology-driven pedagogical practices, thereby aligning Malaysia's secondary education sector with global sustainability goals.

Unified Theory of Acceptance and Use of Technology (UTAUT) Model

The UTAUT model explains users' intention to use an information system (IS) and the subsequent usage behavior. This theory posits that four main constructs performance expectancy, effort expectancy, social influence, and facilitating conditions are direct determinants of usage intention and behavior (Venkatesh et al., 2003). The UTAUT model was selected at the initial stage of this study due to its strong predictive capability in explaining technology acceptance within organizational settings. Compared to other acceptance models, UTAUT accounts for a higher percentage of variance up to 70% thus offering a more robust explanation of user acceptance in the context of Information Systems (IS) and Information Technology (IT) (Camilleri et al., 2025). UTAUT centers on key factors such as performance expectancy, effort expectancy, social influence, security and privacy, and facilitating conditions(Baig & Yadegaridehkordi, 2025).

Based on these key constructs, the questionnaire items were divided into seven components:

1) Performance Expectancy
2) Effort Expectancy
3) Attitude Toward Using Technology

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4) Social Influence
5) Facilitating Conditions
6) Self-Efficacy
7) Behavioral Intention

The UTAUT model has been employed by other researchers during the needs analysis phase, including studies conducted by Altalhi (2021) and Miranda Veiga and Valente de Andrade (2021). Its application is appropriate for the current research, as it encompasses seven key elements that align with the study's context specifically, assessing teachers' knowledge and acceptance of blended learning within the Green IT framework. This model offers a more comprehensive perspective compared to earlier models, which primarily focused on behavioral intention variables in isolation (Su et al., 2025).

Methodology

This study employed a quantitative descriptive approach using a survey design. A total of 161 secondary school teachers involved in the STEM Teacher Ambassador Program from the northern, central, eastern, and southern zones of Malaysia were selected as the study sample.

The sampling method used was cluster random sampling, appropriate for a population that is geographically dispersed but shares uniform characteristics. According to Crossman (2020), homogeneous sampling refers to the selection of samples with similar criteria and backgrounds.

The research instrument consisted of a questionnaire, adapted from the Unified Theory of Acceptance and Use of Technology (UTAUT). It comprised seven aspects of technology acceptance and usability, namely performance expectancy, effort expectancy, attitude toward using technology in learning, social influence, facilitating conditions, self-efficacy and behavioral intention. To ensure content validity and clarity, the questionnaire was reviewed by experts in language and subject matter. The instrument included a demographic section and a main section evaluating the level of knowledge and acceptance of teachers towards blended learning in the context of Green IT.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to analyze frequency, percentage, mean scores, and standard deviation for each item. According to Sekaran (2000), descriptive statistics are suitable for describing a phenomenon or current situation within a study population. The analysis results provide an overview of the knowledge and acceptance level of STEM teachers regarding the implementation of blended learning in a Green IT approach environment at secondary schools.

Result

Demographics

The first section of the questionnaire focuses on the respondents' demographic information, covering four key aspects: age, educational level, ICT (Information and Communication Technology) proficiency, and years of teaching experience in STEM subjects at schools. A summary of the analysis for these aspects is presented in Table 1.

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Referring to the data in Table 4.4, the age group of 41 to 50 years recorded the highest percentage at 43.50%, followed by the 31 to 40 years age group at 27.30%. The 50 years and above group accounted for 22.40%, while the 21 to 30 years age group had the lowest percentage at 6.60%.

Regarding educational attainment, the majority of respondents held a bachelor's degree as their highest qualification, representing 80.70% of the sample. This was followed by master's degree holders at 18.00%, and doctoral degree holders at 1.20%. No respondents reported diploma as their highest educational qualification in this study.

In terms of ICT proficiency, most respondents demonstrated good skills, accounting for 54.00%, followed by moderate proficiency at 34.80%, and very good proficiency at 8.70%. Only a small portion of respondents (2.50%) reported weak ICT skills.

Concerning teaching experience in STEM subjects, the majority of respondents had more than 10 years of experience (59.00%). Those with 6 to 10 years of experience accounted for 20.50%, while respondents with 1 to 5 years of experience comprised 18.60%. The smallest group consisted of respondents with less than one year of teaching experience, representing 1.90%. These findings indicate that most respondents possess adequate experience to competently address questions related to STEM education.

Table 1: Respondent Background Analysis

Item	Frequency	Percent (%)
Age		
21-30 year	11	6.60
31-40 year	44	27.30
41-50 year	70	43.50
50 year and above	36	22.40
Total	161	100.0
Education		
Diploma	0	0
Degree	130	80.70
Master	29	18.00
PhD	2	1.20
Total	161	100.00
ICT Skill Level		
Poor	4	2.50
Moderate	56	34.80
High	87	54.00
Very High	14	8.70
Total	161	100.00
Years of Teaching STEM Subjects		
Less than 1 year	3	1.90
1 – 5 years	30	18.60
6 – 10 years	33	20.50
More than 10 years	95	59.00
Total	161	100.00

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Acceptance Level of Blended Learning in a Green IT Environment

This section explains the analysis of findings regarding STEM teachers' acceptance level of blended learning in a Green IT environment. The findings are divided into three acceptance categories — low, moderate, or high — based on mean scores, as shown in Table 2.

Table 2: Mean Score Interpretation Table

Code	Range	Level
1	1.00 – 2.33	Low
2	2.34 – 3.67	Moderate
3	3.68 – 5.00	High

Source: Adapted from Wiersma, 2000

Table 3 presents a summary of the analysis pertaining to the level of acceptance among STEM teachers towards Blended Learning within the context of a Green IT approach. A five-point Likert scale was employed to gauge the extent of teachers' agreement with seven specifically developed items. The mean scores and standard deviations (SD) were utilised to evaluate the overall acceptance level based on the responses to these items.

Table 3: Analysis of STEM Teachers' Acceptance of Blended Learning in a Green IT Environment

No.	Item	Mean	SD	Level
1.	Performance expectation	4.08	0.648	High
2.	Effort Expectation	4.00	0.683	High
3.	Attitude Toward Using Technology	3.67	0.747	Moderate
4.	Social Influence	3.92	0.730	High
5.	facilitating conditions	3.78	0.80	High
6.	Self-Efficacy	3.56	0.914	Moderate
7.	Behavioral Intention	3.96	0.702	High
Average Score		**3.85**	**0.746**	**High**

Adapted from Thahirah Abd Fattah et al., 2021

Table 3 presents the interpretation of data regarding the level of acceptance among STEM teachers towards the implementation of Blended Learning (BL) within a Green IT environment. Overall, the findings indicate a **high level of acceptance**, as five out of seven items recorded mean scores exceeding 3.70. In practical terms, this suggests that most teachers are receptive to integrating BL in their teaching and learning (T&L) activities and perceive it as a beneficial approach for improving student engagement and performance in STEM subjects.

Among the **UTAUT constructs, Performance Expectation** (M = 4.08, SD = 0.648) and **Effort Expectation** (M = 4.00, SD = 0.683) recorded the highest mean values. This indicates that teachers believe BL can enhance their teaching effectiveness and that the system is relatively easy to use within the context of STEM education. **Behavioral Intention**(M = 3.96, SD = 0.702) and **Social Influence** (M = 3.92, SD = 0.730) also scored highly, reflecting strong motivation to adopt BL and the perceived encouragement from colleagues, administrators, and institutional culture.

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In contrast, **Attitude Toward Using Technology** (M = 3.67, SD = 0.747) and **Self-Efficacy** (M = 3.56, SD = 0.914) fell within the **moderate acceptance range**. This finding implies that although teachers acknowledge the value of BL, some remain cautious or uncertain about their personal capability to implement technology effectively in classroom settings. The relatively lower self-efficacy score highlights a need for **capacity-building initiatives**, such as hands-on training and technical mentoring, to strengthen teachers' confidence and competence in using technology within a sustainable, Green IT framework.

Discussion

Based on the findings of this study, the level of acceptance among STEM teachers towards blended learning within the Green IT framework demonstrated a relatively high mean score (M = 3.85, SD = 0.746). This result indicates that most STEM teachers accept and possess adequate knowledge of the blended learning approach, particularly in integrating Green IT tools into the teaching and learning process (TLP). The high level of acceptance suggests that these educators recognize the potential of blended learning to enhance students' learning experiences, especially in STEM education. This pedagogical approach is perceived to increase student motivation and promote learner autonomy, enabling students to control their learning pace and select appropriate resources to deepen their conceptual understanding.

However, several challenges warrant attention, particularly in the dimension of self-efficacy (M = 3.56, SD = 0.914), which recorded a comparatively lower mean score than other constructs. This finding implies that teachers possess only a moderate level of confidence in integrating technology into their instructional practices, especially in the context of blended learning for STEM subjects. These findings are consistent with Mahalingam and Khairul Azhar (2021), who highlighted that the absence of clear and structured implementation guidelines for blended learning presents significant barriers for teachers, particularly in preparing instructional materials that align with students' mastery levels during home-based teaching and learning (PdPR). The lack of detailed implementation frameworks is likely a contributing factor to reduced teacher confidence. For instance, inadequate professional training and the mismatch between face-to-face and online teaching strategies may hinder the effective application of blended learning methods in the classroom.

Furthermore, Yang and Rao (2022) support this observation, reporting that teachers often struggle to integrate and adapt face-to-face and online pedagogical tools due to time constraints and the lack of subject-specific, outcome-oriented guidelines. These obstacles can lead to decreased student motivation, which may in turn adversely affect academic performance.

In addition, lower mean scores for the construct "Attitude Toward Using Technology" (M = 3.67, SD = 0.747) may be explained by the tendency of teachers to engage more actively with technology only when it delivers high-quality services. This interpretation is supported by Kayali and Alaaraj (2020), who found that user satisfaction positively influences trust and perceived usefulness in cloud-based systems, which in turn impacts technology adoption.

Conversely, the constructs of "Social Influence" (M = 3.92, SD = 0.730) and "Facilitating Conditions" (M = 3.78, SD = 0.800) received relatively high mean scores. This suggests that teachers perceive a supportive environment in terms of peer encouragement and institutional infrastructure for technology integration. These findings reinforce the view of Dwivedi et al. (2019), who emphasized the significant role of social and organizational support in shaping behavioral intentions to adopt digital tools. Positive experiences with facilitative conditions are

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also known to enhance teachers' sense of empowerment and motivation to use technology effectively (Baig & Yadegaridehkordi, 2025).

Despite the challenges associated with blended learning implementation, the study revealed that STEM teachers remain generally positive and willing to adopt this approach. This is reflected in high mean scores for "Performance Expectancy" (M = 4.08, SD = 0.648) and "Effort Expectancy" (M = 4.00, SD = 0.683), which indicate strong expectations regarding the benefits of technology on teaching performance, along with confidence in the ease of its use.

These results reflect an emerging awareness of the potential of Green IT in enriching the teaching and learning process. Beyond its environmental benefits, Green IT also supports more sustainable and flexible teaching practices. By integrating technologies such as cloud computing, paperless content delivery, and energy-efficient devices, Green IT promotes cost savings, broad accessibility, and a reduced ecological footprint. As noted by Lozano et al. (2023), sustainable IT practices not only enhance institutional responsibility but also foster pedagogical innovation, cultivating digital responsibility among both educators and learners.

Finally, "Behavioral Intention to Use Technology" also received a high mean score (M = 3.96, SD = 0.702), further indicating a strong willingness among teachers to continue integrating digital tools in their teaching. This positive outlook is particularly relevant in the post-pandemic era, where digital learning has become an indispensable component of modern education. Supporting this, Camilleri et al. (2025) demonstrated that performance expectancy and effort expectancy are significant predictors of behavioral intention in technology adoption within educational contexts.

Therefore, it is essential for educational authorities and institutions to offer more systematic and targeted support, including high-quality professional development programs and clearly defined implementation frameworks. Moreover, the provision of adequate resources and sustained technical support will further enhance teachers' confidence and capability in applying blended learning and Green IT practices. With comprehensive institutional support, it is anticipated that teachers will be better equipped to deliver innovative instruction, ultimately fostering improved academic performance and greater interest in STEM among students.

Practical Implications

The findings indicate that STEM teachers are generally receptive to blended learning in a Green IT environment, but their self-efficacy remains moderate. To address this gap, several practical measures are needed:

- **Professional Development Programs**: Teachers require structured, ongoing training focused on both pedagogical design and the integration of sustainable ICT practices. These programs should enhance digital competency while fostering confidence in managing blended learning environments.
- **Technical Support Mechanisms**: Schools should provide continuous access to ICT support staff and resources to reduce the technological burden on teachers. This will allow educators to focus on pedagogy rather than troubleshooting.
- **School-Level Initiatives**: Individual schools can adopt cloud-based platforms for lesson delivery, student assessment, and collaboration, thereby modeling environmentally responsible digital practices.

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Policy Implications

At the policy level, the findings highlight the need for systemic reforms to enable effective and sustainable integration of blended learning:

- **Infrastructure Investment**: The Ministry of Education should prioritize investment in reliable, energy-efficient cloud services and ICT infrastructure, particularly for rural and under-resourced schools.
- **Curriculum Alignment with Industry 5.0**: STEM curricula should incorporate sustainability principles and digital responsibility, aligning national education goals with Industry 5.0 and the United Nations Sustainable Development Goals (SDGs).
- **Clear Guidelines and Policy Frameworks**: National education policies should provide explicit direction for teachers on integrating Green IT into blended learning. These policies must also link pedagogy with broader sustainability objectives.
- **Institutional Incentives**: Policies could include recognition, incentives, or certification for schools and teachers that demonstrate effective and innovative use of Green IT in teaching practices.

By addressing these practical and policy implications, Malaysia can accelerate the effective adoption of blended learning in STEM education while simultaneously advancing its sustainability and digital transformation agenda.

Conclusion

This study demonstrates that STEM teachers in Malaysia show a high level of acceptance toward blended learning within a Green IT framework, reflecting both awareness and readiness to incorporate sustainable digital practices in their classrooms. While this finding indicates that blended learning has strong potential to enhance student motivation and engagement in STEM subjects, the study also highlights a key challenge: teacher self-efficacy remains moderate, primarily due to limited implementation guidelines, inadequate professional development, and insufficient technical support.

These findings provide valuable insights for policymakers and educational institutions by emphasizing the need for comprehensive pedagogical guidelines, targeted professional development, and reliable technical support systems. Strengthening these elements will enhance teachers' capacity to integrate blended learning effectively, thereby advancing both teaching quality and sustainability goals.

This research also contributes to the theoretical discourse by validating the applicability of the Unified Theory of Acceptance and Use of Technology (UTAUT) in the Malaysian STEM education context. The study confirms that teacher acceptance of blended learning is shaped not only by perceived usefulness and ease of use but also by the availability of institutional support and alignment with sustainable development principles.

While this study provides an important baseline, future research could adopt longitudinal approaches to track changes in teachers' readiness and self-efficacy over time. Comparative studies across different educational levels and ASEAN countries would also be valuable in identifying regional similarities and differences in the integration of Green IT into blended learning. Such studies would provide deeper insights into how sustainable digital pedagogies can be adapted across diverse contexts.

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In conclusion, with adequate institutional and policy support, blended learning within a Green IT environment can be a transformative strategy for STEM education. By bridging pedagogy, technology, and sustainability, it holds the potential to prepare both teachers and students for the demands of Industry 5.0 while contributing to Malaysia's and the region's sustainable development agenda.

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