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Predictors of Motivation and Barriers to ICT-Enabling Education for Sustainability

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Abstract: There is an increasing interest and effort in reorienting university curricula to address sustainability and preparing teachers to get involved in embedding sustainability and the UN's Sustainable Development Goals (SDGs) in teaching and curricula enabled by Information and Communication Technologies (ICTs). Evidence shows that this interest and effort is often prevented by various barriers at three levels: teacher- level barriers, school-level barriers, and system-level barriers. In this study, the attempt was geared towards identifying the constituencies of these three levels of barriers and examining the extent to which they predict teachers' motivation to embed sustainability and SDGs in various school subject areas, including arts-based education. A survey of 1253 teachers in Malaysia revealed that the teacher- and system-level barriers explain 83% of the motivation variance. By identifying, addressing, and investigating these barriers, higher education institutions—and especially teacher education—could be better informed in reorienting university curricula to embed ICT-enabled Education for Sustainability (ICTeEfS). These results were also used in planning and implementing in-service teacher training interventions in the context of a European Commission Erasmus+-funded project.

Keywords: ICT; Education for Sustainability; teacher-level barriers; school-level barriers; system-level barriers; motivation; SDGs; arts-based education

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1. Introduction

It is widely believed that two of the major forces shaping and driving the 21st century are (1) the exponential development of Information and Communication Technologies (ICTs) and (2) the quest toward education for sustainable development. The link between ICTs and education for sustainable development and, recently, with the UN's Sustainable Development Goals (SDGs), is being addressed widely [1,2]. Indeed, there has been increasing recognition of the need to break with the maladaptive resilience of unsustainable systems by strengthening transformative and transgressive social learning [3]. Thus, embedding SDGs in teaching, learning, and curricula, both in teacher education and across all school subject areas including arts-based education, for learning to live together sustainably is of critical importance and a challenge for all involved in education.

Arts-based education practitioners use various arts-based teaching methods and methodologies, including autobiography, narrative, poetry, the visual arts, drama, dance, music, and performance [4–7]. In particular, arts-based teaching methods integrated into STEM (Science, Technology, Engineering, and Mathematics) provide new opportunities for students and teachers to critically reflect on various local and global issues in regards to the

four pillars of sustainable development [8]. Arts-based teaching methods can be a source of inspiration for all teachers who want to embed sustainability and SDGs such as poverty (SDG1), hunger (SDG2), gender inequality (SDG5), and climate change (SDG13). Generally speaking, arts-based pedagogy covers a broad area that merges creative, cognitive, metacognitive, and transformational processes [6,9], enabling learners to actively participate in the teaching and learning process [10]. Previous research also shows that arts-based pedagogy can help students sustain an interest in the subject matter and understand the key concepts of course material and foster the learning of higher-order thinking skills [4]. Added to that, arts-based pedagogy encourages creativity, helps to build rapport among participants, personalizes interactions, cultivates trust, supports service learning, and has the potential to enhance personal and social transformation for building a more sustainable and just society [5,10–12], especially through enabling learning technologies [13–15].

Digital storytelling and participatory video are among the methodologies that help participants conceptualize and produce their digital products through which they can explore sustainability issues, voice concerns about sustainability justice, critically reflect on their practices, and facilitate empowerment, understanding, imagination, and reflection as well as vertical and horizontal communication [16,17]. Pavlou and Kadji-Beltran [18] showed that the visual arts can enable education to approach challenging socio-economic, cultural, and environmental issues and establish links with real-life issues that can lead to action. In particular, performative arts–based methods such as applied drama provide a creative space for dialogue, which can foster social reflexivity, ecological consciousness, engagement, public deliberation, and understanding as well as an emotional commitment to sustainability [19,20]. Other research that investigated the impact of music, dance, and visual arts classes on children facing poverty risks (SDG1) was found to foster skill development in the arts as well as enhance interdisciplinary learning [21], emotional growth, and skills regulation [22] as well as transformative learning [23]. The arts and humanities, across all education levels, open spaces for critical reflection and reflexivity, envisioning, hands-on learning [23], transformative practice, hope, responsibility, care, and solidarity [24], despite certain barriers that significantly affect teachers' motivation to embed SDGs in teaching, learning, and curriculum enabled by ICTs. Such barriers include insufficient pedagogical support and/or training [25] and a lack of materials and resources [26].

There is an increasing interest in reorienting university curricula to address sustainability and SDGs and preparing teachers to get involved in embedding sustainability and SDGs into teaching and curricula, such as the ICT-enabled Education for Sustainability (ICTeEfS) program funded by the European Commission Erasmus+ project in Southeast Asia (Indonesia, Malaysia, and Vietnam). In this project, an arts-based course has been revised to address SDGs at the Open University of Malaysia. The revised course focuses on the concepts of art education, the visual arts, music, and fundamentals of movement, all of which require imagination, expression, inquiry, and multiple intelligences to optimize and enjoy learning. This three-credit-hour course can be completed entirely online in 8 to 15 weeks. The course also provides opportunities for teachers to participate in activities that explore, experience, and express the sensitivity of children's senses. The teaching and learning approach used includes synchronous, online, face-to-face tutorials performed via Google Meet to enable interactions between learners and instructors (Teaching Presence) and an asynchronous online forum to ensure interactions between learners/peers (Social Presence). The forum uses OUM's MyInspire LMS. Cognitive Presence is achieved through online modules and e-lessons. Preparing pre-service teachers to embed SDGs into arts-based pedagogy and curricula enabled by ICTs is one issue, the other issue concerns the teacher-, school-, and wider system-level barriers that hinder teachers' motivation to embed sustainability and SDGs in schools.

Thus, it makes sense that reorienting university curricula to address SDGs and contextualizing ICTs with Education for Sustainability (EfS) can be affected by several factors that relate to both pedagogy and technology. Although the Malaysian Ministry of Education has

provided schools with computer equipment and relevant affordances, and while teachers were equipped with certain ICT knowledge and skills, the integration and contextualization of ICTs with EfS still lags behind [27–29]. Many factors might influence teachers' successful contextualization of ICTs with SDGs, such as teachers' attitudes and beliefs [30,31], insufficient numbers of computers and ICT peripherals [32], a lack of institutional support and administration [33], and a lack of opportunities for suitable professional development in contextualizing ICTs with EfS and SDGs [34–36]. It has been also pointed out that ESD (Education for Sustainable Development) competency frameworks should be integrated into teacher professional development [37]. These factors can be grouped into three levels, namely: (1) teacher-level barriers; (2) school-level barriers, and (3) system-level barriers. Teacher-level barriers refer to teachers' poor ICT competence, low motivation, and lack of confidence in using new technologies in teaching. They are related to the quality and quantity of teacher training programs. School-level barriers refer to limited access to ICTs, poor quality and inadequate maintenance of hardware, as well as unsuitable educational software and innovative teaching methods. System-level barriers relate to a wider educational system that might be rigid and hinder the integration of ICTs into learning and teaching practices. It has been found that teacher- and school-level barriers are strong predictors of teacher motivation to address ICTs as learning technologies [38], including lack of time, lack of effective training, lack of accessibility to ICT resources, and lack of technical support.

Teacher motivation is one of the most crucial ingredients in education [39,40] and the factors included in the three levels of barriers are expected to determine the level of motivation to encourage teacher educators and teachers' readiness to address the challenges of reorienting university and school curricula toward building a more sustainable and just society. While previous motivational studies [41–44] have focused on responsibility, achievement, recognition, possibility of growth, and opportunity for advancement, in this study, the emphasis is placed on a wide array of factors composing teacher-level, school-level, and system-level barriers to ICT-enabling Education for Sustainability (ICTeEfS). Motivation to use ICTs, either intrinsic and/or extrinsic, in teaching and learning by both pre-service and in-service teachers has a significant influence on ICT adoption and utilization in the context of EfS and SDGs [45–47].

Thus, the question addressed in this study is to what extent do teacher-level barriers, school-level barriers, and system-level barriers predict teachers' motivation toward embedding SDGs in teaching, learning, and curriculum enabled by ICTs? Such an approach will shed light on the composite factors of these three scale levels that could help guide teacher educators and teachers as well as educational policymakers and planners to better tackle the challenges for embedding SDGs in course curricula, including arts-based education. Based on the above literature review, the following hypotheses were formulated.

H1. *Teacher-level barriers have a significant influence on teachers' motivation to address SDGs in teaching, learning, and curricula, including arts-based education.*

H2. *School-level barriers have a significant influence on teachers' motivation to address SDGs in teaching, learning, and curricula, including arts-based education.*

H3. *System-level barriers have a significant influence on teachers' motivation to address SDGs in teaching, learning, and curricula, including arts-based education.*

2. Methodology

2.1. Background of Subjects

The target population was teachers functioning primarily as ICT coordinators and secondarily as teachers experienced in ICTs in education in three geographical areas of Malaysia. The first area was in the center and in proximity to the Open University of Malaysia in the province of Kuala Lumpur, the second was in the north and in proximity

to the University of Science Malaysia in the province of Penang, and the third was in the south and in proximity to the University of Technology Malaysia in the province of Johor. The respondents included 1253 in-service teachers (42% males and 58% females). A bit more than half (51%) of the 1253 respondents were employed as ICT teacher coordinators, 12% had functioned as ICT coordinators in the past, and 37% identified themselves as ICT-experienced teachers. The majority (67%) were working in primary school education, with 66% having graduated from teacher education institutions, 10% from computer science institutions, 8% from applied science institutions, and the rest from other academic fields.

In terms of geographical distribution, 43% of the teachers worked in urban areas, 18% in semi-urban areas, and 39% in rural areas. A total of 42% had teaching experience of 15 years and up, followed by 30% between 10 and 14 years, 20% between 5 and 9 years, and 8% under 4 years. On the contrary, the majority (38%) declared that they have been involved in supporting teaching with ICTs for less than four years, followed by 32% between 5 and 9 years, 18% between 10 and 14 years, and only 12% for up to 15 years. A total of 56% had sufficient knowledge about Education for Sustainability and 20% had above average to excellent, while only 3% declared poor knowledge, and 21% minimal. A similar trend is evidenced in terms of merging ICTs with issues related to sustainable development, with those who expressed sufficient knowledge reaching up to 56%, 18% above the average, 23% minimal, and only 3% with poor knowledge. It is worth pointing out that the in-service teachers who participated in this study were subject to receiving training from teacher educators from the three higher education institutions in Malaysia to embed sustainability issues and SDGs enabled by ICTs into course curricula.

2.2. Instrument and Measures

A questionnaire was developed in line with the theoretical work reviewed in the introduction that contained 156 items divided into three sections: The first section covered standard questions such as gender, teachers' function, school level, educational and work background, area of school, knowledge of ICTs, and education for sustainable development. The second section consisted of items that measured knowledge on merging ICTs with Education for Sustainability, critical reflective practices, sustainability justice attitudes, and items measuring teachers' transformative teaching and learning beliefs. In the third section, the questionnaire addressed issues related to policies on ICTs in Education for Sustainability, rewards for using ICTs in teaching and learning, frequency of using ICTs in teaching, factors that adversely affected the use of ICTs in teaching and learning, and the importance attached to the integration of ICTs in teaching.

The content validity was conducted through discussions with five experts in educational technology and pedagogy. The procedure was carried out in the form of interactive dialogue. Some items were amended and some others were removed because they did not suit the Malaysian socio-cultural context. In the first phase, the appropriate permits were requested from the Provincial Directorates of Education. In the second phase, the research instrument was delivered both in printed form and online during the first months of the 2019–2020 academic year. Subsequently, in the third phase, once the data had been collected, a database was created in the Statistical Package for the Social Sciences (SPSS), version 28.

Based on the items that adversely affected the use of ICTs in teaching and learning, four scales in the form of composite variables were developed, three functioning as predictors, namely teacher-level barriers, school-level barriers, and system-level barriers, and the fourth, motivation to integrate ICTs in teaching and learning for sustainability, functioning as the dependent one. Items were rated on a 4-point scale ranging from 1 (Not at all) to 4 (A lot).

2.3. Type of Analysis

The data analysis was conducted in three steps: First, to determine the structure of the teacher-, system-, and school-level barriers and teacher motivation scales, we carried

out an Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) and the varimax rotation method. Often, PCA is used when there is a greater emphasis on reducing the variables, but we were also interested in assessing the relationships among the variables to construct reliable and valid measurements. The Kaiser–Meyer–Olkin (KMO) test for sample adequacy and Bartlett's Test of Sphericity for data validity were applied. The internal consistency of the items after carrying out the PCA was assessed using Cronbach's alpha reliability statistics. Second, descriptive statistics were used to check the distribution of the data. Third, a stepwise multiple regression analysis was used to identify the explanatory power of the hypothesized predictors of teacher-, school-, and system-level barriers to teachers' motivation to use ICTs to embed sustainability and SDGs into school curricula, including arts education. For the multiple regression analysis, an examination of the multicollinearity was carried out using a metric known as the Variance Inflation Factor (VIF), which measures the correlation and strength of correlation between the predictor variables in a regression model.

3. Results

3.1. Factor Analysis

3.1.1. School-Level Barriers Scale

The KMO value for the school-level barriers was 0.885, indicating very good sample sufficiency and adequacy. From the eight variables, one was dropped because its communality was below 0.50. All the other communalities were over the required value of 0.50 and the Bartlett's Test of Sphericity was statistically significant (χ^2 = 3949.44; df: 21; Sig. $p < 0.001$), indicating that the items are significantly correlated and that the results are suitable for further analyses. The PCA produced a single-factor solution with a direct varimax rotation method and eigenvalues > 1.0, accounting for a considerable amount of the variation in the data (58.12%). The obtained one-factor structure was very well defined and interpretable with theoretical reliability and construct relevance with an eigenvalue of 4.07. Finally, seven items were retained for their substantial loadings (>0.50) on a single factor, as can be seen in Table 1. A single-factor structure was interpreted as a satisfactory factor loading and theoretical relevance of all items to the factor. The Cronbach's alpha of the scale was calculated and the value of 0.88 was obtained, indicating very good reliability and very good internal consistency. The Matrix rotation of the school-level barriers scale is reported in Table 1. The factor loadings of the items ranged between 0.72 and 0.80.

Table 1. Items for the ICTeEfS composite variable.

Items	Factor 1
School organization not supportive of innovations.	0.79
School space organization is prohibitive for ICTeEfS practice.	0.80
Crowded classrooms.	0.72
Limited school time for innovative practices.	0.76
Schools lack digital tools to support innovative teaching and learning.	0.77
Lack of in school-based training.	0.75
Insufficient technical support for school teachers.	0.73

3.1.2. System-Level Barriers Scale

The KMO value for the system-level barriers was 0.931, indicating very good sample sufficiency and adequacy. All communalities, except two which were reduced, were over the required value of 0.50 and the Bartlett's Test of Sphericity was statistically significant (χ^2 = 7506.23; df: 28; Sig. $p < 0.001$), indicating that the items are significantly correlated and that the results are suitable for further analyses. The PCA produced a single-factor solution with a direct varimax rotation method and eigenvalues > 1.0, accounting for a considerable amount of the variation in the data (66.92%). The obtained one-factor structure was very well defined and interpretable with theoretical reliability and construct relevance with an eigenvalue of 5.35. Finally, eight items were retained for their substantial loadings

(>0.50) on a single factor, as can be seen in Table 2. A single-factor structure was interpreted as a satisfactory factor loading and theoretical relevance of all items to the factor. The Cronbach's alpha of the scale was calculated and the value of 0.93 was obtained, indicating very good reliability and internal consistency. The Matrix rotation for the system-level barriers scale is reported in Table 2. The factor loadings of the items ranged between 0.78 and 0.88.

Table 2. Items for the system-level barriers scale.

Items	Factor 1
Insufficient policy and provision for technical support at the school system.	0.78
Insufficient pedagogical support for the school system.	0.80
Lack of adequate content/material for innovative teaching.	0.78
Lack of capacity building for teacher professional development.	0.79
Lack of appropriate course content and instructional programs for ICTeEfS.	0.88
Lack of central technical, administrative, and institutional support.	0.87
Lack of incentives to use ICTs.	0.78
Lack of appropriate software, hardware, and teaching materials.	0.85

3.1.3. Teacher-Level Barriers Scale

The KMO value for the teacher-level barriers was 0.893, indicating very good sample sufficiency and adequacy. All the communalities, except two which were reduced, were over the required value of 0.50 and the Bartlett's Test of Sphericity was statistically significant (χ^2 = 6438.49; df: 15; Sig. $p < 0.001$), indicating that the items are significantly correlated and that the results are suitable for further analyses. The PCA produced a single-factor solution with a direct varimax rotation method and eigenvalues > 1.0, accounting for a considerable amount of the variation in the data (75.23%). The obtained one-factor structure was very well defined and interpretable with theoretical reliability and construct relevance with an eigenvalue of 4.51. The final six items were retained for their substantial loadings (>0.50) on a single factor, as can be seen in Table 3. A single-factor structure was interpreted as a satisfactory factor loading and theoretical relevance of all items to the factor. The Cronbach's alpha of the scale was calculated and the value of 0.93 was obtained, indicating very good reliability and internal consistency. The Matrix rotation for the system-level barriers scale is reported in Table 2. The factor loadings of the items ranged between 0.78 and 0.91.

Table 3. Items for the teacher-level barriers scale.

Items	Factor 1
Lack of time for training, exploration, and preparation.	0.78
Computer anxiety and a lack of confidence.	0.85
Fear of change and a lack of personal change-management skills.	0.91
Limited knowledge of how to make full use of ICTs.	0.90
Limited understanding of how to integrate ICTs into teaching.	0.88
Pressure to prepare students for exams and tests.	0.86

3.1.4. Teacher Motivation Scale

The KMO value for the teacher-level barriers was 0.730, indicating very good sample sufficiency and adequacy. All the communalities were over the required value of 0.50 and the Bartlett's Test of Sphericity was statistically significant (χ^2 = 3895.59; df: 6; Sig. $p < 0.001$), indicating that the items are significantly correlated and that the results are suitable for further analyses. The PCA produced a single-factor solution with a direct varimax rotation method and eigenvalues > 1.0, accounting for a considerable amount of the variation in the data (76.98%). The obtained one-factor structure was very well defined and interpretable with theoretical reliability and construct relevance with an eigenvalue of 3.08. The final four items were retained for their substantial loadings (>0.50) on a single

factor, as can be seen in Table 4. A single-factor structure was interpreted as a satisfactory factor loading and theoretical relevance of all items to the factor. The Cronbach's alpha of the scale was calculated and the value of 0.90 was obtained, indicating very good reliability and internal consistency. The Matrix rotation for the system-level barriers scale is reported in Table 4. The factor loadings of the items ranged between 0.87 and 0.90.

Table 4. Items for the motivation scale.

Items	Factor 1
Teachers are not in favor of the use of ICTs in school practices.	0.85
Teachers lack interest in being trained in ICTs.	0.87
Lack of motivation concerning ICT-enabled Education for Sustainability.	0.90
Lack of motivational rewards concerning the use of ICTs.	0.89

3.2. Regression Analysis

Basic descriptive statistical analysis was used to explore the data based on the assumptions required for carrying out a multiple regression analysis, such as normality and multicollinearity. The skewness for the four scales ranged from 0.28 to −0.33 and the kurtosis from −0.44 to −0.68, as shown in Table 5, which is well within the acceptable ranges of −1 to 1 or −2 and = 2 [48–51]. The data mostly formed a straight line along the diagonal and a rough scatterplot of the standardized residual versus the standardized predicted values was achieved.

Table 5. Descriptive statistics.

Variables	N	Min/Max	Mean	S.D.	Skewness		Kurtosis	
					Stat.	S. Er.	Stat	S. Er
Motivation	1253	1–4	2.46	0.81	0.028	0.069	−0.68	0.14
Teacher-level	1253	1–4	2.49	0.78	0.081	0.069	−0.59	0.14
School-level	1253	1–4	2.67	0.72	−0.20	0.069	−0.42	0.14
System-level	1253	1–4	2.67	0.75	−0.16	0.069	−0.58	0.14

The multicollinearity was assessed using calculated Variance Inflation Factors (VIFs) and their reciprocal tolerance values. The VIFs ranged from 1.00 to 5.87 and the corresponding tolerance values from 1.00 to 0.18. Generally, when the VIF is higher than 10 or the tolerance is lower than 0.10, then it is assumed that there is a significant multicollinearity that needs to be corrected. Thus, the results show that there is no indication of multicollinearity. The multiple regression analysis using the Stepwise method to determine the relationship of a linear combination of the three independent factors or predictors with motivation revealed that only those independent factors with the strongest correlations passed the threshold ($p < 0.05$). Table 6 shows that the overall multiple linear regression test was statistically significant (Adjusted $R^2 = 0.689$, $F(1, 1251) = 2778.10$, $p = 0.000$ for the teacher-level barriers factor and R^2Change = 0.69), indicating that the teacher-level barriers alone explained 69% of teacher motivation to use ICTs for enabling sustainability and SDGs in teaching, learning, and curriculum development. The second predictor that entered the regression analysis was the system-level barriers with adjusted $R^2 = 0.758$, including the teacher-level barriers ($F(1, 1250) = 353.55$, $p = 0.000$). The system-level barriers factor alone accounted for a R^2Change = 0.068, that is, 6.8% of teacher motivation. Lastly, the school-level barriers predictor accounted for an R^2Change = 0.002, which is very minimal, but statistically significant at $p = 0.003$. The teacher-, system-, and school-level barriers significantly predicted 76% of teachers' motivation to embed SDGs in teaching, learning, and curricula; a result that is considered a very high score. The individual scores are also reflected in the beta values, that is, the regression coefficients for standardized data, which

were found to be equal to 0.50 at $p = 0.000$ for the teacher-level barriers with $t = 21.65$ at $p = 0.000$; for the system-level barriers, the beta was equal to 0.33 with $t = 10.29$ at $p = 0.000$; and finally, the least-contributed predictor, the school-level barriers, with a beta = 0.10 and $t = 3.03$ at $p = 0.003$. In general, the beta weight is the average amount by which the dependent variable increases when the independent variable increases one standard deviation and other independent variables are held constant. The 24% unexplained variance is reflected in Table 7 which shows the residuals, that is, the difference between the actual value and the predicted value of the regression model.

Table 6. Stepwise regression analysis to motivation (d).

Model	Predictors	Adjusted R^2	Std. Error	Change Statistics				Durbin–Watson
				R^2 Change	F Change	Df1/2	Sig.	
1	Teacher-level barriers to motivation	0.689	0.456	0.690	2778.10	1/1251	0.000 (a)	
2	System-level barriers to motivation	0.758	0.402	0.068	353.55	1/1250	0.000 (b)	1.89
3	School-level barriers to motivation	0.759	0.401	0.002	9.17	1/1249	0.003 (c)	

(a) Predictors (constant)—teacher-level barriers; (b) predictors (constant)—teacher-level barriers, system-level barriers; (c) predictors (constant)—teacher-level barriers, system-level barriers, school-level barriers; (d) dependent variable—motivation.

Table 7. Analysis of variance to motivation (a).

	Model	Sum of Squares	D.F	Mean Square	F	Sig.
1	Regression residual total	578.016 260.285 838.300	1 1251 1252	687.561 0.208	2778.10	0.000 (b)
2	Regression residual total	635.403 202.897 838.300	2 1250 1252	317.702 0.162	1957.28	0.000 (c)
3	Regression residual total	636.882 201.418 838.300	3 1249 1252	212.294 0.161	1316.44	0.000 (d)

(a) Dependent variable—motivation; (b) predictors (constant)—teacher-level barriers; (c) predictors (constant)—teacher-level barriers, system-level barriers; (d) predictors (constant)—teacher-level barriers, system-level barriers, school-level barriers.

4. Discussion

This study focused on the contextual factors of teacher-, school-, and system-level barriers that affect teachers' motivation to embed SDGs in teaching, learning, and curricula. The research results show that teacher-level barriers and system-level barriers to sustainability education enabled by ICTs accounted for 76% of teachers' motivation to embed SDGs in school curricula, including arts-based subjects. The strongest predictor of teachers' motivation was that of teacher-level barriers, which alone explained 69% of the variance. In general, motivated teachers are much more likely to achieve their potential to address issues related to sustainability education [52,53]. Teachers and teacher educators have shown increased interest and motivation in raising students' consciousness, knowledge, and action competences for building a more sustainable and just society [54]. These results are substantiated by previous empirical evidence [55], which could serve as a point of reference for understanding the challenges that Malaysian teachers face in embedding SDGs with the support of ICTs in arts-based education and other school subject areas. In a

complementary manner, the Malaysia Education Blueprint 2013–2025 offers a comprehensive approach to teacher development, featuring Continuous Professional Development (CPD) programs that are both school-based and individualized. These programs not only aim to enhance general teaching competences, but also offer electives that could potentially address the specific barriers identified in this study and other similar studies. This can be a part explanation of why teachers in the study did not consider school-level barriers as a strong predictor of their motivation to embed SDGs in their pedagogical practices. Moreover, the blueprint's strategic focus on reducing school-based administrative burdens and introducing a fast-track career progression scheme could indirectly motivate teachers to upskill in areas like ICTs and SDGs [56].

Malaysia has taken proactive initiatives to reduce fears and increase teachers' confidence in implementing SDG initiatives in the classroom. This includes proposing a 'greener' or more sustainable learning process in the existing curriculum [57]. In addition, *Kurikulum Standard Sekolah Rendah Malaysia—Semakan* 2017 more clearly highlights SDG elements in the latest content standards, which increases teachers' confidence in implementing SDG-related lessons in the classroom [58]. Effective integration of ICTs is not just about having the infrastructure, but also about having educators who are equipped to use it in a way that aligns with broader education and sustainability goals. The limited focus on how teachers can fully utilize ICTs to teach in a manner that is aligned with SDGs represents a missed opportunity.

Teachers are called upon to translate Education for Sustainability and the UN Agenda for SDGs into classroom practices, but the current research, substantiated by previous reviews, shows that many practicing educators feel unprepared to help learners develop the competences needed to forge more sustainable paths forward [59]. Successful implementation of ICTeEfS requires a shift in focus from teaching to learning and an inter/cross-disciplinary approach that addresses the environmental, social, economic, and cultural pillars of sustainability. Thus, it was not surprising to find out that a lack of adequate skills and interest of teachers, difficulty in integrating ICT use into the curriculum, anxiety and a lack of confidence, fear of change, and a lack of personal change-management skills, and limited knowledge and understanding counted the most in predicting how to embed sustainability across all school subjects. This implies that integrating sustainability education into arts-based education and other curriculum areas will be hindered by both teacher- and system-level barriers and there is a need for it to be addressed by policymakers. This is not only reflected in the current study results, but also in other studies in the country, the region, and globally [60]. This also suggests the importance of modifying or reorienting the course curricula to address real-life experiences to be largely elicited from the 17 SDGs. Such a reorientation would be highly enhanced by engaging students in collaborative, project/problem-based learning focused on problem posing/solving and action around sustainability issues that matter to them. Arts-based education and cultural education, as components of Education for Sustainability, can motivate teachers and empower learners with the knowledge, skills, ethics, values, attitudes, and action competences to address current and future sustainability challenges from poverty (SDG1) and hunger (SDG2) to climate change (SDG13) and sustainability injustices (SDG16). In revising arts-based education at the Open University of Malaysia, teacher educators were challenged with how to connect, for example, SDGs and community-based learning to tackle hunger (SDG2) and malnourishment (SDG3). Teachers participating in the creation of digital storytelling during the ICTeEfS in-service teacher capacity building [61] found opportunities to show, for example, the power of music, dance, drama, and the visual arts as a means of therapeutic impact [62] and curriculum enrichment. Such opportunities provide learning spaces for motivating teachers to critically reflect on who they are and what they want to become.

Contrary to the statistically significant predictive power of teacher-level and system-level barriers to embedding ICTeEfS in teaching, learning, and curriculum, the hypothesis that school-level barriers would also have a strong impact on teachers' motivation to embed SDGs was revealed to be very minimal, but statistically significant. This does not mean that

school-level factors do not play a strong role in motivating teachers, but it seems that in the Malaysian context, the Ministry of Education has taken appropriate steps to eliminate and/or reduce school-level barriers that no longer become a hindrance to embedding ICTeEfS. It has been shown that the enactment of Education for Sustainability (EfS) in Malaysian education has mostly focused on school/campus greening rather than on pedagogic reform [63], which may explain the strong predictive effect of teacher–system-level barriers. To grasp why and how EfS is being implemented in education, the teacher and system structures and contexts need to be highly considered by education policymakers.

Despite providing new insights into the barriers that affect teachers' motivation to address ICTeEfS in teacher and school education, there are also some limitations of the present study that might be addressed in future studies. Firstly, our conclusions are based on teachers' perceptions. Second, the sample is not strictly random, since the target group was chosen based on certain characteristics to serve the purpose of the study (e.g., ICT coordinators and/or those with some experience in ICTs). The results are restricted to teachers with such characteristics, although they can be extended to other teacher categories as well. Thus, it cannot be claimed to be representative of all teachers. Third, since the study focused on teachers' perceptions, future research should also address students, teacher educators, and school leadership. Additionally, future studies are needed to expand our understanding of teacher-, system-, and school-level barriers that adversely affect the contextualization of ICTs with Education for Sustainability. In particular, these types of barriers should be studied in terms of the frequency of ICT use, teachers' beliefs in transformative teaching and learning, as well as the incentives provided to teachers as a reward for their efforts and motivation to infuse SDGs into teaching, learning, and curricula enabled by ICTs.

5. Conclusions

In summary, the motivation for teachers to use ICTs in their teaching practices to enable Education for Sustainability is driven by a combination of factors related to teacher-level barriers and the wider education system referring to the system-level barriers and school-level barriers as well. These include a lack of adequate skills and interest of teachers, difficulty in integrating ICT use into the curriculum, anxiety and a lack of confidence, fear of change, and a lack of personal change-management skills, limited knowledge and understanding of how to make full use of embedding SDGs enabled by ICTs, and a lack of teacher incentives to ICTeEfS. Similarly, factors such as insufficient pedagogical support for teachers, a lack of adequate content/material for teaching, a lack of content in the national language, a lack of time for curriculum and teaching innovation, and a lack of pedagogical models on how to use ICTs for learning. By identifying and addressing these barriers, educational institutions can create targeted interventions, such as specialized professional development programs and incentive measures. These barriers are not merely an academic endeavor, but they address a strategic importance for policy and practice. Policymakers can learn from the predictive power of these barriers to design more effective educational policies that address not only teachers' motivation in regard to ICTeEfS, but also explain the root causes of the slow integration of ICTs, sustainability, and SDGs in teaching, learning, and curriculum. Nevertheless, integrating SDGs enabled by ICTs into the existing curriculum is a major challenge, including arts-based subjects. Arts teaching and learning enabled by ICTs can be seen as an opportunity for both teachers and students to bring society to the school and vice versa.

In general, continuous teacher professional development programs such as the ICTeEfS can be sustained, thereby nurturing both skills and interest to embed SDGs in school subjects, including the arts. Teachers are the front-line implementers of ICTeEfS that can unlock their potential for initiating curriculum changes. Turning teachers into agents of change is a quest to shift from transmissive to transformative teaching and learning practices. Moreover, ensuring the motivation of teachers and the strengthening of their commitment

to change depends much on removing those barriers that restrict their potential to the contextualization of ICTs with Education for Sustainability.

The present study and other studies in Malaysia contribute valuable insights into the complexities of the Malaysian educational system. In general, a fragmented curriculum is not the only barrier to learning for sustainability [64]; the wider issues reflecting both the teacher-level and system-level barriers must be considered, without neglecting the school-level barriers, despite the fact that they contribute less to teachers' motivation to contextualize ICTs with Education for Sustainability. The results of this study increase our understanding regarding teachers' perceived barriers that exert the highest effect on teachers' motivation to embrace teaching and learning with technology for building a more sustainable and just society. Transformative teaching and learning, along with critical reflective practices, are needed to foster more sustainable ways of being and living that cannot take place without equipping teachers with such skills.

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