Predicting Teacher’s Information and Communication Technology-Enabled Education for Sustainability Self-Efficacy

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Abstract: This study focused on the development of a teacher self-efficacy measurement addressing the contextualization of information and communication technologies (ICTs) with education for sustainability (EfS) using principal component analysis. Furthermore, this study, with the participation of 1815 teachers, examined the predictive value of some hypothesized predictors of the ICTeEfS self-efficacy construct such as gender, school setting, years of teaching, knowledge of education for sustainability, knowledge of ICTs, and experience in using ICTs to support the integration of education for sustainability in teaching and school curricula using multiple regression analysis. The research results revealed that gender did not explain any statistically significant variance of teachers’ ICTeEfS self-efficacy; contrary to this, teachers possessing a high level of knowledge on issues about sustainability and ICT competence explained most of the extracted variance. However, a gap remains in utilizing these skills pedagogically. This study also discusses the varying levels of self-efficacy among teachers based on their workplace location, finding that urban teachers demonstrate higher self-efficacy compared to their rural counterparts. This could be attributed to the disparities in resources and support systems, thereby affecting their capacity to employ ICT in EfS effectively. It was also found that novice teachers exhibited higher predictive power to ICTeEfS self-efficacy, possibly due to their recent exposure to ICT training. This study assumes that a profound understanding of EfS, coupled with ICT tools, bolsters the creation of contextualized curricula and enriches the teaching and learning experience towards sustainability.

Keywords: self-efficacy; ICTs; teacher self-efficacy; education for sustainability; ICTeEfS self-efficacy; principal component analysis

1. Introduction

It is widely recognized that teaching fundamental concepts connected with knowledge from various subjects or disciplines is more important than focusing on disciplinary knowledge, usually disconnected from real life [1]. This does not mean that disciplinary knowledge is not important, but the persistence of such a kind of knowledge restricts learners and teachers from synthesizing ideas, integrating multiple ways of viewing reality, personalizing learning, and transferring knowledge to other contexts [2,3]. In particular, when merging text and context, it helps to shift from transmissive to constructing knowledge and to transformational teaching and learning [4–6]. Contextualization is, thus, a significant learning process that takes place by linking ideas and principles from other
disciplines and making learning more authentic and meaningful [7,8]. However, despite increasing efforts to merge text and context (contextualization), the context has been often conceptualized as a static process mostly driven by textbooks and transmissive pedagogical processes [9], as opposed to designing for transformational learning [10]. The instructional design approach is largely driven by surface learning, in contrast to learning design that focuses more on deep and experiential learning [11,12].

Mathematics, for example, is a subject that usually functions in a decontextualized learning environment disconnected from real life, which in turn seems to perpetuate gender and other stereotypes and injustices [13,14]. Merging mathematics with real-life authentic issues that could be elicited from SDGs (Sustainable Development Goals) moves the school to society. By creating authentic tasks where teachers are making connections to the real world, they are more inclined to conceptualize key ideas and relate them to real-life experiences. However, mathematics education still lags in such a situation, largely due to the persistence of weak problem-solving compared to deep problem-posing practices [15,16]. Using authentic situations in teaching and learning mathematics unlocks its potential for emancipatory learning, that is, bridging knowledge–attitude–values–action gaps [17]. Making connections of the mathematics subject matter to real-life contexts turns mathematics into a vehicle for social change [18–20]. In this sense, mathematics is not just the science of quantification and logical reasoning, but also the science of teaching and learning for social justice [21–24].

In addition to mathematics, other subjects, such as languages, also play a crucial role in promoting education for sustainability, supported by ICTs in foreign language teaching. Traditionally approached through instrumental pedagogical methodologies, there are efforts to shift the focus towards education for sustainable development in foreign language teaching and learning. This shift moves away from “shallow environmental and social sustainability” towards an approach characterized by deep learning, transformative teaching, and the cultivation of political literacy. This involves merging critical consciousness with knowledge construction, reflection, and action [25,26]. Thus, contextualizing teaching, learning, and curriculum does not merely merge disciplinary content with other disciplines, but extends more to engage learners in constructing knowledge merging reflection and action [27,28].

Turning teachers to shift from a transmissive pedagogy to a transformative and critical pedagogy was one of the key objectives of a European Commission-funded project entitled ICT-enabled Education for Sustainability (ICTeEfS) targeting seven Southeast Asian universities in Indonesia, Malaysia, and Vietnam, upon which this study was used to provide feedback [29,30]. It is also understood that before contextualizing 72 academic courses, mostly in teacher education, academic staff and in-service teachers needed proper capacity-building interventions. In this context, researching teachers’ ICTeEfS self-efficacy to contextualize teaching, learning, and curriculum is of critical importance for all project activities. As the literature review shows, many studies exploring teachers’ self-efficacy have used Bandura’s [31] concept of self-efficacy, which stresses one’s capabilities for organizing and acting to reach certain goals. Teachers with higher self-efficacy are more likely to exhibit persistence in achieving their goals [32–34]. In our conceptualization, we differentiate between self-efficacy for performance, referring to what one already knows how to do, and self-efficacy for learning, that is, what one can learn to do [35]. The self-efficacy for performance is more compatible with our study since the target group addresses in-service teachers who are going to be trained by teacher trainers mainly from Faculties of Education in the partner countries to embed SDGs in their courses and teaching practices enabled by ICTs. Previous studies have defined ICT self-efficacy as confidence in teachers’ abilities in using ICTs such as multimedia, computers, and the internet for teaching and learning activities [36–38]. Teachers’ ICT self-efficacy and their self-confidence in successfully using ICTs in teaching practice are particularly important [39]. It has been also shown that ICT self-efficacy has a powerful influence on teachers’ and learners’ decisions, behaviors, and achievements [40]. Among other things, ICT-oriented self-efficacy should be designed in
ways to facilitate the process of changing the current transmissive teaching and learning paradigm to one that integrates transformative teaching and learning beliefs. In this respect, research indicates that teachers’ ICT self-efficacy depends on several factors, such as the teachers’ age and gender [41], technology-related attitudes [42,43], and teachers’ computer experience [44], as well as school support [45,46]. Similarly, preservice teachers with higher levels of technology self-efficacy are found to be more confident about integrating technology in their future classrooms, and that could positively impact both the intention and the pedagogical use of ICTs [47]. Teacher reflection is also a critical component in professionalizing teaching to address ICTs as enabling tools of education for sustainability [48] as well as to enhance learning quality [49]. Teacher education, which places a strong emphasis on producing critical reflective teachers, is crucial for bridging the awareness–knowledge–values–action gap that persists [50–52]. It would be, thus, interesting to develop and validate a teachers’ ICTeEfS self-efficacy scale and to test the predictive effect of several background variables, including teachers’ gender, place of work, teaching experience, ICT skills, and knowledge of education, for sustainability. The following hypotheses were formulated for this purpose.

**H1.** Teachers with a high level of knowledge in the field of education for sustainability (EfS) are more likely to exhibit higher self-efficacy in using ICTs to contextualize EfS.

**H2.** Teachers knowledgeable in ICTs are more likely to have higher self-efficacy scores in using ICTs to contextualize EfS.

**H3.** Teachers’ gender is expected to be related to self-efficacy in ICT-enabled education for sustainability (ICTeEfS).

**H4.** Teachers working at the primary or secondary school level may differ in their self-efficacy in ICTeEfS.

**H5.** Teachers’ years of teaching are expected to exhibit higher self-efficacy in using ICTs to contextualize EfS.

**H6.** Teachers’ experience of using ICTs as supportive tools in teaching and learning are more likely to have higher self-efficacy in using ICTs to contextualize EfS.

**H7.** Teachers working in urban, semiurban, and rural areas will differ in their self-efficacy in using ICTs to contextualize EfS.

### 2. Materials and Methods

#### 2.1. Background and Subjects

The target population was teachers in seven universities in Indonesia, Malaysia, and Vietnam who were functioning either as ICT coordinators or teachers with some experience of ICTs in education. A convenience sample consisting of 1815 teachers (40% males and 60% females) participated in the study. A bit more than half (51%) of the respondents declared that they had experience in using ICTs in teaching, while 39% were employed as ICT teacher coordinators, and 10% had functioned as ICT coordinators in the past. The majority (56%) were working in primary school education, with 76% having graduated from teacher education institutions, 12% from sciences, 9% from computer sciences, and the rest from other academic fields. In terms of geographical distribution, 43% of the teachers worked in schools situated in urban areas, 27% in semiurban areas, and 30% in rural areas. The majority of the respondents (40%) had more than 15 years of teaching experience, but close to that (37%) had the least involvement in using ICTs as teaching and learning tools. However, the majority (54%) declared to have sufficient knowledge of education for sustainability.
2.2. Instruments and Measures

A teachers’ ICTeEfS self-efficacy scale was developed to measure teachers’ evaluations of their abilities and beliefs to contextualize ICTs with issues of sustainability. The teachers’ ICTeEfS self-efficacy scale conceptualizes teaching as a complex activity and teacher self-efficacy as a multifaceted construct representing at least two distinct dimensions: (1) transformative contextualization and (2) critical reflection. Teacher experience of using ICTs as supportive tools to embed sustainability issues in teaching, learning, and school curricula, as well as years of working in schools, were measured using an interval scale with the following categories: up to 4 years, 5–9 years, 10–14 years, and 15 years or more. Similarly, the variables for knowledge and skills in ICTs and knowledge of education for sustainability were assessed using a 5-point scale ranging from poor to minimal, sufficient, above average, and excellent. This study was designed for and has been used in developing the ICTeEfS teacher capacity-building program funded by the European Commission in the seven higher education institutions in the three partner countries, Indonesia, Malaysia, and Vietnam. For data collection, the appropriate permits were requested from the Provincial Directorates of Education, before delivering the research instrument in printed form and online during the first months of the 2019–2020 academic year. Once the data had been collected, a database was created to run an analysis through the Statistical Package for the Social Sciences (SPSS Version 23).

2.3. Types of Analysis

For the validation of the teachers’ ICTeEfS self-efficacy scale, the principal component analysis (PCA) method was chosen along with the varimax rotation, including the Kaiser–Meyer–Olkin (KMO) test for sample adequacy and the Bartlett’s test of sphericity for data validity. The items were rated on a 5-point Likert scale, which ranged from “strongly disagree” to “strongly agree”. The internal consistency of the items was assessed using Cronbach’s alpha reliability statistics. Descriptive statistics were also used to check the distribution of the data, and an examination of multicollinearity was carried out using the variance inflation factor (VIF) and tolerance metrics. The stepwise method was used for running a multiple regression analysis, testing H1 to H6, to identify the explanatory power of the hypothesized predictors on teachers’ ICTeEfS self-efficacy. H7, dealing with teachers’ school settings (rural, semiurban, and urban), due to its categorical nature, was tested individually using a one-way analysis of variance and Tukey post hoc multiple comparison test.

3. Results

3.1. Descriptive and Factorial Results

The value of standard deviations (SDs) ranged from 0.43 to 1.0, the level of skewness ranged from 0.10 to ±0.80, and most of the values of kurtosis were below 2.00. These results indicate that there are relatively narrow spreads around the mean, the tails are slightly lighter than the normal distribution, and, in general, there is a sizeable spread from normality that can be accepted in this type of analysis [53,54]. The teacher’s ICTeEfS self-efficacy average scores (means) were a little above 3.00, indicating that teachers demonstrated a relatively high level of ICTeEfS self-efficacy. The collinearity statistics show that the VIF metrics for the regressed variables ranged from 1.05 to 1.96 and the corresponding tolerance between 0.50 to 0.97, indicating that there is no problem of multicollinearity for running a regression analysis.

The principal component analysis (PCA) shows that the KMO (Kaiser–Meyer–Olkin) value for the teacher’s ICTeEfS self-efficacy was 0.848, indicating a very good measure regarding sample sufficiency and adequacy, and the extraction values of the communalities ranged from 0.430 to 0.759. Since the threshold was set at <0.40, all the predefined variables for conceptualizing the teacher’s ICTeEfS self-efficacy measurement were retained. Bartlett’s test of sphericity was statistically significant ($\chi^2 = 7832.49; df: 66; Sig. p < 0.001$), indicating that the items are significantly correlated and that the results support further
The PCA produced a three-factor solution with a direct varimax rotation method and eigenvalues > 1.0, accounting for a substantial (61.29%) amount of the extracted variance, exceeding the threshold of 0.50. Thus, the convergent validity of the construct is substantially supported.

In particular, the first factor accounted for 36.29% of the variance, the second 14.97%, and the third 10.03%. The obtained three-factor structure was very well defined and interpretable with theoretical reliability and construct relevance with an eigenvalue of 4.35 for the first factor, 1.79 for the second, and 1.20 for the third. All the rest were below 1.00 and, thus, did not add anything significant to the scale. Accordingly, the three factors are effective enough in representing all the characteristics highlighted by the stated variables (Table 1). This is depicted in the scree plot graph (Figure 1) which shows that the curve begins to flatten between the three and four components. From factor 4 and onwards, the eigenvalue is less than one, so only three factors were retained. The Cronbach’s alpha of the final scale including the 12 variables was calculated, and a value of 0.84 was obtained, indicating very good reliability and very good internal consistency.

Table 1. Rotated component matrix for the ICTeFs self-efficacy scale.

<table>
<thead>
<tr>
<th>Items, Components, and Loadings</th>
<th>Comp 1</th>
<th>Comp 2</th>
<th>Comp 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to use ICT to support education for sustainability.</td>
<td>0.829</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to use interactive methods to address sustainability.</td>
<td>0.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to use learners’ life experiences to address sustainability.</td>
<td>0.811</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability in critical self-reflection for sustainability.</td>
<td>0.713</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reappraising personal experiences for self-development.</td>
<td></td>
<td>0.733</td>
<td></td>
</tr>
<tr>
<td>Reflecting on challenges firmly held ideas, values, and practices.</td>
<td></td>
<td>0.723</td>
<td></td>
</tr>
<tr>
<td>Reflecting on previous values leads to motivation for change.</td>
<td></td>
<td>0.714</td>
<td></td>
</tr>
<tr>
<td>Belief in acting to build a just and sustainable society.</td>
<td></td>
<td>0.678</td>
<td></td>
</tr>
<tr>
<td>I can make a difference for a better future.</td>
<td></td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>Belief in teaching as a moral and active engagement for sustainability.</td>
<td></td>
<td>0.776</td>
<td></td>
</tr>
<tr>
<td>A belief that learners should have a voice in what they learn.</td>
<td></td>
<td>0.773</td>
<td></td>
</tr>
<tr>
<td>Belief in teacher’s transformative role as agents of change.</td>
<td></td>
<td>0.713</td>
<td></td>
</tr>
</tbody>
</table>

As mentioned earlier, the scree plot and the PCA enabled us to retain the three-factor or component model (Figure 1), with the factor loadings shown in Table 1 accounting for a significant portion (61.29%) of the total variance. Factor or component 1, labeled “ICTeFs competence”, comprises four items reflecting self-efficacy in embedding sustainability issues in teaching, learning, and curricula through ICTs. Factor/component 2, labeled “reflective practices”, includes five items referring to teachers’ self-efficacy in integrating reflective practices and changemaker beliefs to build a more sustainable and just society. Lastly, factor/component 3, labeled “transformative teaching beliefs”, consists of three items related to teachers’ beliefs in active engagement to promote education for sustainability and the role of human agency in transforming teaching and learning.

3.2. Regression Analysis Results

A stepwise regression analysis was conducted to test the hypotheses regarding their predictive value towards teachers’ ICTeFs self-efficacy, which was considered the dependent variable. The predictors examined were knowledge of education for sustainability (H1), knowledge of ICTs (H2), gender (H3), school level (H4), the number of years working as teachers (H5), and teachers’ experience involved in using ICTs to support teaching (H6). A final two-factor statistically significant prediction model emerged through the stepwise regression method (Table 2), excluding gender, school level, years of teaching, and years
of using ICTs as teaching tools. The excluded independent variables or predictors did not meet the probability threshold ($p > 0.050$).

The total coefficient of determination achieved was $R^2_{adj} = 0.275$ with $F(6,1811) = 117.96$, mean square = 17.22, and $p = 0.000$, shown in Table 3, explaining 27.5% of the variability in the ICTeEfS self-efficacy measure. More specifically, the stepwise regression analysis revealed that knowledge of education for sustainability alone explained 24.5% of the ICTeEfS self-efficacy ($R^2_{Change} = 0.245$, $F_{Change}(1,1810) = 590.21.$ at $p = 0.000$), followed by ICT knowledge, which added 3% ($R^2_{Change} = 0.030$, $F_{Change}(1,1809) = 74.21.$ at $p = 0.000$). These two predictors were found to be the most influential in explaining teachers’ ICTeEfS self-efficacy. This is clearly shown by the beta values 0.50 and 0.23, respectively, for the two predictors presented in Table 2.

### Table 2. Multiple regression analysis results.

<table>
<thead>
<tr>
<th>Hypotheses Verified</th>
<th>$R^2_{Aj}$</th>
<th>Df</th>
<th>$R^2_{Ch}$</th>
<th>$F_{Ch}$</th>
<th>Beta</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1. EfS-knowledge $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>0.245</td>
<td>1810</td>
<td>0.245</td>
<td>590.21</td>
<td>0.50</td>
<td>24.29</td>
<td>0.000</td>
</tr>
<tr>
<td>H2. ICT-knowledge $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>0.275</td>
<td>1809</td>
<td>0.030</td>
<td>74.21</td>
<td>0.23</td>
<td>8.62</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypotheses Rejected</th>
<th>$R^2_{Aj}$</th>
<th>Df</th>
<th>$R^2_{Ch}$</th>
<th>$F_{Ch}$</th>
<th>Beta</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>H3. Teacher’s Gender $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.39</td>
<td>1.94</td>
<td>0.052</td>
</tr>
<tr>
<td>H4. Teachers working at the primary or secondary school level $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.08</td>
<td>0.41</td>
<td>0.682</td>
</tr>
<tr>
<td>H5. Teacher’s years of teaching $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.25</td>
<td>-1.29</td>
<td>0.197</td>
</tr>
<tr>
<td>H6. Teacher’s experience of using ICTs as supportive tools $\rightarrow$ ICTeEfS Self-Efficacy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.40</td>
<td>1.90</td>
<td>0.058</td>
</tr>
</tbody>
</table>

Figure 1. Scree plot results.
Table 3. ANOVA results.

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>103.317</td>
<td>6</td>
<td>17.219</td>
<td>117.96</td>
<td>0.000</td>
</tr>
<tr>
<td>Residual</td>
<td>263.476</td>
<td>1805</td>
<td>0.146</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>366.793</td>
<td>1811</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As detailed in the methodology section, a one-way analysis of variance (ANOVA) was conducted to test H7, which examines whether teachers’ ICTeEfS self-efficacy varies based on the location of their school (rural, semiurban, or urban area). Before performing the ANOVA, it was necessary to confirm that the homogeneity of variance assumption was met. The Levene statistic’s significance value was $p = 0.530$, well above the threshold of $p > 0.050$, thus satisfying the homogeneity of variance requirement and validating the robustness of the ANOVA test. The results indicated a statistically significant difference in ICTeEfS self-efficacy among teachers from rural, semiurban, and urban areas, as determined by one-way ANOVA ($F(2,1812) = 12.369$, $p = 0.000$). A Tukey post hoc test further revealed that teachers in rural (mean = 3.47) and semiurban (mean = 3.50) schools had lower self-efficacy scores for embedding sustainability issues in teaching, learning, and school curricula compared to teachers in urban schools (mean = 3.58).

4. Discussion

This study focused on constructing and validating a teacher’s ICTeEfS self-efficacy scale and explored the predictive power of several teacher background factors, such as gender, school level, years of teaching, experience in using ICTs to support teaching and learning processes, knowledge of ICTs, and school setting. Teachers’ perceptions of their ICTeEfS self-efficacy were clustered into one composite variable that was well defined through a principal component analysis.

The results indicated that the combined self-efficacy beliefs in ICTeEfS were explained by a significant portion of its variation from two statistically significant predictors. As expected, the study verified the hypothesis (H1) that the teachers who have a high level of knowledge in the field of education for sustainability (EfS) are more likely to have a higher level of self-efficacy in using ICTs to contextualize EfS. This was the most powerful predictor of the teacher’s ICTeEfS self-efficacy, explaining 24.5% of the total variance. This result is consistent with previous research [55,56] showing that the frequently utilized ICT for out-of-school learning, especially when dealing with real-life issues, leads to significantly higher levels of self-efficacy and persistence. This implies that there is a need to embed sustainability issues in multiple academic disciplines, especially in teacher education faculties, as well as in faculties or disciplines that educate future teachers across all education levels. In the three target countries, especially in Malaysia, teachers are offered opportunities to acquire knowledge and skills about EfS, usually organized by government entities such as the Ministry of Natural Resources and Environment Sustainability under the Department of Environment, as well as sponsored by various nongovernmental organizations [57].

A similar trend is also evidenced with teachers who have a high level of competence in ICTs who are more likely to exhibit a higher level of self-efficacy in using ICTs to contextualize EfS (H2). This assumption is supported by previous studies [58,59] showing that increased knowledge of education for sustainability and ICT tools increasingly support contextualized curricula, teaching, and learning. If such developments and tools are widely adopted and used appropriately, teachers’ ICTeEfS self-efficacy will be enhanced. Nevertheless, contrasting findings suggest that while teachers are proficient in ICT utilization, they encounter challenges in deploying these technologies as effective pedagogical instruments [60]. In general, the results exemplified by their standardized beta values (Table 2) show a strong and positive direction, meaning that for each increase in knowledge of ICTeEfS and ICT skills, with all other independent variables being constant, a subsequent increase in their self-efficacy on ICTeEfS will take place. It can be thus assumed that these
two factors are dialectically related in the sense that their interaction leads to a significant increase in teachers’ ICTeEfS self-efficacy. The importance of developing the capacity of teachers to address the infusion of SDGs and related sustainability issues, especially of local concern and knowledge on how to use ICTs to enable education for sustainability, is of critical importance to teacher educators, educational policymakers, and educational leadership. However, it has to be noted that teachers should not be tempted by the novelty of ICTs to address education for sustainability, since it is more essential to prioritize the development of their skills on how to use and apply ICTs and digital technologies to address sustainability issues in pedagogically meaningful ways.

These results were of particular importance in the design of the ICTeEfS curriculum reconstruction process to embed education for sustainability in the targeted academic institutions as well as for designing suitable capacity-building interventions. Contextualizing the teacher education curriculum in multiple academic disciplines to embed sustainability issues largely elicited from the 17 SDGs can help students and prospective teachers see how their studies are relevant to real life, making them more engaged and motivated to learn and engage in sustainability action. It also helps them to make meaningful connections between different subject areas, which can promote inter/cross-disciplinarity and deepen their understanding of their role both as active citizens and dedicated teachers in building a more sustainable and just society. Contextualization is a paramount teaching and curriculum development strategy that does not only contribute to promoting inter/cross-disciplinary learning but also to quality education (SDG4) in general.

The results also support the hypothesis (H7) that teachers who work in urban, semi-urban, and rural areas will be differentiated in terms of their self-efficacy in using ICTs to contextualize EfS. More specifically, the results show that teachers who work in urban schools have higher self-efficacy than teachers in rural areas. Similar results are also found in previous research [61–63]. In general, for schools’ geographical context, that is, schools situated in remote areas in the partner countries, it seems that their teachers are at a disadvantage in terms of their ICTeEfS self-efficacy compared to teachers from urban areas. This has often been linked to suitable preparation and support for teaching in such specific contexts [63,64]. In general, teacher education programs do not often differentiate teaching in different geographical contexts where learners have different sociocultural characteristics and consequent pedagogical needs. This is a critical factor in ensuring quality education, regardless of the schools’ geographical location. Thus, we strongly argue that teacher education programs must include differentiated instructional and learning strategies in their study programs and school practicum. For teacher education programs, multiple field placements in diverse geographical settings have been consistently advocated [65,66]. This implies that educational policy should be directed at the importance of the preparation of student teachers to work in rural areas if they are to develop self-efficacy in contextualizing ICTs with education for sustainability. It is also worth pointing out that in the target countries, parent–teacher associations are often actively involved in school decisions and providing support and resources to schools, especially the rural ones [67]. In Malaysia, it has been also reported that alumni contribute large sums of money to facilitate the school’s overall development [68].

Unexpectedly, no statistically significant differences are found in teachers’ ICTeEfS self-efficacy concerning teachers’ gender (H3), school level (H4), years of teaching (H5), and teacher’s experience of using ICTs as supportive tools (H6), as depicted in Table 2. It was noticed, however, that the probability values for gender and years of teaching with the support of ICTs were very close to $p = 0.050$. In terms of gender, there are controversial results and there is little evidence in previous research on which to base hypotheses in self-efficacy research [69]. However, discovering gender differences and possible explanations will eventually help to obtain proper measures for bridging gender gaps. A meta-analysis on gender differences in academic self-efficacy identified an overall effect size of 0.08, with a small difference favoring males [70].
While novice teachers experience higher levels of ICTeEfS self-efficacy, perhaps due to their undergoing comprehensive training in education for sustainability and ICTs, older teachers may require tailored in-service training to enhance their ICTeEfS skills meaningfully in their teaching practices. Furthermore, ICTeEfS skills are essential; they must be coupled with meaningful pedagogical approaches that contextualize real-life data into the curriculum. Previous research shows that teachers’ self-efficacy increases from their early career to mid-career and declines afterward [71,72]. In addition to that, the existing empirical studies show inconsistent and even conflicting results in terms of gender differences in ICT attitudes and behaviors [73,74].

5. Conclusions

Summing up, the research results revealed that teachers possessing a high level of knowledge on issues about sustainability and ICT competence are more likely to have increased self-efficacy for contextualizing sustainability issues in teaching, learning, and curricula supported by ICT tools. However, a gap remains in utilizing these skills pedagogically. This study also discussed the varying levels of self-efficacy among teachers based on their workplace location, finding that urban teachers demonstrate higher self-efficacy compared to their rural counterparts. This could be attributed to the disparities in resources and support systems, thereby affecting their capacity to employ ICT in EfS effectively. The research points out that the duration of ICT usage as a supportive tool in education does not necessarily correspond to higher ICT self-efficacy.

The results suggest that longer teaching experience does not guarantee higher ICT self-efficacy. This contradicts the typical expectation that experience enhances competence, implying that the dynamic nature of ICTs demands continual learning and adaptation irrespective of years spent teaching. These empirical insights substantiated by previous research stress the critical relationship between knowledge of ICTeEfS, ICT skills, and the consequent amplification of teachers’ self-efficacy in ICTeEfS. It is imperative to acknowledge that while ICT innovations are significant in teaching and learning, the prioritization of developing teachers’ abilities to apply ICT and digital technologies in addressing sustainability issues within a pedagogical context is of paramount importance. This is supported by previous studies, indicating that a profound understanding of education for sustainability, coupled with ICT tools underpinned by transformative teaching and learning, bolsters the creation of contextualized curricula and enriches the teaching and learning experience [75,76], especially through multidisciplinary projects [77]. These results also suggest the need to cultivate teachers’ digital competence that reflects the Technological Pedagogical Content Knowledge (TPACK) methodology [78], especially taking into consideration the synergistic effects of recent advances in AI technology, supported by innovative pedagogical methods, and contextualized with multiple subject-specific content in the broader field of education; this is termed AI-TPACK [79].

The integration of education for sustainability (EfS) into educational systems depends largely upon the multidimensional approach that includes both knowledge in the field of EfS and competence in ICTs. These two factors serve as effective predictors of ICTeEfS teacher self-efficacy success. The support from various organizations, both governmental and nongovernmental, underscores the significance attributed to these elements in fostering sustainable education practices in schools. By leveraging these insights and fostering collaboration among stakeholders, the three Southeast Asian countries can continue their efforts toward ICTeEfS for preparing today’s learners and tomorrow’s professionals for active citizenship.

Although the sample of respondents is very high, its purposive nature is limited to teachers who possess certain characteristics, such as knowledge of ICTs, which constrains the generalization of the results to the wider corpus of teachers in the targeted countries. Nevertheless, the results of the study are extremely important for its purpose and can provide a good reference for future research in this field. More specifically, it was the first attempt
to establish a teacher’s ICTeEfS self-efficacy scale. In future research, it is also important to further test this scale, especially in a wider context, including all sorts of teachers.


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