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Castledown

Computer-related metacognitive and self-efficacy beliefs of university students: A Japanese case study

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This study aims to measure student cognitive and metacognitive perceptions regarding computer use in university. This study addresses three key questions: a) how does the model fit the key construct of metacognitive and self-efficacy beliefs; b) to what degree do independent variables predict dependent factor outcomes; and c) how can understanding student metacognitive and self-efficacy beliefs inform ICT policy in education? This representative model uses four latent factors to measure student perceptions: self-efficacy (SE), computer anxiety (CA), vicarious experiences (VE), and belief of benefits (BB). This study uses a 16-item survey model to test a sample of 602 students from a university in Japan. Quantitative data were analysed using a confirmatory factor analysis to test the validity of dependent latent factors, and a multiple regression analysis to identify independent variables that can predict dependent variable outcomes. Results identify statistically significant predictors of outcome related to two of the dependent variables (self-efficacy and computer anxiety) concerning the demographic groups: a) Gender, b) Computer use age (the age when participants begin using computers), c) Computer use based on hours per day, d) Ownership of computer devices, and e) Location of computer use. Findings conclude that the tested model gives substantial insights into the cognitive and metacognitive processes of students, which can meaningfully contribute to the development of ICT policies in schools.

Keywords: ICT; metacognition; student beliefs; computer anxiety; self-efficacy; belief of benefits; computers; classroom; education; Japan

Introduction

As a component of social cognitive theory, self-efficacy is the belief or judgement of one's own ability to achieve particular goals (Bandura, 1977). Related to this construct is metacognition, a concept that integrates an individual's knowledge, cognitive processes and methods for evaluating one's own thinking (Nelson *et al.*, 1999). Self-efficacy and metacognition share similarities, as both are forms of self-assessment related to an individual's capacity to perform a task, solve problems, or attain new skills (Cuevas *et al.*, 2004). While metacognition only relates to procedural knowledge, self-efficacy predicts both declarative and procedural knowledge (Nelson *et al.*, 1999). In this paper, metacognitive beliefs refer to the three dependent variables used in the study, computer-anxiety (CA), vicarious experience (VE), and belief of benefit (BB) (regarding computer use). This paper will argue that understanding metacognitive and self-efficacy beliefs about computer use has the potential to predict how students respond to ICT use in education and could help to shape ICT policy in schools.

The growth of the information technology industry (ICT) has created a need to better understand and design learning environments through overcoming obstacles in learning by gaining insight into cognitive and behavioural strategies (Battistelli *et al.*, 2009). Given the slow integration of ICT in the Japanese education system (Funamori, 2017), such insights into learner metacognitive beliefs could prove beneficial. This argument is reinforced due to the sudden worldwide shift to online learning in 2020, caused by the COVID-19 pandemic (Strauss, 2020). Regarding the Japanese experience, the 2020 spring semester had approximately 90% of universities in Japan conduct distance learning (Japan: Ministry of Education Culture Sports Science and Technology, 2020). Increased reliance on ICT education underlines the need to understand student metacognitive beliefs regarding computer use to aid both administrators and teachers to strategise future ICT teaching approaches.

Aims of the study

This study will argue that predicting student metacognitive and self-efficacy beliefs is important in understanding student perceptions, which could contribute to the development of ICT education policy in Japan. This research aims to test the dependent latent variable scales of the quantitative instrument design for goodness-of-fit against independent variables, and reveal the extent that Japanese student populations predict cognitive and metacognitive beliefs about computer use. The study seeks to address the following questions:

a. How does the model fit the key construct of metacognitive and self-efficacy beliefs;
b. To what degree do independent variables predict dependent factor outcomes;

c. How can understanding student metacognitive and self-efficacy beliefs inform ICT policy in education?

Literature Review

Metacognition

Established within the study of developmental psychology, metacognition has been described as "cognition about one's own cognition" (Flavell, 1979), which refers to an individual's knowledge of cognitive processes and output (i.e. the knowledge of how one's own mind, and others', function). Metacognition also relates to the factors (such as age, gender, life events, overestimation of danger, and underestimation of coping skills) that influence the performance of cognition (Ryum *et al.*, 2017). A better understanding of how these factors impact cognition could result in the development of educational structures that improve support for student learning. A metacognitive approach in education encourages participants to communicate and engage in directly relevant goals, including abilities, attitudes, self-belief, principles and understandings (Phelps *et al.*, 2004). Research has explored metacognitive beliefs of students in areas such as self-confidence (Kleitman & Gibson, 2011), study strategies (Yue *et al.*, 2015), and student mental health (Valizade *et al.*, 2013). Specifically, in relation to ICT in education, much of the literature relates to the contribution of metacognitive strategy and skill development to student learning (Cadamuro *et al.*, 2019; Maccann-Alfaro *et al.*, 2019; Wu & Peng, 2017). The widespread transition to online instruction due to COVID-19 supports the need for a greater understanding of student ICT metacognitive beliefs to better connect with students and enhance learning strategies.

Computer-anxiety

Computer anxiety is defined as an individual's temperament that distinguishes various situations involving computers, but finds these circumstances threatening and beyond their control (Lankford *et al.*, 1994; Todman & Monaghan, 1994). Individuals that are prone to CA can be vulnerable to stress, tension, and apprehension in situations that involve computers (Smith & Caputi, 2001), due to the impact cognitive beliefs have on one's ability to regulate behavior (Bandura & Schunk, 1981). Matsumura and Hann (2004) identify CA as a transitional emotional state that includes cognitive expressions, such as negative thoughts or doubts about computing competence. Early research suggests that CA is deeply rooted in individuals' psychological, educational, and operational beliefs and advises that such deeply held beliefs could be difficult to alter (Howard & Smith, 1986). However, Chua *et al.* (1999) argues that CA is multifaceted (for example, anxiety related to computer equipment or computer learning), and addressing various dimensions could influence or reduce its impact on individuals.

Later CA research has shifted focus to emerging technologies that not only shape educational approaches but also influence how students interact with the world around them, for example, smartphones (Lepp *et al.*, 2014; Lu *et al.*, 2011), social media (Ishii *et al.*, 2017; Wang, 2016), and learning management systems (Jung *et al.*, 2012). There has, however, been a recent continuation of CA research focusing on educational settings within specific cultural contexts which highlight the necessity for further insight into this field (Cazan *et al.*, 2016; Celik & Yesilyurt, 2013; Korobili *et al.*, 2010). Wombacher *et al.* (2017) underscore the importance of such research by claiming that anxiety triggered by school-related interaction with computers may cause students to perceive an inability to learn due to cognitive discord. In other words, a clash of acquired computer experience with established beliefs and ideas may generate anxiety, which could distract a student from class-related performance. In a post-COVID-19 world, when learners are expected to conform to digitalised standards of classroom output, CA could trigger avoidance behaviour in students. Without educators obtaining the knowledge or ability to detect such behaviour, students vulnerable to these cognitive tendencies would be left with a predisposed disadvantage in computer-oriented learning environments.

Self-efficacy

Self-efficacy (SE), a subset of social cognitive theory, exerts its influence through cognitive, motivational, affective, and selection processes (Bandura & Jourden, 1991). An individual's high sense of efficacy can mean the ability to visualize success and provide performance support; low perceived efficacy can result in visualisation of failure and concern about things that can go wrong (Bandura, 1993). Beckers and Schmidt (2001) conclude that computer literacy and SE are associated, as it was hypothesised that SE directly influences computer literacy. In addition, some researchers maintain that student perceived SE is an essential factor to determine as it is recognised as an effective predictor of student ability and success (Saunders-Wyndham & Smith, 2020), including computer-supported class programs (Cazan *et al.*, 2016; Celik & Yesilyurt, 2013). Other studies have further argued that student self-efficacy related to technology use is a significant predictor of future academic and career paths (Vekiri & Chronaki, 2008).

Self-efficacy has been shown to be influenced by other factors, such as gender. In a comprehensive review of 276 articles on computer anxiety during the 1990s and 2000s, Powell (2013) reported on 80 publications which investigated the effects of gender on CA, though much of the research is largely inconclusive. While it was concluded that half of those studies reported a connection between gender and CA, women were found to have higher levels than men, except in a small number of studies conducted in Asian contexts (Hong Kong and Taiwan). Powell (2013) also described 28 investigations that found a negative correlation between CA and SE. Several other studies have come to conflicting conclusions regarding gender as a predictor of SE and CA, with some finding higher SE to be attributed significantly to male participants who experience a higher perceived knowledge of computers (Gibbs, 2013), while others attribute higher SE to factors such as educational study majors (Cazan *et al.*, 2016), or cultural identity and masculinity (Huffman *et al.*, 2013). Each of these studies were conducted in vastly different cultural contexts indicating that CA and SE are specific to culture, and thus additional research is needed to provide further insight into various cultural contexts, such as Japan.

Japanese cultural context

Research indicates Japanese culture as characterised by a penchant for phone-based internet access and suggests a possible cultural collective avoidance of PC use (Kubota, 2014). In 2018, Japan's deputy chief government Minister of Cybersecurity, Yoshitaka Sakurada, provoked international reaction after admitting he had never used a computer and was confused when asked to identify a USB memory stick (McCurry, 2018). This experience could be perceived as unsurprising given previous reports on ICT habits in Japan have revealed a preference for mobile phone technology over PC use (Kubota, 2014; Nihei *et al.*, 2008), which is supported by a 2015 report that ranked Japan below the OECD average regarding access to computers at home (OECD, 2016). Claims of Japan's reliance on mobile internet access is further supported by the International Telecommunication Union, which stated that people living in Japan were more likely than the rest of the world to access the Internet by mobile phone, reporting 188.9 mobile-broadband subscriptions per 100 inhabitants versus 76.8% of households with a computer (ITU, 2017).

Cultural complacence regarding computer use can arguably be extended to an educational context. The Japanese education system has been criticised for failing to meet international ICT standards (Aoki, 2010; Funamori, 2017). In 2011 Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) set up a broad educational plan to support the development of a "knowledge-based society" in the 21st Century by enhancing ICT support in classrooms, with a target of creating effective change by the year 2020 (Japan: Ministry of Education Culture Sports Science and Technology, 2011). However, it can be argued that the MEXT vision for education did little to enhance ICT usage in classrooms. A survey by MEXT revealed that as of 2018, public elementary, junior high, and high schools had only one computer available for every 5.6 students (Jiji, 2019) while another concluded that an overwhelming number of universities are deficient in staff able to maintain ICT systems due to insufficient budgets and a lack of ICT skills (Funamori, 2017). Furthermore, results from the 2018 OECD PISA show that roughly 80% of students responded claiming digital devices are not used in school lessons; the lowest among OECD countries (Japan: National Institute for Educational Policy Research, 2019). Results of the same research reveal that only 3% of students regularly do their homework on a computer, while only 3 to 4% of students responded that they regularly check the school's website to download/upload assignments and check for announcements. Moreover, it has been argued that disparity in student access to internet connections and computers, including educator perceptions of student inequality, have caused push-back on ICT methods, and a lack of enthusiasm for ICT in education has meant that schools were ill-prepared to adapt to the COVID-19 crisis (Yamamoto, 2020).

This avoidance of ICT technology may have already caused arguably significant setbacks in the classroom, which is important to understand as delayed action to support ICT learning could negatively impact the future economic needs. Some academics have argued that Japan has fallen behind the rest of the world in terms of ICT education (Yamamoto, 2020). This claim is backed by a 2015 report by the Japanese Ministry of Economy, Trade, and Industry (METI), which predicted that by 2019 the mean age of workers in the IT industry would be 39 and the number of IT graduates entering the workforce would be less than the number of people leaving the same industry (Japan: Ministry of Economic Trade and Industry, 2019). Additionally, a forecast for 2030 predicted that on the current trajectory, the Japanese IT industry would face a shortage of up to 590,000 employees. The evidence suggests that government and educational institutes have failed to adequately support student adoption of ICT methods, which could potentially disadvantage the growth of a future tech-based market economy. By better understanding the cognitive and metacognitive beliefs of students regarding computer use, educators and administrators may better adjust the educational ICT approaches that could support Japan's economic future.

Methodology

This study employed a quantitative research methods approach, which included multiple analyses of statistical data. A confirmatory factor analysis investigated model fit; a comparative means analysis was utilized to identify significant differences in latent variables between population of the demographic, "gender"; and a linear regression analysis was used to test the structural model fit, detect significant variance in in latent factors, and test for predictors of latent factors. Demographic groups were tested using statistically significant variances in mean scores between groups, which were used to identify important predictors of factor outcomes.

Participants

Convenience sampling was employed to gather survey data from $N = 602$ participants who were all of Japanese nationality and aged between 18 and 21 years. Samples were taken from a single private university located in Japan. Data were collected from 25 English communication classes. None of the participants were English majors, but were drawn from a diverse range of disciplines spanning both the arts and sciences. No exclusion criteria were implemented. Student participation in the survey was conducted on a voluntary basis. All students who received the survey agreed to participate. The demographic group of Gender (only the biological gender declared by participants was used) was a nominal report as male ($n = 301$) and female ($n = 301$). Other nominal variables include "Ownership of desktop computer," yes ($n = 130$) and no ($n = 496$);

"Ownership of laptop computer," yes (n = 496) and no (n = 133); "Ownership of digital tablet," yes (n = 86) and no (n = 516). In addition, the scale variable demographic of "Age started using computers" had a population of n = 599 and the demographic of "PC use, hours per day" had a population of n = 577.

Instrument

This study utilized a relational survey model to understand the social effects of perceived beliefs of subgroups on two or more variables (Coleman, 1958). This paper introduces a model to measure the computer-related cognitive and meta-cognitive beliefs of students in order to better understand and address the ICT issues unique to the Japanese university context. The model design and survey questions were adapted from previous studies that address computer-related self-efficacy and computer anxiety in education (Barbeite & Weiss, 2004; Cazan *et al.*, 2016; Celik & Yesilyurt, 2013). The questionnaire survey was designed with two parts. Part I contained 20 items related to demographic information, which included questions that obtain information to be used to characterize survey responses that could be coded and organized as independent variables. Part II contained 25 items that represent the four latent factors, which include Self-efficacy (SE), Computer Anxiety (CA), Belief of Benefits (BB), and Vicarious Experience (VE). Items were randomly ordered to avoid common method bias (Conway & Lance, 2010). The scales aimed to measure participant perceptions of the following: a) ability to use computers ("Self-efficacy"), b) feelings of anxiety surrounding the use of computers ("Computer Anxiety"), c) beliefs concerning the benefits of maintaining computer skills ("Belief of Benefits"), and d) feelings as a reaction to seeing peers use computers ("Vicarious Experience"). Answers were measured using a six-point Likert scale. Number one on the Likert scale measured as "strongly disagree", two as "disagree", three as "somewhat disagree", four as "somewhat agree", five as "agree", and six as "strongly agree. Items values for CA were reversed for analysis to accurately reflect high and low levels of anxiety outcome.

Procedure

Data collection

A Japanese language version of the questionnaire was tested with 60 Japanese students to gauge the design, delivery style, and time required. These participants did not participate in the larger survey, and their responses are not included in the analysis. The questionnaire accompanied a university-approved consent form, and both were translated from English by a native Japanese speaker and proof-read by three other native speakers to confirm comprehension.

Although over 1,000 questionnaire samples were returned, only N = 602 samples were used. Incomplete responses were discarded, to avoid inaccurate statistical results. Remaining male surveys were not included in survey analysis to achieve an even number of male (301) and female (301) participants. All discarded male samples were chosen at random to avoid researcher bias.

The questionnaire was administered by the three researchers and nine other administrators who were approached and briefed two weeks before the scheduled collection phase (as per Dörnyei, 2007). The updated procedure took approximately ten minutes from instruction to collection. Responses on the number of hours spent on each device reflect only participants' perceived use of devices.

Item reduction

Changes to the instrument were made later piloting the survey by deleting eight items to allow better measurement of the fundamental construct. Items belonging to the following factors were deleted: SE, four items; CA, one item; VE, three items; BB, one item. This resulted in a 16-item questionnaire that balanced out to four items for each of the four model factors. The strength of the latent factor structure and bivariate correlations were determined via confirmatory factor analysis. To mitigate threats of internal consistency by inappropriate wording or word items in dependent variables, removal of scale items included those with poor factor loadings identified as having low importance to the key construct. Most of these items included statements regarding smartphones, digital tablets, or social media. See Appendix A for the finalised instrument.

Data analysis

Goodness-of-fit of the latent factor structure and bivariate correlations were verified by confirmatory factor analysis. Cronbach's Alpha was used to test internal consistency of scales and confirm the consistency and strength of items; a value greater than .70 indicates good/relatively high internal consistency and reliability (Taber, 2018). Maximum likelihood parameter estimation (ML) was applied as an estimation of method, conducted by SPSS Amos version 22. The chi-square likelihood test was not considered reliable due to its sensitivity to skewness and large sample size (Keith, 2006). Therefore, other fit indexes were employed, including the normed fit index (NFI) and the root mean square error of approximation (RMSEA), which was used as a supplement for the $\chi 2$-difference test in assessing model fit. The following models were utilized to determine the appropriateness of fit. Due to the large sample size, the noncentral $\chi 2$ distribution (RMSEA) was used, while standardised root mean squared residual (SRMR) determined absolute fit, and a comparative fit index (NFI and CFI) was used (Brown, 2015). The acceptable goodness-of-fit model used in the current study recognized as (c2/df ratio <3, CFI and TLI >.90, SRMR <.10, RMSEA <.08) and excellent fit (c2/df ratio <2, CFI and TLI >.95, SRMR <.08, RMSEA <.06) (Hu & Bentler, 1999).

Organisation of statistical data and analyses was conducted using SPSS version 26. The descriptive analysis identifies means and correlation coefficients between independent and dependent variables. As the sample size was greater than 50, the Shapiro-Wilk test was not used to determine distribution of normality, due to its sensitivity to minor deviations. Instead, skewness and kurtosis z-values were used and supported by visual confirmation of Q-Q Plots graphs for each factor. In sample sizes over 300, an absolute skew larger than two or an absolute kurtosis larger than seven can be referenced as determining non-normality (George & Mallery, 2001). Normal distribution of latent factor mean scores was determined by skewness and kurtosis values.

Correlation analysis identified significant relationships between latent factors. The effect size was determined by Cohen's *d*, which was defined as the following: small = .2, medium = .5, and large = .8 (Cohen, 1988a). The effect size of these correlation values greater than medium point of 0.5 were determined to have statistical significance (Cohen, 1988a). Identification of large correlation effect sizes was used to determine whether different factors are measuring the same latent variable.

Multiple regression analysis was used for two reasons: a) determine overall fit by explaining the degree of model variance, and b) determine the relative contribution of each of the predictors (independent variables) to variation of output (dependent variables). Assumption of normality was met, as assessed by inspection of Q-Q Plots for all four dependent variables. Determination of model fit was done by inspection of effect size, which is defined by correlation coefficient, Pearson *r*, in the order of small (≥.10), medium (≥ .30), and large (≥ .50), although the adjusted R^2 is reported in results to ensure accuracy of outcomes (Cohen, 1988a). The Durbin Watson statistic was used to check for autocorrelation in regression model output. The Durbin Watson statistic with a value close to 2.0 indicates zero autocorrelation (Durbin & Watson, 1950). Nominal independent variables were recoded as dummy variables, which allowed appropriate application to the regression analysis. Recoded variables include, a) Gender, b) Ownership of desktop computer, c) Ownership of laptop; d) Ownership of tablet, e) Computer use location: School, and f) Computer use location: Home. Scale variables that were included, a) Age that participants began using a computer, and b) Daily hours spent using a computer. Only results found to be greater than *adjusted* R^2 = .10, with statistical significance (p = <.05), were reported. Only results for the factors of SE and CA were found to be greater than *adjusted* R^2 = .10, and therefore the results for the factors of VE and BB are not reported in this study.

Results

Internal consistency reliability

The dependent variables were measured as latent factors: self-efficacy (SE), computer anxiety (CA), vicarious experience (VE), and belief of benefits (BB). The latent factors are comprised of four subscales, which demonstrated strong internal consistency and reliability: SE, α = .793; CA, α = .740; VE, α = .752; and BB, α = .711 (Appendix A). The factor loadings offer evidence for the convergent validity of the model factors.

Confirmatory factor analysis

The model demonstrated an adequate fit: The model in this study demonstrated an adequate fit: $\chi 2$ = 430.088, *df* = 98, $\chi 2/df$ = 4.389, *p* = .001; root mean square error of approximation (RMSEA) = .075; Standardized Root Mean Square Residual (SRMR) = .0513; Tucker-Lewis index (TLI) = .885; and Comparative fit index (CFI) = .906. This result indicates that the model fit index is between an acceptable and excellent fit.

Table 1. Factor correlation analysis

	Computer anxiety	Vicarious experience	Benefit of beliefs
Self-efficacy	−.881*	.744*	.358
Computer anxiety		−.957**	.440
Vicarious experience			.558

(a) *Strong correlation between variables

(b) **Very strong correlation between variables

Three large correlational relationships are identified in this study (see Table 1). A strong negative correlation was shown between latent factors for self-efficacy and computer anxiety (r = −.881, p < .001), and a very strong negative correlation between the factors of computer anxiety and vicarious experience (r = −.957, p < .001). Self-efficacy and vicarious experience (r = .744, p < .001) revealed a positive medium-strong relationship between these factors. However, a medium correlation coefficient was shown between vicarious experience and beliefs of benefits (r = .558, p < .001) and a weak correlation between self-efficacy and belief of benefits (r = .358, p < .001) and computer anxiety and belief of benefits (r = .440, p < .001), suggesting that beliefs of benefits regarding computer technology do not share such a strong positive relationship to metacognitive beliefs related to computers. Further analysis was conducted to investigate the very strong negative correlation score between computer anxiety and vicarious experience, and the strong positive correlation between self-efficacy and vicarious experience. A visual inspection of scatterplot graphs revealed a strong linear effect size for both correlations (CA ⇔ VE, R^2 Linear = .501; SE ⇔ CA, R^2 Linear = .494). These strong effect sizes represent causation of correlation to a large degree, but do not completely describe the observable pattern.

Descriptives

Responses to the Likert scale questions revealed mean scores across all factors varied between 3.19 to 4.82 (Table 2). Standard deviations ranged between .63 to 1.01. Skewness and kurtosis results were shown to be within acceptable levels. The descriptive results are graphically represented in a box plot in Figure 1.

Table 2. Descriptive – Dependent latent variables

Dependent variable	Mean	Standard deviation	Skewness	Kurtosis
Self-Efficacy (SE)	3.19	1.01	.286	-.189
Computer Anxiety (CA)	3.51	.83	-.006	.243
Vicarious Experience (VE)	3.95	.72	.113	.497
Benefit of Beliefs (BB)	4.82	.63	-.095	-.273

Note: A high Computer Anxiety score does not reflect high levels of anxiety; the higher scores reflect lower perceived anxiety.

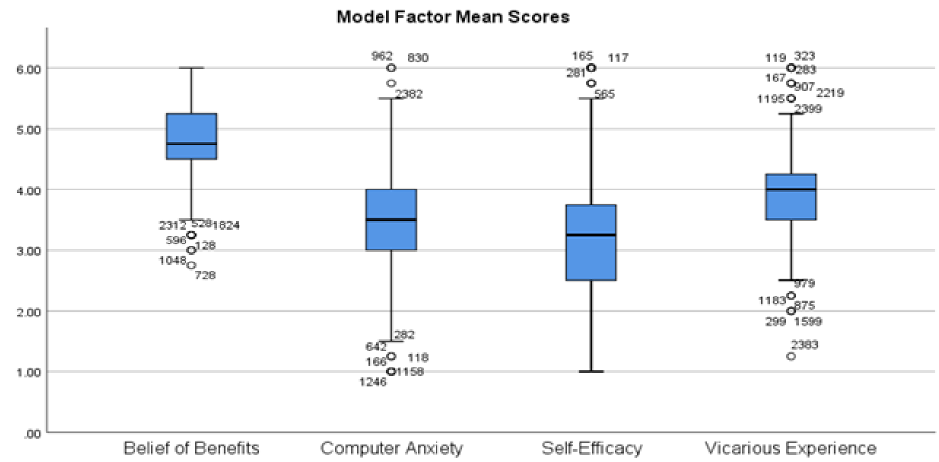

Figure 1. Boxplot of factor mean scores

Multiple regression analysis: Self-efficacy (SE)

A regression analysis was used to test for model fit and identify significant levels of predictive power of eight independent variables (see *Data analysis*) against the dependent variables. There was independence of residuals, as assessed by a Durbin-Watson statistic of 2.068. The multiple regression model significantly predicted the factor of CA, $F(8, 565) = 17.842$, $p < .001$, adj. $R^2 = .19$. The R^2 effect size for SE was 20.2% with an adjusted R^2 of 19%, which is defined as a small size effect (Cohen, 1988b). All except one independent factor, ownership of game consoles, was found to have a predictive effect at a statistically significant level (see Table 3).

Table 3. Multiple regression analysis results for Self-Efficacy (SE)

Self-efficacy (SE)	B	95% CI for B LL	95% CI for B UL	SE B	β	R^2	adj. R^2
Model						.202	.190
Constant	2.82***	2.467	3.173	.02			
Gender: male	.36***	.197	.515	.08	.18***		
Age that participants began using computers	−.05***	−.070	−.020	.01	−.14***		
Daily hours spent using a computer	.11***	.073	.151	.02	.22***		
Ownership of desktop computer	.22*	.011	.427	.11	.08*		
Ownership of laptop	.27**	.078	.458	.10	.11**		
Ownership of tablet	.30**	.082	.511	.11	.10**		
Computer use location: Home	.33***	.155	.497	.09	.15***		

Note. Model = "Enter" method in SPSS Statistics; B = unstandardized regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient; β = standard coefficient; R^2 = coefficient of determination; *adj.* R^2 = adjusted R^2. *$p < .05$. **$p < .01$. ***$p < .001$.

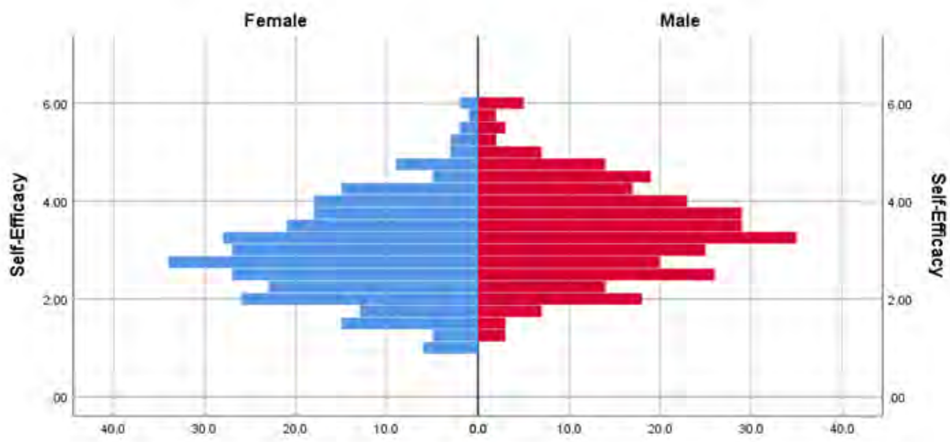

Figure 2. Population pyramid of gender for the factor of SE

Multiple regression analysis: Computer anxiety (CA)

Independence of residuals, as assessed by a Durbin-Watson statistic of 1.972. The multiple regression model significantly predicted the factor of CA, $F(7, 590) = 12.655$, $p < .001$, *adj.* $R^2 = .14$. The R^2 effect size for CA was 15.6% with an adjusted R^2 of 14.4%, which is defined as a small size effect (Cohen, 1988b). All results for the multiple regression analysis for the factor of CA are displayed in

Table 4. The independent variable of "daily hours using a computer" had a significant negative coefficient. Furthermore, "age that participants began using computers" and "no ownership of laptop" was also shown to be statistically significant with a weak positive effect. However, the independent variables of "gender: female" and "computer use location: School" reported the strongest predictive effect at the significant level.

Table 4. Multiple regression analysis results for computer anxiety (CA)

		95% CI for B					
Computer anxiety (CA)	**B**	**LL**	**UL**	**SE B**	**β**	**R^2**	**adj. R^2**
Model						.131	.120
Constant	2.89***	2.553	3.226	.17			
Gender: female	.220**	.086	.354	.07	.13**		
Age that participants began using computers	.030**	.009	.051	.01	.11**		
Daily hours spent using a computer	.11***	.073	.151	.02	.22***		
No ownership of desktop computer	.070	−.103	.243	.09	.03		
No ownership of laptop	.169*	.009	.329	.08	.08*		
No ownership of tablet	.114	−.067	.295	.09	.05		
Computer use location: School	.263***	.118	.407	.07	.14***		

Note. Model = "Enter" method in SPSS Statistics; *B* = unstandardized regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *SE B* = standard error of the coefficient; β = standard coefficient; R^2 = coefficient of determination; adj. R^2 = adjusted R^2. *$p < .05$. **$p < .01$. ***$p < .001$.

Discussion

This study has tested and reported on the design and effectiveness of a relational model aimed at measuring students' ICT cognitive and metacognitive beliefs based on four latent factors: self-efficacy, computer anxiety, vicarious experience and belief of benefits. In addition, this study tested demographic groups as significant predictors of metacognitive and self-efficacy outcomes.

How does the model fit the key construct of metacognitive and self-efficacy beliefs?

The research findings revealed that the relational survey model was a good fit, and factor variables of this instrument proved reliable in measuring student perceived beliefs. Results revealed that computer anxiety shared a very strong negative relationship with vicarious experience, and a strong negative relationship with self-efficacy. While results showed that a large part of this effect can be explained by the direct relationship between latent factors (one factor negatively responds to the movement of another) it does not fully account for why these factors move together. This suggests that other variables are influencing this very strong correlation, which are not included in this study. One possible explanation might be feelings of social anxiety experienced by the participants, which can be triggered in young people by social experiences, such as a class environment (Askew *et al.*, 2015). Negative correlation between self-efficacy and anxiety have been reported in previous research concerning computer use (Srisupawong *et al.*, 2018), however, this did not relate to the Japanese context.

However, high levels of anxiety in Japanese students has been reported in relation to a language learning context (Toyama & Yamazaki, 2018), this has not been related to computer use. Therefore, these findings make an important contribution to the field of study by highlighting the relationship between metacognitive and self-efficacy beliefs in relation to ICT use in education. Furthermore, additional research is recommended to better understand how these negative factor correlations are influenced in Japanese students.

To what degree do independent variables predict dependent factor outcomes?

Results gave important insight into the predictive power of demographic variables, and to what degree these could be considered meaningful. Significant results of independent variable outcomes will be discussed together. However, the variable of "gender" will be exempted and will be discussed separately due to the relative cultural importance of the findings.

Ownership of a desktop computer, laptop, tablet were all found to predict higher self-efficacy outcomes at a significant level (see Table 3), while not owning a laptop was shown to be a significant predictor of higher computer anxiety (see Table 4). In addition, the more hours spent using a computer was shown to have predictive power of higher SE levels. Furthermore, students who tend to only use computers at school are associated with higher computer anxiety outcomes, while those who tend to use computers at home revealed higher self-efficacy beliefs. The age that students started using computers showed a negative coefficient, which indicated that students who start using computers at a later age are more likely to experience weaker self-efficacy beliefs and higher levels of computer anxiety. These findings are not surprising from a cognitive and metacognitive research standpoint, as similar findings regarding computer ownership and usage have been reported by previous studies (Cassidy & Eachus, 2002; Yerdelen-Damar *et al.*, 2017). Moreover, these results align with the notion that beliefs in self-efficacy are a result of interaction with one's environment (Bandura, 1977). Despite this, these findings are important. Low self-efficacy and high anxiety with computers can hinder students' ability to learn and participate in class (Wombacher *et al.*, 2017). These results provide meaningful context about student beliefs, which can influence both classroom management and guide policy planning.

Considerable differences between gender populations (see Figure 2 for visual representation) proved to be an important insight, as male gender was shown to be associated with positive self-efficacy outcomes, and female gender a predictor of higher computer anxiety outcomes. The findings of this study support previous research which has shown that ICT beliefs are culturally unique and influenced by demographics such as gender (Huffman *et al.*, 2013; Powell, 2013). Although the effect size of this demographic could be argued as weak, these findings should be considered substantial. The ability to predict metacognitive beliefs based on gender gives important insight, which argues that women in Japanese universities are statistically more likely than men to have their cognitive and metacognitive beliefs negatively affected by ICT use in classrooms. Although earlier research into gender and computer anxiety in Eastern Europe indicated significant differences between male and female populations (Durndell & Haag, 2002), Cazan *et al.* (2016) claims that over time the differences between gender groups faded, account for the closing gap in differences to increased computer use by a younger generation. It is possible that due to Japan's slow adoption of ICT in schools (Aoki, 2010; Funamori, 2017; Japan: National Institute for Educational Policy Research, 2019), a gender gap in metacognitive beliefs still exists. In other words, Japan seems to be a step behind other parts of the world regarding how computer use affects gender, with women being substantially affected.

How can understanding student metacognitive and self-efficacy beliefs inform ICT policy in education?

The findings provided by this study offer meaningful conclusions about student beliefs that can help administrators form effective ICT policy. Even though the independent variable effects were weak, this research draws attention to the argument that disproportionate access to computers creates inequity among student populations (see Funamori, 2017; Yamamoto, 2020), which, if ignored, has the potential to negatively impact the effectiveness of future ICT education policy. By revealing reliable patterns in differences between demographic criteria, these findings could prove valuable to both educators and administrators who seek to better understand student perspectives. The Japanese government education ministry, MEXT, already promotes the need to better understand student feelings to help guide basic policy direction (Japan: Ministry of Education Culture Sports Science and Technology, 2021). This study reflects and supports this government stance. By better understanding student metacognitive and self-efficacy beliefs, educators could anticipate student emotional responses, which could result in the design of teaching methods that address ICT integration to fit diverse student populations.

With the shift toward online learning during the COVID-19 pandemic, the practical implications of these findings are numerous. First, educators need to be aware of the differences in their students' backgrounds and use of ICT. The early stages of the COVID-19 pandemic forced a global shift to online learning, and by doing so, created a "digital divide" within educational institutes (Karp & Brown, 2020) and has put ICT methods front and center of contemporary education policy direction (Li & Lalani, 2020). This is an important point, as addressing the significant differences within groups, allows increased education equity that attempts to close the digital divide between student populations (Poromaa, 2013). Not doing so could potentially disadvantage post-graduate prospects. This increased reliance on ICT education underscores the necessity to understand and anticipate student computer perceived beliefs to adequately shape and implement education policy direction.

Limitations and future research

Due to this study being conducted at a single private university in Japan, future research could benefit from samples taken at multiple educational institutes. A potential argument could be put forth that data samples collected from a single institute increase the chance of participant bias due to the shared educational environment. In addition, adding research samples from both junior high schools and senior high schools could produce interesting findings that open further debate.

As previously mentioned (see Instrument Section) this model was adapted from previous research design and was done so to allow the researchers a certain degree of freedom to address Japanese classroom conditions. Even though the survey model was shown as a good fit, future research should consider utilizing a verified model of measurement to collect data. This would allow results to be compared to a wider source of previous research that shares the same theoretical construct and reduce potential criticism.

A mixed methods approach to data collection could offer enhanced insight about model factors and give a greater degree of insight into student cognitive and metacognitive beliefs. Qualitative data could reveal possible discrepancies between the two data sets, which could raise curious questions about student beliefs.

Conclusion

Research findings demonstrated that the model latent variables (self-efficacy, computer anxiety, belief of benefits, and vicarious experience) were reliable in measuring students' beliefs of ICT use in the classroom. Furthermore, results revealed that demographic variables such as ownership of a computer device, computer use age, hours of use, and gender have power in predicting statistically significant levels of self-efficacy and computer anxiety, which makes an important contribution to the field of ICT education research, as well as highlights important sociocultural and educational issues specific to the Japanese context. Understanding how students perceive class implementation and usage of computer devices is key to better understanding how to best adapt to rapid change of technological environments. This study draws attention to the importance of understanding student beliefs regarding computer use in the classroom and provides important insight that could help influence ICT policy in Japanese universities.

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Appendix A

Revised 25–item questionnaire

Dependent variable	Scale and items	Loading	Mean	Std. deviation
Self-efficacy (α=0.793)	パソコンの問題をトラブルシューティングできます。 I can troubleshoot computer problems.	.67	2.2562	1.20105
	私は助けなしに新しいタブレットPCを設定することができます。 I can setup a new digital tablet without help.	.67	3.0413	1.31217
	私は自分でパソコンのファイルを見つけてダウンロードすることができます。 I can find and download a computer file by myself.	.71	3.7405	1.27004
	私はパソコンにソフトウェアをインストールすることができます。 I can install a program onto a computer.	.76	3.7107	1.35831
Computer anxiety (α=0.740)	私はほとんどのパソコンプログラムを使用して快適に感じる。 I feel comfortable using and navigating a computer.	.71	3.5603	1.08195
	私はパソコンで勉強をしているのが快適だと感じています。 I feel comfortable doing schoolwork on a computer.	.76	3.6579	1.02468
	私は手で書くよりも、パソコンで学校の勉強をするのがより快適です。 I am more comfortable doing schoolwork on a computer than writing it by hand.	.62	3.2942	1.13758
	私は助けなしに新しいプログラムやアプリを使いこなすのが快適だと感じています。 I feel comfortable trying to use a new program or app without help.	.54	3.4380	1.17854

Dependent variable	Scale and items	Loading	Mean	Std. deviation
Vicarious experience (α=0.752)	私はパソコンやデジタル技術を使用するクラスが居心地が良いです。 I am comfortable in classes that use computers or digital technology.	.74	3.4992	1.06514
	教師がパソコンを教材として使うときは、快適だと感じています。 I feel comfortable when the teacher uses the computer as a teaching tool.	.66	3.9967	.92428
	学校の環境が技術的に進歩していることを知ってうれしいです。 I am comfortable knowing that school environments are becoming more technologically advanced.	.55	4.3934	.84216
	教師がパソコンの使用を必要とする新しいクラスの内容を紹介するときは、私は居心地が良いです。 I am comfortable when the teacher introduces new class work that requires the use of a computer.	.68	3.9174	.97982
Belief of benefits (α=0.711)	パソコン能力は良い仕事を見つけるために重要です。 Computer skills are vital to finding a job.	.64	5.0231	.74771
	パソコン能力は、現代的な日常生活にとって不可欠です。 Computer skills are essential to contemporary lifestyle.	.59	5.0612	.77922
	強力なコンピュータ技術を身に付けることは、私が学校の科目でもっとうまくやるのを助けます。 Having strong computer skills will help me to do better in school subjects.	.68	4.5653	.97031
	技術の知識があれば、情報へのアクセス能力が向上します。 Having a strong knowledge of technology improves my ability to access information.	.59	4.6727	.93603