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To use or not to use: Psychometric properties of the willingness to use technology (WUT) instrument in three Asian contexts

James A. Elwood*, George Robert MacLean

Graduate School of Humanities and Social Sciences, Tsukuba University, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8571, Japan

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A B S T R A C T

With the ongoing development of technology and its ever increasing influence in the social and educational spheres, knowing whether users will embrace technological means is of considerable importance. This article looks at Willingness to Use Technology (WUT; MacLean & Elwood, 2009), an instrument developed to assess a potential technology user's propensity to do so when choosing between a technological medium and a non-technological medium for doing a task. Data were collected from university students in Malaysia ($n = 169$), Cambodia ($n = 131$), and Japan ($n = 1262$). Descriptive statistics showed that Cambodian and Malaysian students were disposed toward selecting technological means for most tasks, while the preferences of the Japanese students varied by task. Rasch analysis showed that the items functioned satisfactorily, and results of two types of confirmatory factor analysis converged, indicating WUT consisted of two factors differentiated by the degree of synchronicity of communication in all three contexts. The investigation of partial-measurement invariance indicated that the factor composition was fundamentally invariant across the three Japan samples yet differed some across the three countries. Although its use in cross-cultural research contexts requires further consideration, the WUT instrument represents a robust measure of users' behavior regarding technology in the specific contexts examined in this study.

1. Background

During the 2007–2008 academic year, one of the authors taught an English Communication course for first-year university English as a Foreign Language students in which the use of Word and PowerPoint was an important part of the syllabus. Near the end of the course, students had to make a presentation. To that point they had received approximately four hours of instruction about how to use Word and PowerPoint. They had already demonstrated adequate competence in preparing and giving PowerPoint presentations, and it was expected that most students would make use of their new skills. Yet given free rein to select the mode of presentation, only two students out of 38 chose to use PowerPoint for their presentation! (35 turned in paper presentations, and one failed to hand in anything). When asked to write in their notebooks about why they chose not to use PowerPoint to make their presentations, 14 of the 28 respondents cited difficulty or lack of confidence using computers and PowerPoint ("annoying," "repulsive," "troublesome," and "sick of" were mentioned in reference to the use of computers and PowerPoint). A further nine students indicated that writing the presentation out by hand was easier, six claimed that they did not have access to PowerPoint (an unlikely situation at the university in question), four indicated that preparing a PowerPoint presentation was too time consuming, and two wrote that using paper copies of pictures was easier.

While the use of digital technologies is best implemented with due regard for different language learning cultures and pedagogical traditions, the incident discussed above from an information communications technology (ICT) implementation context reminds us that there are still situations where resistance may compromise such an alignment, and possessing an instrument to assess ambivalent attitudes toward the use of technology would be prudent. Central to WUT's development and effective use is a set of beliefs influenced by social constructivism that hold that students should be given opportunities to practice 21st-century skills in communication, knowledge sharing, and critical thinking that will help them to succeed in life and in their future workplaces. Among the American Psychological Association

* Corresponding author. Tel.: +81 298 53 5728.
E-mail addresses: elwood.jim@gmail.com (J.A. Elwood), george.university@gmail.com (G.R. MacLean).

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(APA)'s 14 learner-centered principles for cognitive and meta-cognitive factors influencing learning, the eighth principle is particularly relevant:

> The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests…comparable to real-world situations and [tasks that] meet needs for choice and control. (American Psychological Association, 1997, p. 5)

While it is desirable to develop tasks that incorporate all of the above factors, this should be done with due recognition of an educator's responsibility to ensure that students are acquiring digital technologies skills. Certain students are already inclined toward using technology whereas others are less so, yet the instructor may sometimes need to specify that students utilize technology to complete certain tasks, thus better preparing them for the real world. This decision process is informed by ample research about consumer behavior toward technology (e.g., Fournier, 1998; Mick & Fournier, 1998; Szmigin & Foxall, 1998), which has considered possible impediments to the successful implementation of technology products. Such research has revealed potential difficulties that are also relevant in the education domain and that might occur when students are asked to use technology. Fournier (1998) described consumer behavior toward technology that is distinctly similar to some students' behavior where language learning is concerned, especially when the use of ICT is compromised or opposed by students. Behavior such as passive resistance in the form of delay or postponement, as well as active resistance such as complaining, boycotting, or dropping out, are all documented behaviors that will be familiar to foreign language educators (Burrell, 2009; Doyon, 2003; Falout, Elwood, & Hood, 2009).

In addition to such resistance, many students are not the technology experts that they have been posited to be (Howe & Strauss, 2000; Palfrey & Gasser, 2008; Prensky, 2004, 2009; Tapscott, 1996, 2008). Given this reality, there is a need for an instrument that can identity situations where the rationale for using technology instead of another medium should be discussed. Toward this end, the WUT instrument can give a good indication of learners' predispositions toward using technology, which thus can inform practitioners' choices concerning the use of technology and how it is introduced in teaching situations. The WUT instrument was designed to measure user attitudes toward tasks that are commonly used in language education and measurement, such as social media applications, Web-based learning, accessing and using electronic reference material, electronic testing, and the preparation of reports using word processing. In addition to its practical application, this context-specific instrument is posited to occupy a spot in one model of technology acceptance. Relevant literature is reviewed in the following section, after which the psychometric properties of the WUT instrument are investigated.

2. Literature review

In the title of their 1999 article, Agarwal and Prasad asked the thought-provoking question, "Are cognitive variables germane to the discussion of technology acceptance?" With the ongoing spread of technology in everyday life, in education, in business, and in nearly every sphere, it behooves us to understand the process underlying usage and acceptance of technology. This process has been investigated under the auspices of the Technology Acceptance Model (TAM; Davis, 1989), yet subsequent research (e.g., Agarwal & Prasad, 1999) has suggested that cognitive variables represent an under-researched part of this process. Moreover, technology is utilized in various ways, from academic uses to strictly social uses, yet those represent poles of a continuum. With technology playing an ever larger role in second language education, an instrument that yields information about students' predispositions to use technology is a desirable addition to the decision-making process where allocation of precious resources such as time and money are concerned. In our teaching contexts many students arrive still unable to effectively perform many basic ICT tasks, such as word processing, manipulating picture files, changing file names, and using the commenting features of PDF reader programs. Part of our responsibility as educators is to ensure that they develop these skills. Therefore, on a micro level, selecting which English as a foreign language (EFL) tasks should employ ICT entails careful consideration of the class time that will be necessary to teach students the required skills. Furthermore, at a macro level school administrations are often making decisions for purchasing technology infrastructures based on little information, despite the fact that "very few have any idea how to use them—and just as important, when not to use them" (Palfrey & Gasser, 2008, p. 239). Research into instruments and paradigms that yield information about user acceptance of technology and their predispositions is thus in order. It has been underway for nearly two decades, yet it remains a nascent field.

2.1. The hare (technology change)

Recent accounts have posited a situation in which today's students have become so proficient with technologies that a thorough reconsideration of pedagogy is required (Howe & Strauss, 2000; Palfrey & Gasser, 2008; Prensky, 2004, 2009; Tapscott, 1996, 2008). While technological devices have become commonplace in many contexts, that ubiquity does not necessarily correspond with high levels of proficiency (Bennett, Maton, & Kervin, 2008; Elwood & MacLean, 2009; Kennedy, Judd, Churchward, Gray, & Krause, 2008). At least some of this can be attributed to the rapidly changing world of technology, a world in which a highly-caffeinated version of Moore's Dictum seems to be moving much faster than in the past. Moreover, the process of acceptance and usage of technology in education is not well understood, and the rapidly changing nature of the technosphere complicates the picture.

2.2. The tortoise (theory)

The evolution of the TAM (Davis, 1989) illustrates this point well. Building on the theory of reasoned action (Fishbein & Ajzen, 1975), Davis and colleagues posited that perceived ease of use and perceived usefulness were the primary determinants of technology acceptance. Both lauded and criticized for its salient features of simplicity and parsimony (see Lee, Cheung, & Chen, 2005, for an overview), it has been widely researched and found to have adequate validity and reliability (Venkatesh, Davis, & Morris, 2007). Elsewhere, TAM has been extended to consider its applicability within, and between, different cultural settings (Al-Senaidi, Lin, & Poirot, 2009; Arenas-Gaitán, Ramírez-Correa, & Rondán-Cataluña, 2011; Ngai, Poon, & Chan, 2007; Teo, Lee, Chai, & Wong, 2009). Nonetheless, some 10 years after TAM's original conception, Davis and colleagues refined the concept with TAM2, which sought to further explain the two fundamental tenets in terms of social influence and cognitive instrumental processes (Venkatesh & Davis, 2000). Not long thereafter, Venkatesh, Morris, Davis, and Davis (2003) further broadened the scope of the TAM construct with the somewhat grandly-named Unified Theory of Acceptance and Use of Technology (UTAUT); however, as Bagozzi (2007) noted, the over-addition of moderating variables can make a model "both unwieldy and conceptually impoverished" (p. 244).

A more parsimonious model that draws on different theories was explored by Lu, Zhou, and Wang (2009), who evaluated a model of internet messenger (IM) usage. In the upper, lefthand corner of Fig. 1 are the two components of TAM, *perceived usefulness* (for one's task) and *perceived ease of use*. Beneath that is a bifurcate flow rectangle that includes perceived enjoyment and concentration (Csikszentmihalyi, 1990; also addressed in Agarwal & Karahanna, 2000). The TAM and Flow then underpin the large 'Theory of Planned Behavior' rectangle in which *attitude*, *subjective norm*, and *perceived behavioral control* lead to intention and finally to usage. As shown in Fig. 1, five variables underpin Intention to Use IM: *perceived usefulness*, *attitude toward using IM*, *perceived enjoyment*, *subjective norm*, and *perceived behavioral control*. *Intention to use IM* and *perceived behavioral control* then predict *actual IM usage*.

2.3. *The importance of affective variables*

Understanding the role of affective variables in this usage theory is central to any effective analysis of how people will react to technology. Among such variables is motivation, a well-researched variable in second language acquisition (SLA) and one that likely plays a salient and perhaps leading role in technology acceptance. Lee et al. (2005), for example, in examining the role of extrinsic and intrinsic motivation, concluded that perceived usefulness and perceived enjoyment had a direct impact on students' intentions to use an internet-based learning system. The ability to express emotions or identity is another potential mediating factor (Nysveen, Pedersen, & Thorbyørnsen, 2005). Yet another variable is societal norm, defined as a "person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302), which plays an important role in second language education with its intermingling of learners from different cultures.

However, the roles of affective variables might be subsumed by higher-level factors that obscure the importance of those variables. Together, they represent aggregated constructs that were well described by Ajzen (1991):

> One proposed remedy for the poor predictive validity of attitudes and traits is the *aggregation* of specific behaviors across occasions, situations, and forms of action (Epstein, 1983; Fishbein & Ajzen, 1974). The idea behind the principle of aggregation is the assumption that any single sample of behavior reflects not only the influence of a relevant general disposition, but also the influence of various other factors unique to the particular occasion, situation, and action being observed. By aggregating different behaviors, observed on different occasions and in different situations, these other sources of influence tend to cancel each other, with the result that the aggregate *represents a more valid measure of the underlying behavioral disposition than any single behavior.* (italics added; p. 180)

2.4. *Willingness to use technology*

The WUT instrument follows this line of thinking because it addresses the aggregated tendency to use or not to use technological devices. *Willingness to Use Technology* is defined as 'the extent to which technology users would use technology to do a task when presented with the choice of technology (for example, a computer) or a non-technological medium (for example, paper) to attempt the task' (MacLean & Elwood, 2009). Drawing upon existing instruments (Davis, 1989; Heinssen, Glass, & Knight, 1987; McCroskey, 1992; McCroskey & Richmond, 1991), WUT investigates, for example, whether a person would choose to use a computer or a paper and pencil when faced with the task of writing a memo. The matrix structure is similar to that of Willingness to Communicate (WTC), as respondents address 11 tasks with two options (using technology versus using non-technological means). In the order queried, the 11 tasks include the following: writing a memo, taking a test, writing a five-page report, communicating with a teacher, looking at reference material (for example, looking at books versus viewing webpages), receiving information about classes, doing a presentation (using an overhead projector versus using PowerPoint), dividing a restaurant check to determine how much each person should pay, exchanging mail (using e-mail versus sending a traditional paper letter), and communicating with someone (face-to-face versus internet chatting).

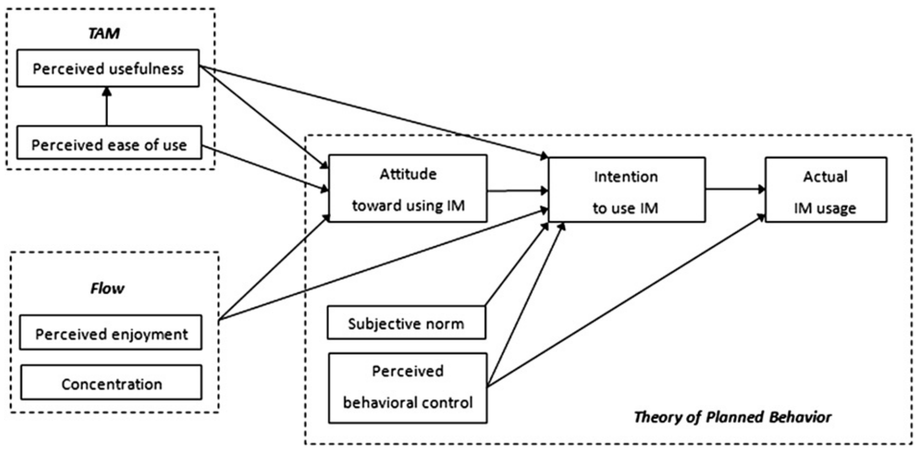

Fig. 1. Model of IM usage incorporating TAM, Flow and Theory of Planned Behavior (TPB). From Lu et al. (2009). Copyright 2009 by Elsevier B.V. Adapted with permission.

Table 1
Demographic information for the five data samples.

	Cambodia	Malaysia	Japan-2008	Japan-2009	Japan-2010
# of Participants (*n*)	131	169	327	530	405
Age (SD)	26.80 (4.04)	19.98 (1.20)	19.19 (1.76)	18.64 (1.02)	19.21 (.71)
Gender (% male)	72.22%	42.01%	52.80%	50.29%	52.10%
Major (s)	Education	Engineering	Various	Various	Various

Note. Due to a clerical error, the statistics for gender in the Japan-2008 sample include 250 of the 327 participants.

WUT shares conceptual roots with the Willingness to Communicate concept in SLA literature (e.g., McCroskey, 1992; McCroskey & Richmond, 1991); with its underpinnings in the social construction of meaning (e.g., Berger & Luckmann, 2002; Gergen, 1999), WTC is the notion that the nature of the conversants' relationship and the type of discourse (e.g., a speech versus a casual conversation) influence one's willingness to engage in communication. WTC is operationalized as a matrix that queries an individual's willingness to speak in the company of three different groups (a group of strangers, a group of acquaintances, or a group of friends) while doing one of four tasks (doing a speech, talking in line, speaking in a meeting, and casual chatting). The result is 12 queries about the respondent's WTC. In a similar fashion, WUT addresses 11 specific tasks rather than a general tendency to use or not to use a device or program.

2.5. Intention to use technology

The similar *Intention to Use Technology* in the TAM model appears to have generally been operationalized as a holistic propensity toward using technology (i.e., 'I would use [Technology A] in the future') without specifying details. We posit that the construct of intention in the TAM should be tightened to include context-specificity; this would reflect a complementary dyad in which Davis' attitude represents a state-like static propensity toward computer use while the WUT is a context-dependent, trait-like complement. In second language acquisition this type of dyad (essentially a continuum) appears in several incarnations, including L2 anxiety, which is increasingly regarded as a combination of both state and trait components (MacIntyre, 2007), and motivation, which Tremblay, Goldberg, and Gardner (1995) parsed into state and trait motivation; the former represents an enduring, stable propensity and the latter an ephemeral response. Closer to the issue of willingness to use technology, a behavior, Julkunen (2001) asserted that the task behaviors of students derive from a juxtaposition of generalized and situation-specific motives, which depend on the specific characteristics of the task.

3. Research gap and goals

The need to better understand the process leading to technology usage remains the focus, and WUT represents an aggregated instrument that allows practitioners to assess potential technology users' willingness to choose and then utilize technological devices. Moreover, given the theoretical basis and need for a parsimonious instrument like WUT, a detailed investigation of its psychometric performance is necessary. As Little (2000) noted, "Ensuring construct comparability when testing for between-group differences is of paramount importance in cross-cultural research" (p. 213), and in the field of second language acquisition (SLA) this is especially important because of the myriad groups learning a second language. Because such groups often come from different countries or cultures, any attempt at comparing them depends on the use of instruments that demonstrate minimal variance across cultures. In the current study we thus present the results of several statistical analyses that evaluate the psychometric performance of the WUT instrument. Specifically, to assess the instrument's construct validity across different contexts, conventional analysis of descriptive statistics, Rasch analysis, and structural equation modeling (SEM) were used. If the results of the different analyses converge, this indicates that the WUT instrument demonstrates acceptable construct validity and stability across the five contexts investigated.

Thus, we arrive at the rationale for this study. First, the process leading to willingness to use technology is not well understood, and with the recent growth of social media and Web 2.0 functionality and applications, this situation is arguably even less understood than before. Second, to better understand how technology is viewed and used, psychometrically sound instruments are crucial. Given that a context-dependent element mediates computer acceptance and usage, which is widely touted as beneficial in SLA, and that WUT may shed light on that process (Elwood & MacLean, 2009; MacLean & Elwood, 2009), the primary foci of this study are to (a) examine the psychometric properties of the WUT instrument in different Asian contexts, and (b) assess whether WUT is stable within and across the respective contexts.

More succinctly, the research questions were the following:

1. To what extent is the WUT instrument psychometrically sound in these different contexts?
2. To what extent is the WUT instrument invariant across the various contexts?

4. Method

4.1. Participants

A total of 1560 university students participated in this study, including 131 in Cambodia, 169 in Malaysia, and 1262 in Japan (Table 2). The five contexts addressed in this study include one each in Cambodia and Malaysia as well as the three chronologically distinct samples from Japan. The Cambodian participants were education majors enrolled in a national education university, the Malaysian students were engineering students at a medium-sized national university, and the Japanese participants were enrolled at a large public university in the eastern part of Japan. The Cambodian participants were on average over six years older with a larger range of ages, while male participants

Table 2
WUT (preference for a technological medium) for five data sets.

Task	Context				
	Cambodia	Malaysia	Japan-2008	Japan-2009	Japan-2010
1. Memo	60.22	67.04	22.57	20.89	24.08
2. Test-taking	51.53*	54.76*	18.54	16.97	18.03
3. 5-Page report	59.83	71.98	75.76	73.10	78.14
4. Contact teacher	62.35	67.49	80.93	78.77	80.79
5. Budget	64.26	63.70	58.92	54.86	58.04
6. Reference material	56.65*	61.01	42.69	44.73	47.39*
7. Get class info	60.79	55.28*	61.55	61.48	62.75
8. Presentation	60.12	65.69	83.62	79.71	83.09
9. Divide check	63.24	63.23	76.02	77.05	78.26
10. Mail exchange	65.19	65.70	81.75	79.35	81.13
11. Chatting (internet chat)	65.59	62.61	47.13*	36.61	40.09

Note. Values are percentages showing the extent to which participants would choose technological media for the respective tasks. Values marked with an asterisk were not significantly different from the midpoint of 50%.

outnumbered females by a ratio of seven to three. The Malaysian group had more females, but the Japanese groups were nearly evenly balanced with respect to gender; the average ages of the Malaysian and Japanese groups were in the 18–20 range.

Aside from characteristics of the participants themselves, it is prudent to note the environment of the respective universities inasmuch as that certainly influences technology use (e.g., perceived ease of use in TAM). In Japan the students all had cell phones, in excess of 90% had a computer at home, and all had access to the many computer labs at their university. The Malaysian data were collected at an engineering university, and those students also had cell phones, access to computers both at home and at their university, and a strong emphasis on using technological devices in their coursework. Finally, the Cambodian sample consisted of education majors, most of whom had cell phones yet rather limited access to computers; however, they exhibited enthusiastic views of the potential of technology. In light of these differences, stark contrasts could be expected in levels of WUT, yet the results indicated otherwise (Table 1).

4.2. Instrument

Administered as part of a larger study examining computer usage in these contexts, the WUT instrument included 11 items and a demographic section which documented age, gender, and university major. Participants indicated the percentage of the time they would choose a non-technological medium for a particular task; thus, a response of 80% indicated that a person would use a paper and pen 80% of the time for that particular task and a technological device such as a computer only 20% of the time. Administered in Japanese for the Japanese context, the survey was first translated into Japanese, back-translated for accuracy, and revised accordingly. For the Cambodian context, it was administered in English with simultaneous translation and clarifications by a native speaker of Khmer. In Malaysia it was administered in English. Participants completed the entire survey in about 20 min.

5. Preliminary analyses

First, responses were carefully screened for missing data, non-normality, and the presence of outliers. A total of 38 surveys were deleted, 31 with incomplete response sheets and a further seven with ‘flat-line’ response sheets (i.e., all responses were neutral or on the midpoint). Second, the data were screened for unusual behavior of items and dimensionality using Rasch analysis (Linacre, 2006a). Descriptive statistics provided an overview of individual items that were reverse-coded so a higher value indicates greater willingness to use technology. For all items a one-sample t-test with a false discovery rate (FDR) correction for each sample (Benjamini & Hochberg, 1995) was conducted to discern whether the mean was statistically different than the neutral midpoint; non-significant values are indicated with an asterisk in Table 2.

As shown in Table 2, the participants preferred technological media for most tasks. In both the Cambodian and Malaysian contexts, two tasks were not statistically significantly different from the 50% midpoint, yet participants indicated preference for technological media on the other nine tasks. However, in the three Japanese samples, non-technological means were preferred for four items: memos, test-taking, viewing reference material, and chatting, and those results were quite similar among the three Japan samples.

One point of note is the limited range of means for the Cambodian and Malaysian samples (ca. 50–70%); although these values indicated preferences for technological means, it was not a strong endorsement of those media. The three Japanese samples, however, tended toward stronger means than in Cambodia and Malaysia (e.g., endorsement means near 75%). The Japanese means were also quite consistent over time with statistically significant differences appearing only for ‘chatting’.

Looking at trends, technological media were preferred across all five samples for doing a 5-page report, contacting a teacher, doing a budget, doing a presentation, dividing a restaurant check, and exchanging e-mail. For writing a memo and taking a test, the Japanese participants strongly preferred non-technological media, while the Cambodians and Malaysians opted for technological means. For receiving information about class, technological means were rather tepidly endorsed in four cases (the mean for the Malaysians was not significantly different from the midpoint). Finally, viewing reference material had mixed results with two non-significant results, two means for the Japanese samples opting for non-technological means, and the Cambodians preferring technological means.

6. Results

Next, the psychometric performance of WUT was investigated. In the following pages the results of analyses are presented for the 2009 Japan data. The same analyses were conducted on the other four data sets; a summary of all analyses follows, yet space precludes showing

Table 3
L2 WTC measure: Rasch item fit statistics and point-measure correlations.

Item	Measure	SE	Infit MNSQ (*t*)	Outfit MNSQ (*t*)	Pt-M Corr
Asynchronous communication					
1. Memo	49.78	.01	1.12 (1.7)	1.26 (3.1)	.37
2. Test-taking	49.72	.01	1.05 (.7)	1.06 (.7)	.39
3. Write report	50.33	.01	1.16 (2.3)	1.11 (1.4)	.57
5. Make budget	50.14	.01	1.02 (.4)	1.14 (.6)	.54
6. Reference material	50.04	.01	.96 (−.8)	1.03 (.5)	.50
Synchronous communication					
4. Contact teacher	50.04	.01	1.10 (1.4)	1.06 (.7)	.34
7. Info about classes	49.86	.01	.78 (−3.9)	.86 (−2.2)	.44
8. Presentation	50.05	.01	1.15 (2.0)	.96 (−.5)	.34
9. Split check	50.01	.01	1.41 (5.3)	1.22 (2.6)	.33
10. Mail Exchange	50.04	.01	1.06 (.9)	.98 (−.2)	.34

Note. $N = 530$; Pt-M Corr = point-measure correlation. The respective subscale configurations are based on the SPSS factor analysis, in which Item 11, chatting, formed a separate pseudo-factor and is thus omitted from this table.

detailed results for all five sets. All five data sets were investigated with Rasch item analysis and principal component analysis of residuals (Linacre, 2006a), exploratory factor analysis with SPSS (2009), and confirmatory factor analysis and assessment of partial-measurement invariance using EQS, Build 6 (Bentler, 2006a). This resulted in three separate statistical evaluations of each sample. Congruence of such triangulation will offer support for the validity of the WUT instrument. The cross-cultural query is evaluated with structural equation modeling to investigate the factorial partial-measurement invariance of the WUT instrument.

6.1. Rasch analysis

The initial step was Rasch analysis of each sample to evaluate the performance of individual items as well as assess the dimensionality of the WUT scale. As shown in Table 3, 10 items had adequate infit and outfit statistics based on Linacre's (2006b) suggested .5–1.5 range. However, 'chatting' was misfitting with an MNSQ outfit value of 1.65. Temporarily omitting 16 unexpected responses resulted in an adequate outfit value of 1.41, so the item appeared to function satisfactorily. The point-measure correlations ranged from .33 to .57, which is satisfactory. The overall instrument yielded a person reliability of .61, which is reasonable based on the relatively small range of coverage (Linacre, 2006b) and also corresponds closely with the reliability from the CFA below.

The person estimates formed a normal distribution, and the means of the person estimates and the item difficulties were just .57 CHIPS apart, which indicates the scale was at an appropriate level. The range of person estimates and the Rasch–Thurstone category thresholds were also similar, signifying that the items covered the range of person estimates adequately.

Dimensionality was investigated by examining the principal components analysis of item residuals. The first construct accounted for 5.9% of the unexplained variance with a strength of 1.9 units (about two items), which indicates there may be a viable second dimension. While these values alone are inconclusive, the disattenuated correlation of the positive and negative loadings of residuals was just .40, suggesting that multiple dimensions were present (Linacre, 2006b). For all five samples, Rasch analysis indicated the presence of two dimensions. The dimensional configurations were investigated further using SPSS, and those results were then used as the bases for further confirmatory factor analyses using structural equation modeling.

6.2. SPSS factor analysis

An initial exploratory factor analysis using principal components analysis was carried out on the 11 items (Table 4). The extraction method of principal components was chosen to extract linear combinations of the variables explaining the majority of the variance (Kline, 2005). Varimax rotation was initially requested, and factor correlations in excess of .32 indicated that oblique rotation would be appropriate.

Table 4
Pattern matrix for willingness to use technology (Japan-2009 data).

Task	Components			h^2
	Synchronous	Asynchronous	Chatting	
8. Presentation	.676			.477
10. Mail exchange	.638			.417
9. Divide check	.594			.327
4. Contact teacher	.559			.322
7. Get class info	.487			.280
2. Test-taking	(−.256)	.779		.579
1. Memo		.635		.411
5. Budget		.513		.397
3. 5-Page report		.499		.330
6. Reference material		.414		.378
11. Chatting (internet)			.871	.029
Eigenvalue	2.345	1.601	1.101	
% of Variance	21.32%	14.56%	10.01%	

Note. The secondary loading of 'test-taking', although below the cutoff value of .40, is shown to facilitate comparison with structural equation modeling results below.

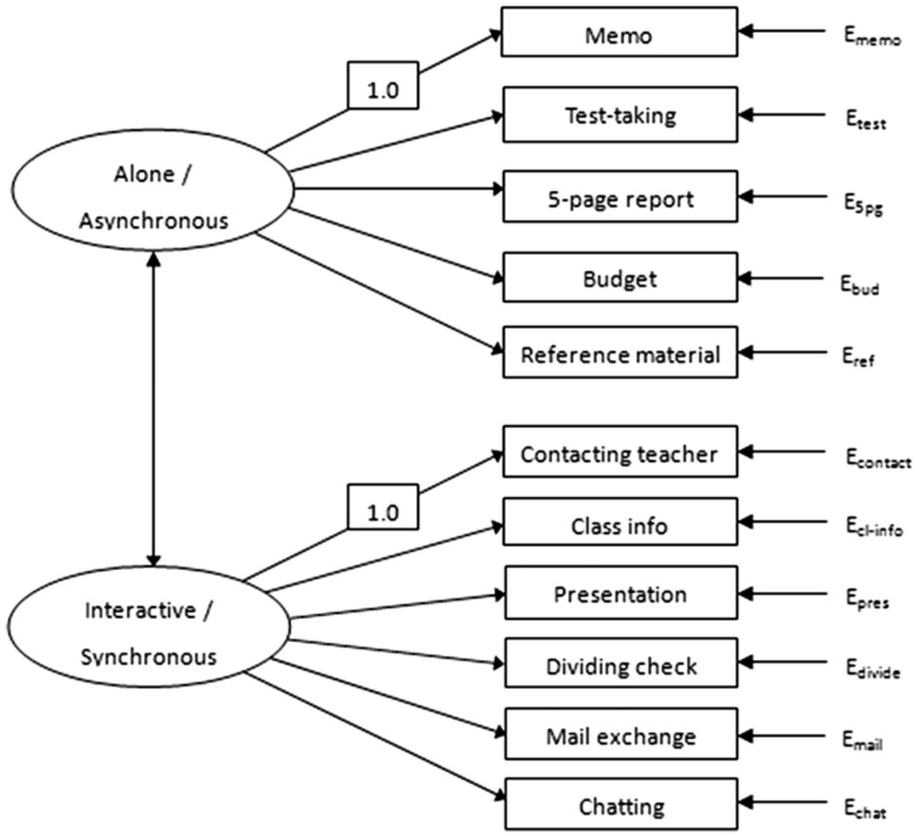

Fig. 2. Hypothesized factorial structure of WUT (Japan-2009 sample) based on SPSS results.

Items with factor loading of less than .40 were excluded. In addition, reliability analyses using SPSS were conducted, including examination of the corrected item-total correlation and the resulting coefficient alpha if the items were temporarily deleted.

Results for the exploratory factor analysis indicated the presence of two primary factors based on eigenvalues and scree plots. The two subscales appear to anchor a WUT continuum whose salient feature is the degree of synchronicity of communication. The stronger component addresses tasks involving interaction with others on a synchronous or near-synchronous level and was labeled *Synchronous Communication (Interactive)*; among the items were getting class information and doing presentations. The second component included such items as writing memos, doing a budget and writing a five-page report, which appear to address tasks which need not be temporally contiguous; this component was thus labeled *Asynchronous Communication (Alone)* oriented toward personal use. The two subscales appear to anchor a WUT continuum whose salient feature is the degree of synchronicity of communication.

Chatting, however, loaded on neither factor yet accounted for slightly more than 10% of the variance with an eigenvalue in excess of unity. While a single item is insufficient to construct a further factor, the strength of the 'chatting' item and the fact that it did not load with the other two factors merits notice. Thus, we arrive at two interpretable components that explained 35.88% of the variance. The final configuration of the WUT scale included *synchronous communication*, *asynchronous communication*, and a single-item pseudo-component, *chatting.*

6.3. Structural equation modeling

Factorial validity of the WUT was addressed with confirmatory factor analysis using structural equation modeling (SEM) techniques. Maximum likelihood (ML) estimation, using EQS 6.1 for Windows (Bentler, 2006a), was employed for this analysis using a covariance matrix. Based on the above results, it was posited that an SEM confirmatory factor analysis of the WUT would yield results indicating that responses to the WUT could be explained by two factors identified as *asynchronous communication* (i.e., alone), and *synchronous communication* (i.e., interactive in 'real time').

The SEM technique employs fit indices to provide estimates of how well the data fit the model hypothesized *a priori*. Because different indices reflect different aspects of model fit, the values of multiple indices are typically reported. The fit indices selected for these analyses included the comparative fit index (CFI), the standardized root mean square residual (SRMS), the root mean square error of approximation (RMSEA), and the 90% confidence interval for RMSEA. Since χ^2 is strongly influenced by sample size, in the current study χ^2/df is reported instead; values smaller than two provide a rough estimate that fit may be adequate (Tabachnick & Fidell, 2001). The CFI compares how much better the model fits compared to a baseline model, typically the independence (null) model in which the observed variables are assumed to be uncorrelated (Kline, 2005). For the SRMS, a value less than .08 is generally considered adequate (Hu & Bentler, 1999) and less than .06 is deemed good (Browne & Cuduck, 1993). The RMSEA takes into account the error of approximation in the population and is a measure of discrepancy per degree of freedom (Byrne, 2006). Finally, the 90% confidence interval for the RMSEA indicates the precision of the measurement.

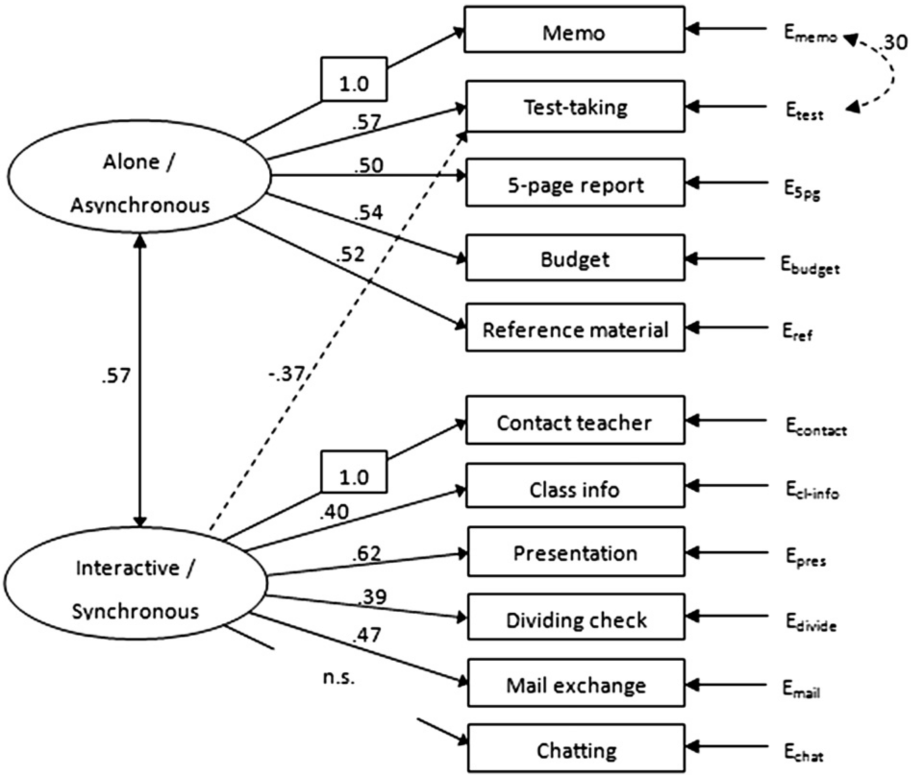

Fig. 3. Final factorial structure model for the WUT (Japan-2009 sample).

Fig. 2 shows the configuration of WUT for the Japan-2009 sample based on the SPSS and Rasch analyses. This represents a typical configuration for a first-order, two-factor structure. The ovals represent the two factors, *Asynchronous Communication (Alone)* and *Synchronous Communication (Interactive)*, while the 11 rectangles are the 11 WUT items, each of which is posited to be composed of a contribution from its respective factor plus an error term (indicated as the rightmost 'E' term). For each factor, the metric must be defined by fixing one path, which is indicated by the values of 1.0 for 'memo' and 'contact teacher'. In addition, all the error paths (not shown) are fixed to 1.0.

All five data sets were screened for missing data and adequate levels of kurtosis. In all five sets, data were missing, yet those data represented only .27% of responses and appeared to be missing completely at random. Thus, for the CFA using SEM, a maximum likelihood procedure was used; this is an EM-type computation that provides optimal results when the data are multivariate normally distributed (Bentler, 2006b). For each data set, results include figures on kurtosis. With missing data, the normalized estimate of the Yuan, Lambert, and Fouladi coefficient is used, and in this case it was adequate at 15.62 (Byrne, 2006, p. 267). In all five data sets the cases with an abnormally large contribution to kurtosis were deleted, leaving a total of 1550 cases of the original total of 1560.

Returning to the Japan-2009 sample, the average absolute standardized residual was .023 and the average off-diagonal absolute standardized residual was .028, both of which suggest a very good fit of the model to the data. The standardized residuals were normally distributed with 53 of the 55 residuals (96.37%) in the $\pm.1$ interval. Finally, the question of singularity was adequately addressed with the convergence of the matrix. These results indicate that the hypothesized model fit the sample data well.

Even with adequate fit statistics, post hoc specifications based on the Lagrange multiplier test and the Wald test can be included if they are theoretically justified. In all five cases, post hoc modification resulted in improved fit; modifications for the Japan-2009 analysis are

Table 5
CFA results for the five data sets.

	Fit indices				90% C.I.	ρ[a]	Δpara[b]
	χ^2/df	CFI	SRMR	RMSEA			
Fit criterion	<2	>.95	<.05	<.06	'Small'[c]		
Cambodia	2.040	.940	.056	.089	.061–.115	.909	+2
Malaysia	2.554	.926	.055	.097	.073–.120	.898	+3/−1
Japan-2008	1.786	.912	.053	.049	.029–.067	.624	+4
Japan-2009	1.308	.979	.035	.024	.000–.043	.649	+2/−1
Japan-2010	1.567	.937	.045	.037	.015–.056	.625	+1/−1

[a] Because Cronbach's alpha is theoretically based on a model that requires all factor loadings and error variances to be equal (Bentler, 2006b), a better estimate of internal reliability for a multi-factor model is the coefficient ρ (Byrne, 2006).
[b] Δpara indicates the changes in the number of parameters based on the Lagrange and Wald test results; in the Japan-2010 sample, for example, one error covariance was added and one regression path omitted for a net change of zero.
[c] A smaller confidence interval indicates more precise measurement of error.

Table 6
Tests for invariance of WUT factorial structure: summary of goodness-of-fit statistics (Japan-2009–Japan-2010).

Model	S-B χ^2 (df)	CFI	SRMR	RMSEA	90%C.I.	ΔS-B χ^2	Δ*CFI
Model 1	85.490 (65)	.964	.040	.026	.003–.040	–	–
Model 2	89.189 (71)	.969	.042	.024	.000–.038	3.936*	.005
Model 3	89.176 (72)	.970	.042	.023	.000–.037	4.084*	.006

Note. S-B χ^2 = Satorra–Bentler scaled χ^2. An asterisk indicates the change was significant at $p > .05$. Model 1 – configural (no constraints), Model 2 – measurement model invariance, and Model 3 – structural invariance. The delta values for Models 2 and 3 reflect comparison of the respective model with Model 1 (i.e., Model 2 versus Model 1 and Model 3 versus Model 1, respectively).

shown in Fig. 3. Dashed lines represent additions to the model, while the one broken line indicates a deletion. Results for the Japan-2009 sample indicated that 'taking a test' loaded on both *Asynchronous Communication* and *Synchronous Communication*, although negatively on the latter (the modest cross-loading is indicated parenthetically in Table 4). This was justified by the fact that group assessment is quite common in this university context in addition to the traditional method of testing individual students. A covariance was also added between the error terms of memo and test-taking for two reasons: both tasks involve writing, and jotting a memo while taking a test (in particular a listening test) is common in Japan.

Finally, 'chatting' did not load on either factor, which was also the case for the Japan-2010 sample. With the exception of the path from synchronous communication to chatting, all standardized regression coefficients and the added error variance were statistically significant at $p < .05$.

The following values were obtained for the fit indices: χ^2/df = 1.308, CFI = .979, SRMR = .035, RMSEA = .024, and C.I. = .000–.043. Moreover, the χ^2 value (32, $n = 530$) = 41.931, $p = .112$, was *not* statistically significant, the desired result. These values indicate excellent fit of the model to the data.

This analysis was repeated for each of the five data sets. In all five cases, post hoc modifications were added to achieve optimal fit of the models to the data. Results and modifications for the CFA of the five data sets are shown in Table 5.

In results from both the Cambodia and Malaysia groups, we find an interesting anomaly as CFI and SRMR values indicate adequate fit of the proposed model although the RMSEA value indicates poor fit. These apparently contradictory results deserve explication. Comparing CFI and RMSEA, Rigdon (1996) showed that CFI and other incremental fit indices are less stable across different estimation methods because a null model is involved in the calculation of the indices. On the other hand, RMSEA is insensitive to changes in sample size, especially when the sample size is large. Rigdon stated that "CFI [is] better suitable to more exploratory, small sample cases, and RMSEA [is] better suited to more confirmatory, large sample situations" (p. 376). Because the sample size for the Cambodia and Malaysia groups is relatively small (cf. Cheung, Leung, and Au (2006) with $N = 7590$, in which RMSEA was deemed more appropriate for assessing model fit), in these cases CFI is more appropriate than RMSEA for evaluating the model fit.

Thus, for both the Cambodian and Malaysian samples, CFI and SRMR results indicated nearly adequate fit of the model to the data although the RMSEA value is slightly high. The Japan-2008 sample had adequate fit with both SRMR and RMSEA quite close to the cutoff points although the CFI value was somewhat low. Japan-2009 had very good fit (as noted above, the χ^2 value was even non-significant), and Japan-2010 also had adequate fit. In all cases the 90% confidence interval was reasonably small (.038–.054), indicating that accuracy of measurement was adequate. Both the Cambodia and Malaysia samples had high levels of internal reliability, while the Japan samples had somewhat low yet still acceptable levels.

6.4. *Cross-cultural validity of the WUT*

Having obtained models with moderate fit for the various samples, the next step was to assess factorial invariance between pairs of the multiple independent samples. The first step involves using the baseline models established in Section 6.3, pairs of which comprise the respective hypothesized configural models. Looking at the Japan-2009 and Japan-2010 dyad, the goodness-of-fit statistics indicate that the configural model fit the data well: S-B χ^2 (df = 71) = 101.375, $p < .01$, CFI = .953, SRMR = .046, and RMSEA = .032.[1] Thus, the configuration of the WUT appears to be optimally represented by the dual-factor model with the array of factor loadings specified in the respective baseline models.

Utilizing the configural model, the next step in assessing multigroup invariance involves evaluating goodness-of-fit statistics of the measurement model (i.e., only the invariance of factor loadings and measurement error variances–covariances is of concern). Parallel parameters in the two groups are fixed to be equal, while parameters unique to either group are allowed to freely vary (hence the use of the term "partial invariance"). Overall fit deteriorated slightly, and one parameter was found to be not invariant based on results of the Lagrange multiplier test; when this parameter was allowed to freely vary in a second iteration, the model was found to have good fit to the data: S-B χ^2 (df = 76) = 114.182, $p < .01$, CFI = .941, SRMR = .049, and RMSEA = .034. Next, following Byrne (2006), the partial invariance of the models was assessed using both ΔS-B χ^2 and ΔCFI. With the respective degrees of kurtosis being somewhat high, robust statistics were requested and the change in the Satorra–Bentler χ^2 was adjusted to account for the fact the difference was not a χ^2 distribution.

Finally, the structural model was tested for partial invariance by fixing factor covariances, a more stringent requirement. The goodness-of-fit statistics indicated that the model fit the data well: S-B χ^2 (df = 76) = 112.898, $p < .01$, CFI = .943, SRMR = .050, and RMSEA = .034. Lagrange Multiplier results indicated two-factor loadings were not invariant across the Japan-2009 and Japan-2010 samples (writing a 5-page report and giving a presentation). Details of the three steps are shown in Table 6. Based on the testing of the partial-measurement invariance, the equivalence of parameters composed of the measurement structure (factor loadings and error covariances) and of the

[1] Although space constraints preclude showing the complete set of fit statistics for the original models and the respecified models, those statistics are available on request from the authors.

Table 7
Willingness to use technology factor composition for five data sets.

Task	Asynchronous communication (alone)					Synchronous communication (interactive)				
	C	M	J-08	J-09	J-10	C	M	J-08	J-09	J-10
1. Memo	TS	TS	tS	TS	TS					
2. Test-taking	TS	TS	TS	T[S]	TS				[S]	
3. 5-Page report	TS		TS	TS	S		tS			t
4. Contact teacher	TS						TS	TS	TS	TS
5. Budget	TS	TS	T[S]	TS	[T]S			[S]		[T]
6. Reference material	TS	[T]	TS	TS	S		[T]S			T
7. Get class info	[T]		TS			[T]S	TS		TS	TS
8. Presentation		[S]				TS	T[S]	TS	TS	TS
9. Divide check		T	[S]			TS		T[S]	TS	TS
10. Mail exchange						TS	TS	TS	TS	TS
11. Chatting				Δ	Δ	TS	TS	tS		

Note. C = Cambodia; M = Malaysia; J-08 = Japan, 2008; J-09 = Japan, 2009; J-10 = Japan, 2010. Each 2-letter TS sequence indicates item loading from the respective analyses, with T = traditional factor analysis (SPSS) and S = structural equation modeling. Thus, TS for a particular sample means that the item loaded on that factor in the two types of analysis. Complex loadings are indicated by enclosed letters, and a lower-case letter indicates a 'weak' loading (i.e., beneath the cutoff point of .40).

structural model (factor covariances) was found to be supported, meaning the structural relations between the two factors of WUT are fundamentally invariant across the 2009 and 2010 Japan samples.

The above sequence was repeated for the other two Japan dyads, and based on the results, the three samples were found to be fundamentally partial-measurement invariant. The data for the three Japan samples were then pooled and analyzed to establish a baseline Japan model. This baseline model was then used to examine invariance across the Japan-pooled sample and the Cambodia sample as well as the Japan-pooled sample and the Malaysia sample. In both cases, the pairs were not found to be invariant, suggesting that the WUT instrument was interpreted somewhat differently in the Cambodia and Malaysia contexts than in the Japan context.

7. Discussion

At the item level, Rasch analysis indicated the WUT items had adequate fit to the Rasch model in all five data sets. Moreover, items showed reasonable correlation with the total WUT estimate (the point-measure correlation). These findings support the construct validity of the instrument.

Regarding validity of the WUT, two types of analysis agreed on the basic configuration (bipolar with synchronous and asynchronous poles). In the three venues and all five samples, WUT was composed of two dimensions that appear to anchor a continuum corresponding to the level of synchronicity of communication. The *Asynchronous Communication* component (e.g., writing memos or a five-page report) addressed tasks that need not be temporally contiguous, while the *Synchronous Communication* component consisted of tasks involving synchronous or near-synchronous interactions with other people. The variance in the composition of the two components likely reflects local (perhaps cultural) tendencies: 'contacting one's teacher', for example, was considered to be adequately accomplished as asynchronous communication for the Cambodian and Malaysian students, whereas for the Japanese it seems to be viewed as best done face-to-face as synchronous communication.

With respect to the three statistical methods, we find reasonable agreement with only minor discrepancies (Table 7). The *Asynchronous Communication* factor appears to consist of taking a memo, test-taking, writing a 5-page report, doing a budget, and viewing reference material. The *Synchronous Communication* factor includes five items: contacting a teacher, getting class information, doing a presentation, dividing a restaurant check, and exchanging mail. Chatting, however, fit in the synchronous communication factor for three of the five samples yet in neither factor for the Japan-2009 and Japan-2010 samples.

The reader will find that the factor compositions of the three Japan samples were quite similar, yet the factor compositions of the Cambodia and Malaysia samples were somewhat different.

The bipolar configuration of the WUT instrument was common to these three national contexts and the composition of factors was similar (Table 7), yet the results indicate that the WUT was not invariant across cultures. Future research could explore this issue by asking, for example, how students interact with teachers and how they perceive such interactions. Until that time, however, caution is prudent in interpreting results from different contexts, for different uses of technology and perhaps differences in perceptions of the use of writing may influence a potential user's willingness to use and subsequent use of technology. Another issue for future research is where and how WUT resides in the pantheon of factors affecting technology acceptance and usage. In this vein, a replication of Lu et al. (2009) would be prudent.

An empirical investigation of the invariance of the WUT instrument across cultures and across time would be a logical sequel to the current study. Given a larger data set, one appropriate form of analysis would be multi-level structural equation modeling, which investigates individual and higher-level (e.g., cultural group) differences simultaneously.

8. Conclusion

The current study examined the psychometric properties of the WUT instrument in three different Asian contexts. The results of the Rasch analyses indicated that the WUT instrument was a psychometrically sound construct that had adequate validity and reliability. Based on a triangulation strategy employing three types of analysis, the configuration of WUT was similar in three contexts, with student ICT propensities with respect to the 10 tasks situated along a bipolar continuum characterized by the degree to which the task is performed alone (and thus in an asynchronous fashion) or in a face-to-face, synchronous manner. The congruence of the analyses offers support for the structure of WUT in the respective research venues, but not necessarily across them; this indicates that WUT is a valid, reliable instrument if used prudently.

Prensky (2009) noted that "Digital wisdom can be, and must be, learned and taught" (p. 7). Although many governments have recognized this fact and expended considerable capital on technology infrastructure, policy has not always effectively aligned with implementation. The availability of technology and simply expecting students to use it "because it's there" is not necessarily an effective measure for fostering effective and enduring use of technology. Certain contexts that are predictable via an instrument such as WUT can dictate whether special care regarding choice of a technology format versus a non-technology format need be considered before implementing certain educational tasks. We therefore recommend that further research utilizing instruments such as WUT should be an integral part of education planning and resource allocation in foreign language classrooms in Asia and elsewhere.

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