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EXPLORING INDIVIDUAL DIFFERENCES IN THE IMPACT OF WEB-BASED LEARNING TOOLS (WBLTS)

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The purpose of this study was to explore individual differences in middle and secondary school student attitudes and learning performance regarding Web-Based Learning Tools (WBLTs). The student characteristics assessed were gender, age, computer comfort level, subject comfort level, and average grade. Attitudes toward WBLTs were measured using a reliable, valid survey designed to gather data on student perceptions of learning, design, and engagement. Learning performance was assessed by comparing pre- and post-test scores on four knowledge categories (remembering, understanding, application, analysis) based on the revised Bloom's taxonomy. Female students had significantly more positive attitudes toward WBLTs. Students who were more comfortable with using computers and the subject area addressed by a WBLT had significantly more positive attitudes toward WBLTs. Average grade was unrelated to student attitudes toward WBLTs. Student age was the only student characteristic that was significantly associated with learning performance. When older students use WBLTs (different from those used by younger students), learning performance is significantly greater than younger students. It is speculated that WBLTs may be better suited toward older students who have better self-regulation skills.

Keywords: Evaluate; attitudes; performance; individual differences; secondary school; middle school; learning objects; web-based learning tool.

1. Introduction

Web-Based Learning Tools (WBLTs), also known as learning objects, are operationally defined in this study as interactive web-based tools that support the learning of specific concepts by enhancing, amplifying, and/or guiding the cognitive processes of learners (Kay & Knaack, 2008b, 2009). Recent evidence suggests that the impact of WBLTs on student attitudes and learning performance is positive in middle and secondary school classrooms. Students report that WBLTs are engaging (e.g. Kay, 2009; Kay & Knaack, 2005, 2007a, 2007b), enjoyable (Clarke & Bowe, 2006a, 2006b; Kay, 2009; Reimer & Moyer, 2005) and easy to control with respect to the pace of learning (Clarke & Bowe, 2006b; Docherty, Hoy, Topp, & Trinder, 2005; Kay, 2009; Reimer & Moyer, 2005). They also note that WBLTs provide timely feedback (Brown & Voltz, 2005; Reimer & Moyer, 2005), include a wide range of motivating multimedia (Clarke & Bowe, 2006b; Kay & Knaack, 2007a, 2007b, 2009), and help them learn (Bradley & Boyle, 2004; de Salas & Ellis, 2006; Kay, 2009; Kay & Knaack, 2007a, 2007b, 2009; Lim, Lee, &

Richards, 2006; MacDonald et al., 2005; Schoner, Buzza, Harrigan, & Strampel, 2005). In addition, considerable evidence suggests that student learning performance improves when WBLTs are used (Akpinar & Bal, 2006; Bower, 2005; Docherty et al., 2005; Kay & Knaack, 2007a, 2007b, 2009; Kong & Kwok, 2005, Liu & Bera, 2005; Nurmi & Jaakkola, 2006; Reimer & Moyer, 2005; Rieber, Tzeng, & Tribble, 2004; Windschitl & Andre, 1998).

However, with the exception of Kay and Knaack (2008a), limited research has been conducted on student characteristics and the use WBLTs in the classroom. Examining the impact of these characteristics is important for at least two reasons. First, the data could be used to alter the conditions and strategies for using WBLTs, thereby helping instructors to adapt to the individual needs of students. Second, analysis of student characteristics might provide a more comprehensive model for understanding the WBLT learning environment. Blanket statements about the effectiveness of WBLTs in middle and secondary school classrooms are a starting point, however a potentially more productive question for both educators and researchers is, "Which student characteristics influence student attitudes toward WBLTs and learning performance?"

2. Individual Differences and WBLTs - Students

A previous content analysis of 183 peer-reviewed articles conducted by Kay and Knaack (2009) revealed only seven papers mention individual differences and WBLTs, and no studies directly examine the impact of student characteristics. Five areas of potential differences in the use and impact of WBLTs included gender, age, computer comfort level, subject comfort level and ability. This is not meant to be a comprehensive list of student characteristics, but rather a reasonable starting point based on previous research.

2.1. *Gender*

Extensive research has looked at gender differences in computer-related behavior (see American Association of University Women (AAUW), 2000; Barker & Aspray, 2006; Kay, 2008; Sanders, 2006; Whitley, 1997 for detailed reviews of the literature). Overall, there is a persistent pattern of small, but statistically significant differences in computer attitude, ability, and use that typically favors males, however considerable variability exists. Therefore, it is reasonable to examine gender differences in any new computer-based technology to determine the impact of potential gender biases.

Limited research has been conducted on gender differences and the use of WBLTs - only two peer-reviewed studies could be found (Kay & Knaack, 2007b, 2008a). Kay and Knaack (2007b, 2008a) reported no significant differences between male and female secondary school students' attitudes and learning performance when WBLTs were used. More data is needed though, particularly for middle school students, to either conform or deny a gender effect with WBLTs.

2.2. *Age*

A number of researchers have explored differences in computer attitude and ability among various age groups. In several studies, older students (15-16 years old) viewed computers as tools for getting work done (e.g. word processing, programming, use of the Internet, and email), whereas younger students (11-12 years old) saw computers more as a source of entertainment (e.g. play games and use graphics software) (Colley, 2003; Colley & Comber, 2001; Comber, Colley, Hargreaves, & Dorn, 1997). On the other hand, Harris and Granfgenett (1996) and Kubek, Miller-Albrecht, and Murphy (1999) observed that age had a negligible effect on computer attitudes.

With respect to WBLTs, Kay and Knaack (2007b, 2008a) reported that older students (Grade 12) were more positive about WBLTs and performed better than younger students (Grade 9 and 10). De Salas & Ellis (2006) added that second and third year university students were far more open to using WBLTs than first year students. Since WBLTs were originally designed for higher education students (Haughley & Muirhead, 2005), it is conceivable that they might not work as well for younger students, who may be less prepared to engage in the rigors of self-guided discovery. More research is needed to assess the influence of age on using WBLTs, particularly at the middle and secondary school levels.

2.3. *Computer comfort*

Computer comfort, also referred as self-efficacy and confidence, has been studied in some depth with respect to general computer-related behavior (Barbeite & Weiss, 2004; Christensen & Knezek, 2000; Durndell & Haag, 2002; Liu, Hsieh, Cho, & Schallert, 2006; Torkzadeh, Pflughoeft, & Hall, 1999). A greater comfort level with computers is typically associated with a higher level of computer ability and/or use.

Regarding WBLTs, attitudes toward learning value, design, and engagement were positively and significantly correlated with computer comfort level (Kay & Knaack, 2005, 2007b, 2008a). Lim et al. (2006) added in a case study, that students who were not comfortable with computers used WBLTs less. These studies, though, focused on older students, so the results may not apply to their younger counterparts. Because many WBLTs are easy to use (e.g. Haughey & Muirhead, 2005; MacDonald et al., 2005; Nesbit & Belfer, 2004) and most of today's net generation feel comfortable with computers (e.g. Montgomery, 2009; Palfrey & Gasser, 2008; Tapscott, 2008), it is speculated that computer comfort level should have a minor impact on the perceptions and use of WBLTs with younger students.

2.4. *Subject comfort level and ability*

Two variables that have not been examined with respect to WBLTs are student comfort level and ability in the subject area that a particular WBLT covers. When students are not comfortable with a subject or do not feel competent, motivation is typically low (Cross & Steadman, 1996; Wlodkowski, 2008) and they may not be particularly receptive to

WBLTs when they are introduced. A negative reaction to WBLTs, then, might reflect a feeling of incompetence in the subject area being addressed. Furthermore, the additional cognitive load of having to use a new learning tool combined with weak subject-area knowledge may result in an overall negative learning experience (Chandler & Sweller, 1991). Kay and Knaack (2008a) recommended that subject area comfort level and aptitude be examined when looking at individual differences and WBLTs.

2.5. *Summary and purpose*

In summary, five potential influences, gleaned from previous research on computer-related behavior, use of WBLTs, and motivational learning theory include gender, age, computer comfort level, subject area comfort level, and subject aptitude. The purpose of this study was to examine the influence of five student-based characteristics (gender, age, computer comfort level, subject comfort level, and average grade) on attitudes toward WBLTs and learning performance.

3. Method

3.1. *Overview*

After conducting an extensive review of WBLT research, Kay and Knaack (2009) noted at least three areas of concern: (a) focusing on a narrow range of WBLTs (e.g. Bradley & Boyle, 2004; Krauss & Ally, 2005; MacDonald et al., 2005), (b) small and poorly described sample populations (e.g. Cochrane, 2005; Krauss & Ally, 2005; MacDonald et al., 2005; Van Zele, Vandaele, Botteldooren, & Lenaerts, 2003), and (c) a noticeable absence of reliability and validity in data collection tools (e.g. Howard-Rose & Harrigan, 2003; Lopez-Morteo & Lopez, 2007; Schoner et al., 2005; Vacik, Wolfslehner, Spork, & Kortschak, 2006; Vargo, Nesbit, Belfer, & Archambault, 2003).

Three additional problems not mentioned by Kay and Knaack (2009) included random selection and use of WBLTs with no theoretical structure or guidance, a wide range of loosely described teaching strategies employed, and the application of general, non-standardized measures of learning performance.

To address these methodological challenges, a wide range of WBLTs were used, reliable and valid measurement tools were included, a database of pre-selected WBLTs was created, pre-designed lesson plans were developed by experienced teachers, and an enhanced measure of learning performance was custom designed for each WBLT.

3.2. *Sample*

3.2.1. *Students*

This sample was comprised of 834 middle (n=444) and secondary (n=390) school students (392 males, 441 females, 1 missing data), 11 to 17 years of age (M = 13.3, SD = 0.97). Most students were enrolled in grades seven (n=229), eight (n=215), and nine

(n=340). Over three quarters (n=628) of the students reported that their average mark was 70% or more in the subject area where the WBLT was used. In addition, over 75% of the students agreed that they were good at working with computers. The sample population was selected from 25 middle and 20 secondary school classes located in a sub-urban region of nearly 600,000 people.

3.2.2. *Teachers*

This sample included 28 teachers (8 males, 20 females) who taught mathematics (n=15) or science (n=13) in grades seven (n=9), eight (n=9), nine (n=7) or ten (n=2). Class size ranged from 9 to 28 with a mean of 18 students (SD= 5.4). Teaching experience varied from 0.5 to 23 years with a mean of 7.1 (SD= 6.7). Twenty-three out of 28 teachers agreed that they (a) were good at working with computers and (b) liked working with computers at school.

3.2.3. *WBLT selection and lesson plan design*

Four teachers (not involved in the study) were hired and trained for two days on how to choose WBLTs for the classroom and develop effective lesson plans. WBLTs were selected based on Kay and Knaack's (2008b) multi-component model for assessing WBLTs. Lesson plans were designed from previous research on effective teaching strategies for using WBLTs (Kay, Knaack, & Muirhead, 2009). Key features of each lesson plan included a guiding set of questions, a structured well-organized format for using the WBLTs, and time to consolidate concepts learned. All lessons were designed to be approximately 70 minutes in length with 10 minutes for introduction, 50 minutes for WBLT use, and 10 minutes for consolidation. In order to minimize the impact of extraneous teaching and learning variables, pre-tests were given immediately before the lesson and post-tests were given right after.

Over a period of 2 months, a database of 122 lesson plans and WBLTs was created (78 for mathematics and 44 for science). A total of 22 unique WBLTs were chosen from the WBLT database and used by classroom teachers in this study. A wide variety of WBLTs were used involving experimentation, virtual manipulatives, task-based applications, and formal presentation of concepts followed by a question and answer assessment. See Kay (2011) for links to all WBLTs, detailed descriptions of the lesson plans, and pre/post tests used in this study.

3.3. ***Procedure***

Teachers from two boards of education were emailed by an educational coordinator and invited to participate in WBLT study. Participation was voluntary and teachers could withdraw at any time. Each participant received a full day of training on using and implementing the pre-designed WBLT lesson plans. They were then asked to use at least one WBLT in their classroom. Email support was available for the duration of the study. All students in a given teacher's class used the WBLT that the teacher selected, however,

only those students with signed parental permission forms were permitted to fill in an anonymous, online survey (Appendix A). Students also completed pre- and post-tests based on the content of the WBLT.

3.4. *Data sources*

3.4.1. *Explanatory variables*

Five student-based explanatory variables were examined in this study: gender, age, computer comfort level, subject comfort level, and average grade in subject area associated with the WBLT used. Computer comfort was assessed using a scale developed by Kay and Knaack (2005) which showed good construct validity and reliability. The internal reliability for the computer comfort scale was 0.82. Subject comfort level was assessed using two questions asking students about their ability and attitude regarding the WBLT subject area. The internal reliability for the subject comfort scale was 0.77. Finally, students were asked to estimate their average grade in the subject area where the WBLT was used.

3.4.2. *Response variables*

Two categories of response variables were used in this study: student attitudes toward WBLTs and learning performance. Student attitudes were assessed using the WBLT Evaluation Scale for Students. This scale consisted of 13, seven-point Likert scale items asking students about their perceptions of how much they had learned (learning construct - 5 items), the design of the WBLT (design construct - 4 items) and how much they were engaged when using the WBLT (engagement construct - 4 items). According to Kay and Knaack (2009), the scale displayed good internal reliability, construct validity, convergent validity, and predictive validity (see Appendix A for the scale items).

To assess learning performance, students were asked to complete a pre- and post-test based on the content of the WBLT used in class. These tests were included with all pre-designed lesson plans to match the learning goals of the WBLT. All tests consisted of two to six questions worth a total of five to eight marks. The type of questions varied according to the learning goals of the WBLT and included open-ended, short-answer, multiple choice, fill in the blank, and application questions. All pre- and post-tests with scoring rubrics are provided in Kay (2011).

The difference between pre- and post-test scores was used to determine changes in student performance on four possible knowledge areas: remembering, understanding, application, and analysis. These categories were derived from the revised Bloom's Taxonomy (Anderson & Krathwhol, 2001). The number of Bloom's knowledge categories assessed varied according to the learning goals and type of the specific WBLT used.

3.5. *Research questions*

In order to examine individual differences in the impact of WBLTs on middle and secondary school students, the following questions were addressed in the data analysis:

(1) Are student gender, age, computer comfort level, subject area comfort level, or average grade significantly related to student perceptions of learning, quality, or engagement for WBLTs?
(2) Are student gender, age, computer comfort level, subject area comfort level, or average grade significantly related to learning performance?

3.6. *Data analysis*

3.6.1. *Gender differences*

To assess whether gender had an impact on student perceptions of WBLTs, a MANOVA was run for gender and the three constructs assessing student perceptions of WBLTs. Age, computer comfort level, subject area comfort level, and average grade in subject area were entered as covariates to ensure that any differences observed were due to gender.

To evaluate the relationship between gender and learning performance, independent *t*-tests were run on the four learning performance measures. While a MANOVA is generally considered a better test when multiple response variables are assessed, most WBLTs focused on only one or two knowledge areas, consequently the sample size was not large enough to evaluate all four knowledge areas simultaneously using a MANOVA.

3.6.2. *Age, computer comfort level, subject comfort level, and grades*

To examine the relationship between the remaining four student characteristics (age, computer comfort level, subject area comfort level, grades), student attitudes and learning performance, simple correlation coefficients were used. This approach was followed instead of a multiple regression because there was no theoretical background to support a predictive model (Fields, 2005).

4. Results

4.1. *Gender differences*

4.1.1. *Perceptions of WBLTs*

The MANOVA run for student gender and the three constructs assessing student perceptions of WBLTs revealed that Hotelling's T was significant ($p < .001$), therefore independent comparisons of WBLT quality constructs were analyzed. Female student attitudes toward the learning value ($p < .001$), design ($p < .001$), and engagement ($p < .05$) of WBLTs were significantly higher than those of male students. The effect size for these differences based on Cohen's *d* are considered small (Cohen, 1988, 1992) (Table 1).

Table 1. Student perceptions and learning performance as a function of student gender.

	Female		Male		Test	Effect Size Cohen's D
	M	*(SD)*	*M*	*(SD)*		
Perceptions of:						
Learning	26.0	(6.3)	24.2	(7.1)	$F = 17.7$ **	0.27
Design	21.8	(4.7)	20.8	(5.0)	$F = 13.1$ **	0.21
Engagement	20.0	(5.8)	19.2	(6.1)	$F = 6.0$ *	0.13
Learning Perf (% Change)						
Remembering	30.9	(44.3)	25.8	(42.9)	$t = 1.2$ *ns*	---
Understanding	31.5	(43.7)	41.5	(44.4)	$t = 1.8$ *ns*	---
Application	17.0	(33.8)	15.7	(27.9)	$t = 0.4$ *ns*	---
Analysis	39.9	(46.3)	33.5	(50.4)	$t = 0.6$ *ns*	---

* $p < .05$ *** $p < .001$

4.1.2. *Learning performance*

The independent *t*-tests revealed no significant gender differences in percent change of learning performance scores for the remembering, understanding, application, or analysis knowledge area.

4.2. *Age differences*

Correlations among age and student perceptions of learning were either very small or not significant (Table 2). In other words, a student's age was not related to his/her attitudes toward WBLTs. On the other hand, age was significantly correlated with percent change in remembering, understanding, application and analysis knowledge areas (Table 2). Older students in higher grades (using different WBLTs) performed better than younger students in lower grades.

Table 2. Age, computer comfort, subject-area comfort, average grade correlated with student perceptions and learning performance.

	Age	Computer Comfort	Subject-Area Comfort	Average Grade
Perceptions of				
Learning (n=822)	0.08 *	0.29 ***	0.35 ***	0.03
Design (n=827)	0.05	0.27 ***	0.44 ***	0.12 **
Engagement (n=825)	0.06	0.29 ***	0.45 ***	0.06
Learning Performance				
Remembering (n=421)	0.34 ***	- 0.09	- 0.08	- 0.01
Understanding (n=254)	0.21 **	- 0.04	- 0.02	- 0.02
Application (n=422)	0.24 ***	0.05	0.11 *	0.08
Analysis (n=87)	0.36 ***	0.12	0.19	0.02

* $p < .05$ ** $p < .01$ *** $p < .001$

4.3. *Computer comfort level*

Correlations among computer comfort and student attitudes toward learning, design, and engagement of WBLTs were positive and significant (Table 2). Students who were more comfortable with computers, rated the quality of WBLTs higher in learning, design, and engagement. Computer comfort, though, was not significantly correlated with changes in learning performance for any of the four knowledge areas assessed (Table 2).

4.4. *Subject area comfort level*

Comfort level in the subject area addressed by a WBLT was significantly correlated with student attitudes toward learning, design, and engagement of WBLTs (Table 2). Students who were more comfortable with the subject area covered by a WBLT rated the learning, design, and engagement quality higher. Subject area comfort level was significantly and positively correlated with the application knowledge area, although the magnitude of the correlation was small (Table 2). Subject area comfort level was not significantly correlated with remaining three knowledge areas (remembering, understanding, and analysis).

4.5. *Average grade*

The self-reported average grade in the subject area where the WBLT was used was not significantly correlated with student attitudes about the learning or engagement value of WBLTs (Table 2). A small but significant positive correlation was observed between self-reported average grade and ratings of WBLT design. Overall, a student's average grade in the subject area covered by the WBLT did not appear to influence student attitudes toward WBLTs. In addition, average grade was not significantly correlated with changes in learning performance for any of the four knowledge areas assessed (Table 2).

5. Discussion

This study looked at the impact of student characteristics on middle and secondary students' attitudes toward WBLTs and learning performance. Five characteristics were examined including gender, age, computer comfort level, subject area comfort level, and self-reported average grade. The influence of each of these variables will be discussed in turn.

5.1. *Gender*

Past research on general computer behavior suggests that there would be small, but significant gender differences in favor of males for perceptions and learning performance associated with the use of WBLTs (AAUW, 2000; Barker & Aspray, 2006; Kay, 2008; Sanders, 2006; Whitley, 1997). However, the only two previous studies focusing on gender differences and WBLTs (Kay & Knaack, 2007b, 2008a) reported that male and female students had similar attitudes toward WBLTs and performed equally well on pre-

and post-tests. In the current study, a significant, but small effect was observed with respect to student attitudes in favor of female students. No significant gender differences were reported with respect to learning performance.

There are at least two possible explanations for the marginal impact of gender when using WBLTs. First, a number of studies suggest that WBLTs are very easy to use (e.g. Kay & Knaack, 2008b, 2009), therefore factors such as anxiety, confidence or ability are unlikely to influence attitudes or undermine learning performance. The impact of gender on attitudes toward WBLTs and learning performance may be minimized because the tools are so easy to use.

A second reason for the limited impact of student gender in this study might reflect a recent trend citing fewer gender differences in computer-related behaviors for younger students (Kay, 2008). The ubiquity of computer use for today's new generation of students also supports the notion of gender neutrality in computer-related behaviors (e.g. Montgomery, 2009; Palfrey & Gasser, 2008; Tapscott, 2008).

5.2. *Age*

Student age appeared to have a negligible impact on student attitudes toward WBLTs. This result confirms previous research on the impact of age on computer attitudes (e.g. Harris & Granfgenett, 1996; Kubek et al., 1999) and perceptions of WBLTs (Kay & Knaack, 2007b, 2008a). In other words, older and younger students view WBLTs the same with respect to learning, engagement and overall design. Since most of the students in this study are members of the "net generation" described by Tapscott (2008), it is speculated that WBLTs are viewed as just another interactive interface in a long list of Internet tools used on a daily basis.

Age was significantly correlated with all four measures of learning performance. Older students in higher grades performed significantly better than younger students in lower grades in remembering, understanding, application, and analysis knowledge areas. This result was partially supported by research suggesting that older students may be more serious about using computers for learning rather than entertainment (e.g. Colley, 2003; Colley & Comber, 2003; Comber et al., 1997). Kay and Knaack (2007b, 2008a) reported a modest, positive age effect on general learning performance, however, the results in the current study suggest a more robust effect, perhaps because the age range extended down to middle school.

One explanation for the impact of age on learning performance might involve student expectations as well as the range of cognitive skills required to use a WBLT including reading instructions, writing down results, interpreting and digesting "what-if" scenarios, and working independently. Younger students expecting to be entertained, might be surprised and even overwhelmed by how much effort is required to learn with WBLTs.

5.3. *Computer comfort level*

Students who were more comfortable with computers rated WBLTs higher for learning, engagement, and design. In other words, they appeared to have more positive attitudes

toward WBLTs than their less able peers. However, computer comfort level was not significantly correlated with any of the four learning performance measures. This result is congruent with previous research (e.g. Kay & Knaack, 2005, 2007b, 2008a) and confirms while that students who are not as comfortable with computers may not enjoy using WBLTs as much as their more confident peers, learning performance is largely unaffected.

5.4. *Subject area comfort level*

The results for the impact of subject area comfort level mirrored those of computer comfort level. Students who were more at ease with the subject area covered by a WBLT, rated the WBLT higher, but did not perform better than their less comfortable peers on three of the four learning performances measures. While motivation learning theory (Cross & Steadman, 1996; Wlodkowski, 2008) suggests that subject comfort level would have a positive impact on learning, it seems that with WBLTs, the influence is less pronounced and is reflected by student attitudes toward WBLTs, not performance. Further research is needed to determine the rigor of these findings.

5.5. *Average grade*

Overall, the average grade of a student in the WBLT subject area was unrelated to attitudes toward WBLTs and the four measures of learning performance. As stated earlier, because most of the students in this study are exposed to a steady diet of web activity (e.g. Montgomery, 2009; Palfrey & Gasser, 2008; Tapscott, 2008), it is reasonable to assume relatively uniform acceptance WBLTs regardless of average grade. This assumption is supported by the fact that there is no significant correlation between average grade and computer comfort level.

It is surprising that average grade was not correlated with learning performance. One would predict, in general, that students with higher grades would perform better than students with lower grades. It appears that WBLTs, as they were used in this study, minimized the impact of average grade. Using WBLTs may be a teaching approach that helps level the academic playing field.

6. Implications for Education

This study is one of the first comprehensive efforts to explore the influence of student characteristics on student attitudes toward WBLTs and learning performance, so it would be bold to offer strong recommendations to educators. That said, several tentative suggestions are worth considering. First, it appears educators need not be overly concerned about gender biases in the use of WBLTs, particularly with respect to student learning performance. This is the second study that has confirmed the minimal impact of gender on WBLT use. Second, WBLTs may be better suited to older students (e.g. secondary vs. middle school), perhaps because of the extensive self-supporting cognitive skills required to use these tools effectively. If WBLTs are used with younger students, it

may be prudent to offer more scaffolding and guidance to ensure gains in learning performance. Third, students who are less comfortable with computers or the subject areas addressed by a WBLT may be more resistant to using them as teaching tools. While this resistance does not appear to translate into reduced learning performance, students with these limitations may benefit from additional support. Finally, WBLTs may be a useful tool to reach a wider range of student ability levels, as average grade did not appear to influence student attitudes toward WBLTs or learning performance.

7. Future Research

Careful attention was paid to method in this study. Well tested, reliable, valid, and comprehensive measures were used to assess a wide range of systematically selected WBLTs in a large, diverse sample of middle and secondary school students. Nonetheless, because the investigation of individual differences in the use of WBLT is relatively new, more research is needed to replicate the findings and to address unanswered questions. Perhaps the most important new direction to pursue is collecting detailed qualitative data in the form of interviews, focus groups, or open-ended questions to help explain why certain differences exist and whether these differences are idiosyncratic or robust. Finally, this study examined the impact of individual differences in personal characteristics like age, gender, and comfort level with computers and subject area. Other variables such as socio-economic status or cognitive style might be important. In addition, the effect of variations context, such as teaching strategies, subject area, and technological support need to be explored too. In other words, the next important question to ask is, "Under what environmental conditions are WBLTs less or more useful?"

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Appendix A. WBLT Evaluation Scale

Learning

1. Working with the learning object helped me learn.
2. The feedback from the learning object helped me learn.
3. The graphics and animations from the learning object helped me learn.
4. The learning object helped teach me a new concept.
5. Overall, the learning object helped me learn.

Design

6. The help features in the learning object were useful.
7. The instructions in the learning object were easy to follow.
8. The learning object was easy to use.
9. The learning object was well organized.

Engagement

10. I liked the overall theme of the learning object.
11. I found the learning object engaging.
12. The learning object made learning fun.
13. I would like to use the learning object again.

All scale items used the following 7-point Likert scale:

1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree