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The Effect of Culture on Usability: Comparing the Perceptions and Performance of Taiwanese and North American MP3 Player Users

Steve Wallace
National Chiao Tong University (NCTU)
1001 University Road
Hsinchu 300
Taiwan
steve@iim.nctu.edu.tw

Prof. Hsiao-Cheng Yu
National Chiao Tong University (NCTU)
1001 University Road
Hsinchu 300
Taiwan
chengyu@cc.nctu.edu.tw

Abstract

A study of how 23 Taiwanese and North American subjects use a consumer electronic product shows that culture strongly affects the usability of the product. Survey data shows that North American users had much lower levels of user satisfaction and perceptions of effectiveness and efficiency than Taiwanese users. On the other hand, results on performance were unclear, indicating similar levels of effectiveness for both cultural groups and conflicting results on levels of efficiency.

Keywords

usability, culture, usability measurement

Introduction

Taiwan is a major producer of consumer electronic products, most of which are sold overseas. However, to succeed in the international market Taiwanese companies must realize the importance of good design. Designing for usability is clearly one way to sharpen Taiwan's competitive edge. Mayhew and Mantei (1994) describe improvements in usability resulting in increased sales, decreased training costs, and less need for after-sales support. But is making a product usable in a local market the same as designing for usability in a global market? Can it be presumed that an electronic product that is usable in the Taiwanese market is equally usable in other major markets such as the North American market? To answer this question, this article attempts to analyze how the culture of users from North America and Taiwan affects the usability of a new touch-screen MP3 player produced by the Taiwanese company ErgoTech.

The definition of usability has evolved over the last two decades. Earlier definitions of usability have usually focused on performance-related criteria such as ease of use and effectiveness (Shackel, 1991), but more recently the concept of usability has been expanded to include a subjective aspect, user satisfaction. It is now an International Organization for Standardization (ISO) standard defined in terms of product effectiveness, efficiency, and user satisfaction (ISO, 1998). A literature survey by Hornbaek (2006) of 180 usability articles suggests that the ISO definition is commonly accepted, and that there is also a distinction made in the literature between perceptions of usability and actual usability. Based on this distinction we can therefore define usability as a construct comprising a user's perceptions of product effectiveness, efficiency, and user satisfaction, combined with the actual effectiveness and efficiency of the product. To measure and compare the usability of a product across two cultures, it is these factors that must be measured and compared.

Research on Web site and software usability has helped describe much about the relationship between culture and usability, or "culturability" as it is described by Barber and Badre (1998). It has been shown that Web sites vary across cultures based on culturally-specific characteristics, or cultural markers (Singh, 2003) initially described by Hofstede (1984), and that users' preference for a Web site is affected by the cultural features of a Web site (Badre, 2000). Users from different cultural backgrounds are likely to use a Web site for different purposes (O'Keefe et al., 2000). In addition, the use of translation in a multilingual Web site (even when done expertly) affects user satisfaction (Nantel & Glaser, 2008), as does the use of culturally familiar or unfamiliar icons (Shen, Woolley, & Prior, 2006) in software applications. In a more comprehensive study of usability and culture Evers and Day (1997) found culture to be an important factor regarding the interrelationships of perceptions of efficiency, effectiveness, satisfaction, and user behavior when using a software application. In short, culture is likely to influence many elements affecting the usability of a product.

However, while many studies identify the effect culture has on many important aspects of usability, it cannot be certain that any single aspect of usability is correlated with the overall usability of a product (Frokjaer, Hertzum, & Hornbæk, 2000). It is important therefore, when studying the effect of culture on usability, to consider the usability of a product as a whole. In this study this is done by identifying the effect of culture on the elements Hornbaek (2006) found as commonly considered factors in usability: perceptions of efficiency, effectiveness and satisfaction, as well as performance-based measures of efficiency and effectiveness.

Methods

Hornbaek (2006) describes the main components of usability as being both subjective and objective. So to measure subjective impressions of product efficiency, effectiveness, and user satisfaction, this study surveys users to evaluate their perceptions of usability. To measure the actual efficiency and effectiveness of the product, users are observed as they use the product.

The Product

The product is an MP3 player from a Taiwanese electronic company called ErgoTech. The player includes a touch screen with a graphical interface. While the graphical interface reduces the use of text, text is still required for many functions. The interface can be configured in a variety of languages, including Traditional Chinese (for Taiwanese users) and English (for North American users).

An MP3 player was chosen for a number of reasons. This kind of product is popular among both young Taiwanese and North Americans, thus reducing the chance one group would be less familiar with the product than the other. There are also a small number of functions, reducing the chance that different cultures would use the product for different purposes—a cultural difference identified by Keefe et al. (2000). A touch screen interface that relied mainly on icons was chosen in order to reduce the influence of translated text on usability, as translated text may result in a reduced level of usability for users (Nantel & Glaser, 2008). Finally, it is hoped that results of such research will have implications for manufacturers and exporters of consumer electronic products in Taiwan and elsewhere.

Survey Sample Characteristics

Participants in the study were chosen for being representative of the target market. Analysis of marketing materials and the product's design and features indicated that the MP3 player was aimed at a young and international audience, interested in the latest hi-tech gadgets, many of whom would be students. In total 23 people were selected based on their match with the target market. Of those tested 13 had a Taiwanese cultural background and 10 had a North American (U.S.A. and Canada) cultural background. Subjects were compensated for their time in the form of food and refreshments. Apart from cultural backgrounds and other factors such as age, gender ratio, education levels, and experience with the product or other similar products were at similar levels between the cultural groups.

The following table indicates the characteristics of the sample.

Table 1. Sample Characteristics

Cultural Background	**Taiwan**	**North America**
Average age (rounded)	26	28
Gender ratio	4 females and 9 males	4 females and 6 males
Average education level	Bachelors degree	Bachelors degree
Average reported experience with similar products	Somewhat—very experienced.	Somewhat experienced
Average reported level of confidence with consumer electronics (on a scale 1-5, 1 is low, 5 is high)	3.38	3.35
Sample size	13	10

Measuring User Performance

Subjects were then given a series of tasks to complete using the MP3 player. Using scenario-based analysis, a number of tasks were identified as being likely tasks that the target user would perform. These tasks included listening to the radio, playing a song, recording a voice, playing a game, and adjusting settings. The subjects were observed using the product as they carried out these tasks. As the subject was using the product she or he was observed to see how effective and efficient the product is to use.

Effectiveness was measured by recording whether or not a user could complete a task. Because time was a variable in this study no time limits were given. The user either completed the task or announced she or he was unable to complete the given task. The binomial (yes or no) result was then recorded and summated for all tasks attempted by the user.

Efficiency was measured using the time taken and the number of errors made. Errors were defined as an attempt to click on the screen or other hardware attachment that would not result in completing the task assigned. The resulting scores on the time taken and number of errors made however, were not combined into a total score for efficiency. As noted by Hornbaek (2006), this would result in two errors. Firstly, in order to combine the scores a weighting for

each score would have to be identified, which is beyond the scope of this article. Secondly, combining scores may lead to the overlooking of important patterns in data representing each score. Finally, by separating the time taken and number of errors made we may better examine the usefulness of these variables as a measurement of efficiency.

User satisfaction was not measured by empirical means as the methods available (facial or verbal expressions) were considered too variable across cultures to be a culture-neutral method of measurement.

These measurements were then analyzed using a t-test (based on a small sample size and assumptions of a normal distribution) to identify whether the average result differed based on cultural background.

Measuring User Perceptions

Subjective measurements of effectiveness, efficiency, and user satisfaction were carried out using a Likert survey. The survey items were initially developed by Lund (2001) in the Usefulness, Satisfaction, Ease of Use (USE) survey on usefulness, ease of use, and user satisfaction, but were adapted in this survey to indicate efficiency, effectiveness, and user satisfaction. This survey was selected among others for a number of the following reasons:

- It can be used when testing a variety of products, compared to other usability measurement methods such as the Questionnaire for User Interaction Satisfaction (QUIS) or System Usability Scale (SUS) tests that focus on Web site or software usability.
- The variables covered in the survey closely follow those identified by Hornbaek (2006) as being a component of usability, as well as being the industry standard used by ISO.
- The survey aims to become a commonly accepted usability measurement tool. Using the survey helps to address the problem identified by Hornbaek (2006) of the lack of replication and comparability of studies of usability measurement.

The USE survey was found to be a highly reliable indicator of user perceptions as indicated by Cronbach's alpha. Similarly, Lund (2001) reports high levels of Cronbach's alpha when designing the survey. The following table shows the high level of internal consistency of this survey.

Table 2. Survey Reliability Estimates

Perceived Usability Factor	Cronbach's Alpha
Efficiency	0.86
Effectiveness	0.92
User satisfaction	0.88
Total usability	0.96

The survey responses for each variable (efficiency, effectiveness, and user satisfaction) were summated and then analyzed for differences based on cultural background. Both the Mann-Whitney U test and the t-test were applied. The t-test is commonly used in studies such as this where the sample size is small and a normal distribution is assumed. However, one set of results, the number of tasks completed, was not found to be normally distributed, so the Mann-Whitney U test was also applied to the data. These tests gave similar results, so for convenience only the t-test results are given in this article.

In this section of the study one set of hypotheses is examined. The null hypothesis is that the mean or median values of all usability factors are the same for Taiwanese and North American users. The alternative hypothesis is that they differ.

Measuring Correlations

The correlation between variables was also estimated using Pearson’s correlation co-efficient and the Spearman Rank Correlation. The latter measure was used for the reason mentioned earlier, that the number of completed tasks is not normally distributed. However, because

results for both measures are similar, only measures of Pearson's correlation coefficient are used in this article.

Correlations are shown in two aspects. Firstly, the correlation between subjective and objective measures of usability and users' cultural background is examined. While focusing on the connection between culture and usability, other correlations were also estimated for the purpose of comparison. Secondly, a comparison is made of correlations between usability factors within each culture group—Taiwanese and North American users.

In this section of the study two sets of hypotheses are made. Firstly, correlations between culture and other usability factors are examined across both culture groups. The null hypothesis is that there is no significant correlation between culture and any usability factor. The alternative hypothesis is that there is a statistically significant correlation between culture and one or more usability factor. Secondly, correlations between usability factors in one culture group are examined to see whether they are significantly different from correlations in the other culture group. The null hypothesis is that there is no significant difference between any usability factor correlation in one culture group and its equivalent in the other culture group. The alternative hypothesis is that one or more usability factor correlations in a culture group differ significantly from the equivalent correlation(s) in the other culture group.

Results

The following results from the analyses conducted support the first two of the hypotheses made but found no statistically reliable evidence to support the third:

- The first test showed that there are many statistically significant differences in the mean values of the usability factors obtained from each culture group.
- The second test confirmed our hypothesis that correlations exist between cultural background and usability factors.
- The third test found no statistically reliable evidence to suggest that correlations between usability factors differ significantly between culture groups.

Comparing Averages for the Two Groups

Results from the t-test show that the average perceptions of usefulness, ease of use, and user satisfaction differ significantly between Taiwanese and North American users. Culture clearly is associated with perceptions of usability. However, the average levels of performance do not differ so clearly between Taiwanese and North American users. There is no clear difference in the average number of tasks completed between groups, indicating that the culture of the user may not have an impact on the actual effectiveness of a product. The link between culture and product efficiency is also not clear. The average number of errors made differed significantly according to culture. While the other measure of product efficiency, the time required to complete a task, showed no clear difference in averages.

The following table summarizes the difference in distributions between the samples.

Table 3. Comparison of Mean Measures of Usability Between Cultures

	Taiwan	**North America**	**P-value (t-test)**	**Significance**
User Perceptions (mean score as a rounded percentage of total possible)				
Effectiveness	70%	41%	< 0.001	Highly significant
Efficiency	64%	45%	< 0.01	Very significant
User satisfaction	63%	42%	< 0.01	Very significant
Total perceived usability	62%	44%	< 0.05	Significant
User Performance (mean score)				
Tasks completed (max 16)	13.46	13.60	> 0.05	Not significant
Time required (seconds)	667.08	788.80	> 0.05	Not significant
Errors made	93.92	155.70	< 0.01	Very significant

Correlations Between Usability and Culture

It is also interesting to see how significantly culture is correlated with the variables associated with usability. The following table indicates the correlations (r) between the variables measured in this study. The degree of correlation is indicated by the closeness of the correlation measure to 1 or -1. A result of 0 indicates an absence of correlation, while a result of over 0.5 or -0.5 shows a moderate to strong association. There is disagreement about where exactly the cutoff for a moderate or a strong correlation lies. In this study *r* values from 0.5 to 0.7 or from -0.5 to -0.7 indicate a moderate correlation, while *r* values above 0.7 or below -0.7 (shown in bold) indicate a strong correlation. Weak correlations, an absence of correlation, or statistically insignificant correlations (p >= 0.05) are not shown in this table.

Table 4. Correlations Between Factors in Usability for Both Culture Groups

	Culture	**No. of Errors**	**Effectiveness**	**Efficiency**	**Satisfaction**
User Perceptions					
Total perceived usability	-0.501*	-0.590**	0.634**	**0.755*** **	**0.744*** **
User satisfaction	-0.633**	-0.687***	**0.787*** **	0.694***	
Efficiency	-0.579**	-0.593**			
Effectiveness	**-0.774*** **				
User Performance					
No. of Errors	0.588**				

* = p < 0.05
** = p < 0.01
*** = p <0.001

The results in Table 4 confirm the alternative hypothesis. Culture clearly is correlated with many of the factors that make up usability. Firstly, culture is moderately to strongly associated with perceptions of usability. In particular, culture has a strong association with perceptions of effectiveness but was only moderately associated with other perceptions of usability. The negative correlation shown in some cells reflects the numbers used to represent the different cultures for statistical purposes. Taiwanese and North American cultures were represented by the numbers *1* and *2* respectively. So the negative correlation between culture and effectiveness reflects the impression North American subjects had of the lack of effectiveness of the product.

Secondly, culture is also directly linked to a user's actual efficiency when using the device, as shown by the number of errors. It is also possible that culture indirectly affected perceptions of usability. The number of errors had a negative correlation with variables representing perceptions of usability. As the number of errors increased, perceptions of effectiveness, satisfaction, and overall perceptions of usability fell.

While not strictly related to this study, it is also clear that perceptions of usability shared some correlation. Perceptions of effectiveness and efficiency were moderately positively correlated with user satisfaction. Understandably, total perceived usability was correlated with the variables that it comprises—effectiveness, efficiency, and satisfaction. It also shows an extremely moderate relationship with cultural background and the number of errors, possibly as a result of its indirect relationship with these variables.

Interestingly, one measure of efficiency, task completion time, showed no significant correlation with any other variables measured in this study. While the other indicator of efficiency, the number of errors, showed a strong connection to many perceptions of usability. The lack of correlation between two measures of efficiency, time taken and number of errors, combined with the lack of correlation between time taken and any other variable raises questions as to the usefulness of this variable as a measure of efficiency.

Comparing Correlations Between Usability Factors Across Cultures

This study also examines the correlations between usability factors within each culture. Tables 5 and 6 show moderate to strong, statistically significant ($p < 0.05$) correlations between usability factors for North American and Taiwanese users. Weak correlations, an absence of correlation, or statistically insignificant correlations ($p >= 0.05$) are not shown in these tables. Because the sample size for each culture group is roughly half that of the total sample size, there are fewer statistically significant observations available.

There are marked differences in the correlations observed in each culture group. For example, the number of errors is clearly correlated with user perceptions in both groups. For the Taiwanese, the number of errors is correlated with perceptions of efficiency. This is in contrast to North American users for whom the number of errors was strongly correlated with lower levels of satisfaction. Unfortunately, because these correlations are for different sets of variables, these correlations cannot be compared.

In fact, the correlation between overall usability and efficiency is the only correlation found in both culture groups. For Taiwanese users there are moderate to strong correlations between perceptions of effectiveness, efficiency, and user satisfaction. These values were also strongly correlated with overall usability. For North American users however, only a moderate correlation between perceptions of efficiency and overall usability was observed. However, we cannot say with a 95% confidence level that the correlation between perceived efficiency and total perceived usability is statistically different between cultures.

In short, no statistically significant comparisons of correlations can be made between these two user groups. Because of this the hypothesis that there is no difference between usability correlations for Taiwanese and North American users still stands.

Table 5. Correlations Between Usability Factors for North American Users

	No. Errors	**Efficiency**
Total Perceived Usability		0.578*
Satisfaction	**-0.730****	

* = p < 0.05
** = p < 0.01

Table 6. Correlations Between Usability Factors for Taiwanese Users

	No. Errors	**Efficiency**	**Efficiency**	**Satisfaction**
Total Perceived Usability		**0.814****	**0.877****	**0.906*****
Satisfaction		**0.824****	0.641*	
Efficiency	-0.672*			

* = p < 0.05
** = p < 0.01
*** = p <0.001

Discussion

This study shows that the cultural background of the user is a likely factor in determining the usability of a consumer electronic product, such as ErgoTech's MP3 player. Most aspects of usability identified by Hornbaek (2006) in his survey of usability literature are affected by the cultural background of participants, in particular, users' perception of effectiveness, efficiency, and levels of satisfaction. In addition, efficiency as measured by the number of errors is also clearly connected to culture.

However, in this study efficiency was measured by both the time taken and the number of mistakes made when performing a task. It is to be expected that as users make more mistakes they also require more time to complete tasks. However, this was not the case. North American users required similar amounts of time to their Taiwanese counterparts but made more errors within that time. One possible explanation for this could be a different problem-solving style. It was often observed during tests that, when faced with a problem using the MP3 player, North American users sometimes became more active or even clearly frustrated, which may have been the reason for the higher number of errors. The number of errors then correlated with low levels of user satisfaction and perceptions of efficiency among North American users. On the other hand, the lack of correlation between completion time and any other variable raises questions as to the usefulness of this variable as a measure of efficiency, a point also raised by Dillon (2001).

While efficiency may have been affected by culture, effectiveness as measured by the number of tasks completed is similar for both cultural groups. That there is little connection between efficiency and effectiveness is supported by Frokjaer et al. (2000) who found little correlation between efficiency and effectiveness. As the study by Frokjaer et al. notes, the lack of correlation between efficiency and effectiveness means any attempt to measure usability must take into account the range of factors that make up usability.

So, on the whole, culture affects usability, but how much does usability vary according to culture? So far this study has only considered whether a relationship exists between culture and

the perceived and actual components of usability—efficiency, effectiveness, and user satisfaction. Given that there is a relationship, is it possible to also say how much culture affects usability as a whole? While it may be possible to give a total value for usability by combining the results for each component, the question is how much weight should be given to each component. This question is made more difficult because culture may also affect the weighting given to the components of usability. Research on Indonesian and Chinese users show higher importance placed on efficiency by Indonesians and more emphasis placed on effectiveness by the Chinese (Evers & Day, 1997). To arrive at a total measure of usability for each culture, more research is needed to compare the weightings different cultures have for each component of usability.

Why is culture such an important variable in usability? This study does not attempt to answer the "why" in culturability. For suggestions as to possible reasons, studies on software and Web site usability have implications. Nantel and Glaser (2008) argue that translated text reduces Web site usability, Shen et al. (2005) finds evidence that software interfaces using icons with a relevance to their own culture are more satisfying for users, and Badre (2000) finds the cultural content of Web sites affects preference for a Web site. How do these elements of a product affect overall usability for each culture? Much research has also been done on the overall effect of individual elements of consumer electronic product design, such as size, look and feel, etc. on usability (e.g., Han, Hwan Yun, Kwahk, & Hong, 2000). However, this has been done in a single culture. It would be useful to compare the effects such design elements have on usability across cultures.

The main implication for this study is for Taiwanese manufacturers who hope to sell their products in overseas markets such as the U.S.A and Canada. What may seem to be good usability design in one culture may not be perceived as such in others. As a solution to this problem, companies are already using *co-design* in recognition of the need for culturally-aware design. This is a design process that takes place in both the country of the manufacturer and the target market. For example, Vodaphone works with Chinese manufacturers to ensure the user interface is suitable for the European market (Williams, 2006). It would be interesting to identify the solutions such companies arrive at and to analyze their effectiveness in solving the problem of cultural differences and usability.

Recommendations

This study provides strong evidence that culture affects usability as a whole. In so doing, it is hoped this study provides a methodology to be used in further research into the effect of culture on usability. It is recommended that future studies along similar lines consider the following:

- All aspects of usability must be assessed including subjective and objective measures of efficiency, effectiveness, and user satisfaction. It is not certain that a measurement of a single aspect of usability will accurately represent levels of usability as a whole.
- A standard measuring instrument to measure attitudes should be used when measuring usability. A tool such as the USE instrument allows results to be compared across different products including software, Web sites, and consumer electronics.

This study also raises the possibility of further research in the following areas:

- To evaluate the total level of usability of a product it is necessary to understand the weighting a culture gives to the components of usability—efficiency, effectiveness, and satisfaction. For example, Evers and Day (1997) show Indonesians place more importance on efficiency while Chinese users place more importance on effectiveness. By rating the usability of a product based on the weighting given for each aspect of usability, a culturally specific value of total usability could be derived, which could then be compared across cultures.
- Single culture usability research has isolated a range of product design factors affecting usability such as size, look, and feel (Han et al., 2000). A similarly detailed comparison of the effect of product characteristics on usability across cultures may help to identify reasons why culture affects usability so strongly.
- Many companies design for overseas markets. What solutions have they already found to the problem of culturability?

Conclusion

This study shows good evidence of a link between culture and usability. To understand usability as a whole, both subjective and performance-based measures of usability were considered. To gather data, commonly accepted usability measurement tools, such as the USE survey, and standard measures of performance, such as tasks complete, time taken, and errors made, were used. By doing so, it is hoped similar studies can be made in the future to further develop understanding of the influence of culture on usability.

So, the overall message for business is clear (and has already been noted by such corporations as Nokia), product design in the consumer electronics industry or any industry with a multicultural market must acknowledge the need for usability across cultures.

Practitioner's Take Away

Usability practitioners should be aware of the following points:

- Ensure usability testing includes subjects that are culturally representative of users. Because culture has such a strong influence on usability, testing subjects from the wrong culture may seriously skew the results of usability testing.
- Include subjective and objective measures of efficiency, effectiveness, and user satisfaction when measuring usability.
- Keep in mind different cultures have differing concepts of usability and value effectiveness, efficiency, and user satisfaction differently.
- Aim to minimize the possibility of user error when designing products for the North American users. In this culture, users' perceptions of usability are strongly influenced by this variable.
- Expect North American and Taiwanese users to be similarly effective when using a product.
- Expect Taiwanese users to perceive the usability of a product at a much higher level than North American users, especially with regard to the effectiveness of a product.

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About the Authors

Steve Wallace
Steve Wallace currently works at Chiao Tong University in Hsinchu, Taiwan as a lecturer in the College of Electrical Engineering where he teaches classes in oral communication, engineering English, technical writing, and academic writing. He has a background in Biology as well as an MBA. He is currently completing his PhD in Technology Management.

Hsiao-Cheng Yu
Professor Hsiao-Cheng Yu is assistant dean of the College of Management at Chiao Tong University in Hsinchu, Taiwan, where he has been based for the last 13 years. His research interests focus on the telecommunications and high-tech industries, specifically in entrepreneurship, venture capital, trade skills, and business paradigms in these areas.