The Impact of Navigation and Language on International E-learning

Master's Thesis of:

Sebastian Linxen, B.A.
sebastian.linxen@stud.unibas.ch
Institute of Psychology
Department of Cognitive Psychology and Methodology
University of Basel

May 2009

Thesis Supervisors:

Peter Schmutz, M. Sc.
Department of Cognitive Psychology and Methodology, University of Basel

Prof. Dr. Klaus Opwis
Department of Cognitive Psychology and Methodology, University of Basel

Abstract

An important part of designing e-learning software for international markets is to take cultural aspects and language skills of the target groups into account. The aim of the present study was to examine effects of used navigation on participants from cultures with different levels on Hofstedes cultural dimension of power distance. Another aim was to examine the effect of the language of the user interface and the content during the work with a web based training (WBT) module. An online experiment was conducted to identify differences between the influences of the navigation styles (open routes versus prescribed routes) and the language of the user interface and the content of the WBT modules (first language versus English). 173 subjects from three different language areas worked with a WBT module. Subjective measures like duration, the achievement of knowledge as well as objective measures like assessment of usability and mental workload were assessed. The presentation of user interface and contents in the first language affected only the subjective assessment of usability and some aspects of mental workload. The results of participants with a low power distance level showed no effects caused by the navigation style on objective measurements or the assessment of usability. However, the open paths showed a lower mental workload. The results of this study clarify the need for further research into how culture affects international e-learning.

The Impact of Navigation and Language on International E-learning

Introduction

In the last decades globalization and internationalization as well as the incredible possibilities of international commerce have created new and lucrative markets all over the world. The main markets for computer technologies and software products like e-learning environments expanded from the western countries to the entire world. The target group for such a product exists no longer just in the already-claimed home markets, but also in international markets. In order to stand one's ground and to succeed in international markets a lot of different aspects must be taken into account. In addition to visible cultural differences like gesture or language, other non-visible aspects like social behaviors or conventions differ from culture to culture and therefore from market to market. These aspects provide the necessity for a new approach to the development and deployment of e-learning products. Further aspects like local languages, technical requirements, learning and teaching styles as well as cultural characteristics need to be taken into consideration, so that high usability and knowledge acquisition rates can be achieved. For instance, several western e-learning products provide an open learning environment so the user is able to navigate through open routes. But this kind of learning could be unfamiliar to persons from cultures that differ in the style of learning and teaching.

One way to adapt products like e-learning software to different markets is the localization process. During this process several elements like the language of the new market, navigation preferences, reading directions, social values, learning styles, etc. are taken into account. The level of localization is able to influence the success of a product on a market. However, a high level of localization results in a high investment of financial, temporal and personnel resources. Due to these economic factors, a reasonable and focused method for developing a localized product is necessary in order to determine the ideal cost-

benefit ratio. Therefore the goal of the present study is to examine the influence of both localization and the style of navigation on knowledge acquisition as well as on user satisfaction.

Existing Research

In the design of information and communication technologies, human-computer interaction (HCI) and instructional design (ID) are two fields which took cultural influences into account (Young, 2008). However, the national and ethnic culture is a neglected topic in the field of research of human-computer interaction. In the period from 1990 until 2005, less than one percent of the 3286 published articles in five major HCI forums (articles and conference) concentrated on culture-related issues (Kamppuri, Bednarik, & Tukiainen, 2006). Since 1998 a small increase in the number of articles on the subject can be noted, but the topic is still underrepresented. Furthermore in fields like the design of information and communication technologies, cultural influences are less considered. Within the field of instructional design, there exist several cultural models, but they are not yet commonly used (Young, 2008).

In the next subsections the focus is on an introduction to the different levels of culture-oriented design. Furthermore the opportunities of cultural models in software design and the use and impact of English with regards to the development of international software products like web based training (WBT) modules is presented.

Culture-oriented Design

During the development of a product, like an e-learning module for a global commercial launch and therefore for an international target group, there are different levels of culture-oriented design to adapt or prepare the product for the different market areas. Each of these processes differs in how it adapts products to cultural differences. Lommel and Ray (2007) divide these different levels into globalization, internationalization and localization.

They described globalization as “the process of making all the necessary technical, financial, managerial, personnel, marketing and other enterprise decisions necessary to facilitate international business” (p. 49). Day (1996) described this process rather as a product status. Products of this status are cultureless with no adjustments to the culture of different target groups and often provided in English.

Internationalization is a step forward to adapt a product to an international target group. The level is described as “the process of ensuring at a technical/design level that a product can be easily localized” (Lommel & Ray, 2007, p. 17). This process takes cultural differences into account. The concept development, planning and implementation of a product provides space for cultural adaption, so that an integration of another language or another navigation structure (e.g. in languages with special reading directions like the Arabic language) after the engineering phase is possible without becoming uneconomical.

The level of localization is defined as: “the process of modifying products or services to account for differences in distinct markets” (Lommel & Ray, 2007, p. 11). The process of localization involves several aspects like linguistic, physical, business, cultural and technical issues. An important factor in the localization of software products is the linguistic adaption to a new market, which differs from the place of origin, where the product was developed.

The different levels of a culture-oriented design process include different efforts in economic areas, like more investment of financial means or expenditure of time. But the process of localization is often an important aspect for the acceptance and the success of a product on the international market (Esselink, 2000).

Cultural models in software design

Due to the globalization of the markets and the new target groups for internet, computer and e-learning technology related to this, developers of software products are now interested in cultural aspects. Compared to traditionally western markets, the new grounds are

characterized not only by cultural differences between experts and novices, but also by differences in cultural traditions (Kamppuri, Bednarik, & Tukiainen, 2006). The first measures taken for meeting the new challenge were the development of rules and guidelines by the developing industry, designers and hands-on professionals working in the field of global software development. In the nineties, the works of Nielsen (1990), Fernandes (1995) and del Galdo and Nielsen (1996) arrived on the market and provided practical hints for the development of international user interfaces. Another approach to provide support for the development of cultural friendly products is to take cultural dimensions into consideration. An important aspect during the developing process of software for the international market and during the internationalization and localization process is to categorize and compare different cultures. A couple of anthropologist authors like Geert Hofstede (1980), Edward T. Hall (1959) and Fons Trompenaars (1993) challenged the task with different methods and developed cultural dimensions. The well known work of Hofstede was based on a great study of national work related values. The survey was carried out during 1967 and 1972. 116.000 employees of IBM in 53 countries took part in filling out a questionnaire which was available in 20 languages. Based on this data, Hofstede was able to identify the following five different dimensions of culture:

1. Power Distance: The first dimension is the so called power distance. Hofstede and Bond (1984) described this dimension as “the extent to which the less powerful members of institutions and organizations accept that power is distributed unequally” (p. 419).
2. Uncertainty Avoidance: This is the second of the cultural dimensions and is defined as “the extent to which people feel threatened by ambiguous situations, and have created beliefs and institutions that try to avoid these” (Hofstede & Bond, 1984, p. 419).

3. Individualism versus Collectivism: Hofstede and Bond (1984) set up two poles. The pole individualism is defined as “a situation in which people are supposed to look after themselves and their immediate family only” (p. 419). Contrarily, collectivism is described as “a situation in which people belong to in-groups or collectivities which are supposed to look after them in exchange for loyalty” (p. 419).
4. Masculinity versus Femininity: Masculinity is defined as “a situation in which the dominant values in society are success, money, and things” (p. 419). The contrary pole is Femininity. This aspect is defined as “a situation in which the dominant values in society are caring for others and the quality of life” (p. 419).
5. Long Term Orientation: The fifth dimension was added by Hofstede after a study carried out by The Chinese Culture Connection (1987) using questionnaires designed by Chinese scholars. The poles of these dimensions are Long-term orientation and Short-term orientation. Cultures of the first pole are described by Hofstede (1997) as influenced by old traditions and the actions of the present binding to the future. Cultures tending to the contrary pole see traditions under a nostalgic point of view.

A theoretical approach to use anthropological cultural models was presented by Marcus and Gould (2000). By using the cultural dimensions which were created by Hofstede and with references to Hofstede (1997) the authors made clear which possible influences these dimensions had on web user interface designs, and provided explanations and implications for the design of user interfaces and web content. The authors suggested for instance that cultures with a high value on power distance level had tall hierarchies in their mental models and a strong focus on elements like expertise, authority, official stamps or logos. On the other hand cultures with a low value on the power distance index had shallow hierarchies and a weak focus on the mentioned points.

In addition to this work, Marcus (2005) presented another approach and mapped the five cultural dimensions by Hofstede (1997) with the different elements of a typically user interface. He divided the elements of a typically user interface into five different components:

1. Metaphors: The first components are metaphors, like the desktop metaphor of the graphical user interface of an operating system. This component is communicated through words, images, audio and tactile experiences (Marcus, 2005).
2. Mental models: Mental models work as another component. Marcus listed the structure or organizations of data, functions or tasks and roles. Aspects like content, function, media or task hierarchies can be assigned to mental models (Marcus, 2005).
3. Navigation: The Navigation enables the movement through the mental models, content and tools. Elements of the navigation through these aspects are common points like menus, windows, dialogue boxes, icons, etc. (Marcus, 2005).
4. Interaction: The Interaction with a user interface includes aspects such as input and output techniques, status display and other ways to give feedback to the user. Input techniques are characteristics of input devices, like keyboard, mice, etc. and displays or speakers for output, as well as the use of drag-and drop for selection and action sequences (Marcus, 2005).
5. Appearances: This point includes all essential perceptual attributes like visual (e.g. color, fonts), auditory (e.g. system sounds) and tactile characteristics (e.g. vibration mode) of an interface (Marcus, 2005).

By mapping the five cultural dimensions by Hofstede (1997) with the typically elements of a user interface and vice versa, Marcus (2005) tried to provide a system to show and to understand the relationship of special user interfaces to special cultural dimensions. With this method comprehension and predictions of the use, acceptance and enjoyment of user interface components are possible. Additionally he shows an analysis and provides

examples of the influences of high and low values to the different user interface components for every single cultural dimension. For example the author suggested that a high value on the power distance level had impacts on preferences. Navigation with restricted access and choices as well as prescribed routes on the navigation elements of a user interface are preferred by members of this group. Contrary cultures with a low value on the power distance index prefer an open access, multiple options and navigation styles like sharable paths.

The validity of theoretical studies of Marcus and Gould (2000) is questionable due to different reasons, like the fact that users from the same country and culture do not automatically fit into the dimensions established by Hofstede (Jagne & Smith-Atakan, 2006). In studies of websites from China, Smith et al. (2004) tried to verify cultural dimensions. By using the findings of Marcus and Gould, websites were chosen which differs in the value of the cultural dimension laid down by Hofstede. The results of the studies supported these cultural models only in a limited way (Smith, et al., 2004).

A study by Dormann and Chisalita (2002) tried to investigate the relation between websites and the cultural dimension of masculinity vs. femininity. The study showed significant differences between the subjects of different cultures as well as between the rankings of websites of masculine or feminine related websites.

Another approach to use the cultural dimensions of Hofstede is worked out by Caroli (2005). Hofstede (2001) used his proposed cultural dimensions to derive generically characteristics of culture-specific aspects in different areas of social life. These areas include workplace, family, state as well as education and learning. An important aspect of this work is the fact that these characteristics are not based on empirical studies. The characteristics are derivations of the original cultural dimensions, and empirical studies, which compare not only education systems, are still missing (Caroli, 2005). Caroli discussed the characteristics of education and learning in reference to the development and implementation of localized e-

learning products. For an example Hofstede (2001) suggested that a high value on the power distance level leads to teacher-centered instruction. Caroli picked up this implication and suggested that an e-learning environment had to bear this in mind and provide the learner with orientation and direction. On the other hand, contrary cultures with a low level on the power-distance index prefer for example a learner-centered instruction (Hofstede, 2001) and Caroli (2005) reasoned that these cultures would prefer a learning environment that supports a light explorative system.

The approaches of Marcus (2005) and Caroli (2005) framed preferences for several elements like navigation and learning style. A culture with a low level on the power distance index prefers a lightly explorative system (Caroli, 2005), which takes the form of open routes navigation. The navigation style should have effects on the performance and satisfaction of the participants. Therefore it can be hypothesized:

Hypothesis 1: For participants with a low power distance index web based training modules with open routes navigation will positively affect performance and satisfaction. On the other hand a negative effect on performance and satisfaction will be found for participants with a high power distance index.

English – language for global software

A common strategy to produce software like e-learning products for a worldwide market and therefore for a heterogeneously target group with different cultural background is to globalize the product. By presenting the contents and the user interface of a product in English, a wide group of customers is available and the investment is less substantial compared to a localized version of the software. Furthermore, English is the most influential language of the world (Weber, 1997, 2008). Weber (1997) ranked twenty major languages

with a score based on six points, inter alia on the number of primary speakers, the number of secondary speakers and the economic power of countries using the language. The English language emerged clearly as the most influential language. In 2008 the author stated that even today the top ten of the influential languages remains unchanged due to proportionate development (Weber, 2008). Most of the large and international companies use English as a working language. And even 87% of worldwide acting institutions like the NATO or the EU use English as a kind of administrative language (Crystal, 2003a).

Next to the overall influence of English, this language is used as a lingua franca and is the number one spoken language in the world (Glaser, 2003). The types of people using the English language can be divided in three different groups. The first group exists of the first-language speakers. According to the engco model, the number of first language speakers is approximately 372 million (Graddol, 1997).

The second group of English speaker consists of persons using English as a second language. A second language is a language, which is used as an official language in a country for instance in government issues, jurisprudence, media and the educational system, without being the first language of the majority (Crystal, 2003b). More than seventy countries are using English as a second language (Crystal, 2003a) and the number of second language speaker varies from source to source from 220 (Görlach, 2002) to 400 (Crystal, 2003b) million people.

Worldwide, English is the most learned foreign language. In more than 100 different countries, English is an inherent part of the curriculum and quite often the only taught foreign language (Crystal, 2003a). An estimate of the British Council suggested that in the year 2000 more than 1 billion people in the world learned English, either as a foreign language or as a second language. The number of learners will increase to 2 billion persons in 10 to 15 years (Graddol, 2006). The high number of second and foreign language speakers of English

outperforms the number of native speakers by many times over. The high spread of English as a second language has produced many different versions of the language, labeled as 'New Englishes' and the language of a native speaker is no longer the aimed ideal (Meierkord & Karlfired, 2002).

These circumstances lead to different claims and needs. If globalised software is developed and English is used for the user interface and the content, the developer has to use a simple version of English to cover a range of users with different linguistic backgrounds and different English skills. This Global English is the best way to obtain a general acceptance and provide the best opportunity for understanding the presented material (Schell, 2007). Schell suggested the use of a simpler syntax, less jargon, fewer idioms and no slang to create Global English.

English is the number one spoken language in the world, and a study conducted in the European Union showed that there are wide variances in the English skill levels and the numbers of English speakers within different cultures and countries (European Commission, 2006). Several studies (Marschan-Piekkari, Welch, & Welch, 1997, 1999) showed that international companies underestimate the foreign language skills of the employees and only the members of the upper management were able to communicate in the official company language. The study of Marschan-Piekari, Welch and Welch (1999) explored the impact of language on structure, power and communication and revealed that documents which were prepared in the company language, English, of the corporate headquarters often had to be translated into the first language of the different branch offices.

There are several factors in favor of developing and distributing an e-learning environment with an English user interface and content. With minimal investment a substantial group of possible customers is available. But previously mentioned aspects, including the heterogeneous distribution of the number of English speakers and English skills,

affect the success of using English as a working language. The studies of Marschan-Piekkari, Welch, & Welch (1997, 1999) showed employees of international companies exhibited general problems with foreign language skills. For these reasons, it seems that an English version would have a negative influence on a non-native speaker. Therefore it can be hypothesized that:

Hypothesis 2: Web based training presented in the first language of the participants will positively affect performance and satisfaction when compared to modules presented in English.

Aim of the study

Cultural influences are an important factor for the success of international software products, like web based training modules. One aim of the present study is to examine the usefulness of approaches like those of Marcus (2000, 2005) and Caroli (2005), which use anthropological studies to generate recommendations for the development of software or e-learning products. Presently there is little empirical support for the validity of this kind of approach. Therefore the recommendations of Marcus (2005) and Caroli (2005) for one user interface element, navigation, are selected for investigation. Based on their recommendations, the present study aims to identify the effects different navigation styles have on participants originating from cultures featuring either low or high power distance levels.

Another aim is to examine what effect the language used has on an e-learning product. The focus of both inquiries is on how they influence effectiveness and efficiency as well as mental workload and perception of usability.

Method

Study Design

The survey used a 2 x 2 between-subjects design to identify the effects of language (first language vs. English) and navigation (prescribed routes vs. open routes).

Dependent variables were the time required for the completion of the web based training module (duration), subjective assessment of the usability, subjective mental workload and the result of a test which assessed the gained knowledge (achievement). The study was developed as an online experiment.

Participants

The total numbers of persons which took part in the study can be divided in the following three groups: German speaking, Thai speaking and Spanish speaking participants. The participants were recruited primarily in the university environment due to the skills and competences of this group of persons, which are relatively equal to the target group of international e-learning software. The recruiting of the participants was realized in different ways. The German speaking target audience was recruited via email by using a database of persons which were interested in participating online surveys. The link to the online survey was also placed in different academic forums and social network communities in Germany and Switzerland. The Thai- and Spanish-speaking participants were recruited via email from different universities of Thailand, Spain, and different countries of Latin America, where Spanish is the official language. In addition, different forums and social network communities of Thai and Spanish speaking academic groups were used to get subjects for the experiment. As a reward for the participation all subjects had the opportunity to win one of 15 gift cards worth 20 CHF.

A total of 742 persons started the online survey. 363 subjects dropped out on the start screen and generated no data. Due to aspects like non-appropriate first language and

unusually low expenditure of time while completing the web based training module, 52 participants were excluded from further analysis. This group consisted of 12 subjects, who mismatched the required native language and 40 persons who showed a noticeably low duration of less than 100 seconds. 154 subjects dropped out during the online survey and did not generate useable data. Possible reasons for this high dropout rate could be the partial presentation of the survey in English and the high estimated time of 30 minutes needed to complete the survey. The adjusted sample used for the data analysis consisted of 173 participants. Table 1 shows an overview of participants who started, were excluded, who dropped out and were involved in the analysis. The table is broken down by the first language.

Table 1

Summary of Numbers of Participants who Started, were Excluded, who Dropped out and were Involved in the Analysis Broken Bown by Language and Total

	Participants (*N*)			
Language	Started	Excluded	Dropout	Included
German	215	30	64	121
Spanish	67	11	38	18
Thai	92	6	52	34
Other	5	5	-	-
Total	379	52	154	173

Note. Reasons for the exclusion of the participants were improper first language and a duration of the web based training <100 seconds.

The adjusted sample consisted of 114 females (*M* = 29.1 years, *SD* = 9.6; range = 17-64) and 59 males (*M* = 29.2 years, *SD* = 9.7; range = 20-55). An overview of the distribution of sex and age of the participants broken down by first language can be found in Table 2.

Table 2

Summary of the Sex, Number and Age of the Participants Involved in the Analysis Broken Down by Language and Total

	Female				Male				Total			
Language	*N*	*M*	*SD*	Range	*N*	*M*	*SD*	Range	*N*	*M*	*SD*	Range
German	80	29.3	10.3	17-64	41	29.6	10.2	21-55	121	29.3	10.3	17-64
Spanish	10	25.6	4.7	21-27	8	25.9	5	20-40	18	25.6	4.7	20-40
Thai	24	30.2	8.8	19-50	10	28.5	7.8	20-40	34	30.2	8.8	19-50
Total	114	29.1	9.6	17-64	59	29.2	9.7	20-55	173	29.1	9.6	17-64

Note. No.=Number; *M* = Mean; *SD* = Standard Deviation

The computer and internet skills of most of the participants were well developed. The participants ranked their skills on a 7-point scale ranging from very low to very good. The average of the computer skills was 5.12 (SD = 1,29) and of the internet skills 5.43 (SD = 1,36). The e-learning skills were not so well developed (M = 3.59, SD = 1,86). 96.95% of the participants were familiar with the use of the English language. A small number possessed basic knowledge in English (10.9%) or were able to hold a normal conversation (24.85%) whereas most of the subjects stated that they are able to read and understand English technical literature or better (61.2%).

The samples from Spanish and Thai speakers failed to reach a statistically relevant number of subjects. Therefore and for the sake of brevity the main focus is on the German speaking sample.

Apparatus

The online survey was constructed by using the authoring environment Adobe Flash CS3. Adobe Flash CS3 was used to develop a closed system, to embed Thai characters and due to the high penetration of the Adobe Flash Player Version 8. In the mature markets,

including U.S.A., Canada, Germany, U.K., Japan and France, the Flash Player Version 8 has a market penetration of 99%. In emerging markets, including China, South Korea, Russia, India and Taiwan, the rate is 98.6% (Adobe Systems Incorporated, 2008). It is therefore supposable that the software has a similarly high penetration rate in the countries of the participants. To gain the data of the embedded questionnaires and measurements the environment was connected via php-script to a mysql-database.

Preparing the frame for the independent variables

A medium difficulty learning environment about volcanism was designed and implemented as a web based training module. The participants started the survey in one of four different conditions. The first condition presented the survey in English to the subjects and included prescribed routes navigation through the e-learning program. In the second condition the language of the study was still English but the navigation style of the WBT module used open routes. The third and the fourth condition used the first language of the participants and used either navigation with prescribed or open routes.

The participants working with either of the prescribed routes navigation conditions used “back” and “next” buttons to navigate through the WBT module. Subjects provided with open routes navigation could choose topics directly from a content site. They could navigate from topics to the content site by clicking “back to content site”. Within the topics direct navigation to continuative elements was possible by clicking on corresponding pictures. A “back” button was implemented to go back to the previous page. Because of this navigation style a maximum navigation depth of two levels was embedded. An example of an English and a Thai version with prescribed routes is shown in Figure 1. On the contrary Figure 2 shows an example of the content site and a specific topic slide of an English version with open routes navigation.

Figure 1. Samples of open routes navigation in the English and Thai version of the web based training module.

Regardless of the condition, the textual content and layout of each page remained the same. Only the path to the content differed depending on whether navigation with prescribed or open routes was presented. To minimize any confounding influence from the style of presentation the content was developed according to the principles for the design of multimedia learning (Mayer, 2009). For the English content the recommendations for global English by Schell (2007) and language translation issues by Aykin and Milewski (2005) were used to minimize the effects of the differing English skill levels of the participants.

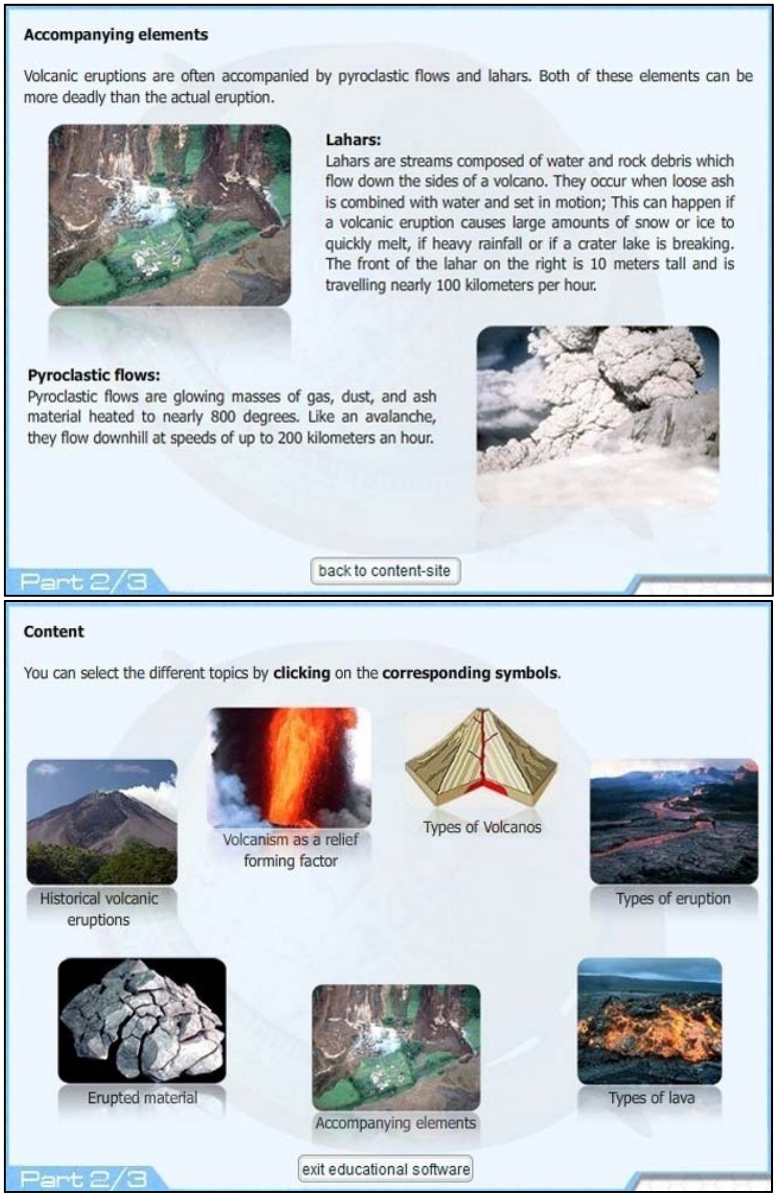

Figure 2. Sample of prescribed routes navigation in the English version of the WBT module. A picture detail shows the content site and a slide of the accompanying elements topic.

Preparing the frame for the dependent variables

Duration. During the work with the WBT module the total duration and the needed time for the several thematic topics was measured using client-side programming.

Usability. Usability was measured using an adapted version of System Usability Scale (SUS) (Brooke, 1996). As the work with the WBT module requires a high lead time, the

usability questionnaire should fulfill conditions of effectiveness and efficiency. With a ten-item scale the SUS was ideal to minimize the overall time and it had a high level of reliability compared to other common usability questionnaires (Tullis & Stetson, 2004). Furthermore the SUS is characterized by asking the user to evaluate the system as a whole and not to evaluate specific aspects of a system. Along with these advantages over other systems the SUS was shown as a highly robust and multifunctional instrument (Bangor, Kortum, & Miller, 2008). To identify minimalistic differences in the target groups, the scale was adapted from a five to seven point scale. To fit the outcome to the SUS score, the calculation formula was adapted to this modification. The term “system” used in the original version of the SUS was replaced with the term “e-learning program”. Table 3 shows the ten questions used in the SUS.

Table 3

Questions of the Adapted System Usability Scale

Number	Question
1	I would like to use this e-learning program more frequently.
2	I found the e-learning program unnecessarily complex.
3	I thought the e-learning program was easy to use.
4	I think I would need Tech Support to be able to use this e-learning program.
5	I found the various functions in this e-learning program were well integrated.
6	I think there was too much inconsistency in this e-learning program.
7	I would imagine that most people would learn to use this e-learning program very quickly.
8	I found the e-learning program very cumbersome to use.
9	I felt very confident using the e-learning program.
10	I needed to learn a lot about this e-learning program before being able to use it effectively.

Note. Subjects reported on a 7-point scale ranging from strongly disagree to strongly agree.

Mental Workload. NASA Task Load Index (NASA TLX) (Hart & Staveland, 1988) was used to measure post-treatment workload estimates from the different participants. This multi-dimensional scale is composed of the following six subscales: mental demand, physical demand, temporal demand, performance, effort, and frustration level. The first three dimensions refer to the demand on the participants and the last three refer to the interellation of participants and the given task.

Originally the subjects had the opportunity to weigh the different dimensions. As this procedure would increase the overall time of the survey, weighting was excluded. Furthermore an analysis of 550 studies, in which NASA-TLX was used, showed that the exclusion of the weighting process is quite common (Hart, 2006). Key benefits of this procedure are that it makes it easier to apply, and results in no substantial loss of sensitivity.

Achievement. At the end of the survey a test consisting of ten questions was included to evaluate the gained knowledge during the web based training module. The quiz was made up of ten multiple choice questions, four of which the participant was required to answer by selecting more than one response.

Procedure

A random generator assigned the participants to one of the four different conditions. After a short introduction to the study, the subjects began the first part of the online survey. They filled out a short demographic questionnaire, stated the number of spoken foreign languages, and ranked their English skills and their international experience. Furthermore they ranked their e-learning experience and their knowledge in the area of volcanism. Afterwards the web based training module started. On the first screens the subjects got an overview about the covered topics, the handling of the navigation and the embedded notes function.

After accomplishment of the module the participants worked out the last part of the survey. They ranked their increase of knowledge in the area of volcanism and ranked the

usability of the web based training. Finally they assessed their mental workload and worked out a short quiz about the topic of the web based training.

Results

Due to the large difference in the number of participants from Germany and Switzerland compared to those speaking Spanish or Thai, a statistical analysis of all three groups was not reasonable. The sample of Spain and Thailand failed to reach a statistical relevant number of subjects. Therefore a statistical analysis was performed only for the German speaking sample.

Results of the German speaking sample

For all statistical tests in the present study an alpha level of .05 was used. All data were checked for normal distribution. If normal distribution did not appear nonparametric tests were used. Table 4 shows all surveyed mean values and standard deviations of all objective and subjective measures in the four presented WBT modules.

Table 4

Objective and Subjective Measures in the Four Web Based Training Modules

	German/open routes (*N*=28)		German/prescribed routes (*N*=39)		English/open routes (*N*=27)		English/prescribed routes (*N*=27)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Objective Measures								
Duration (sec)	541.23	388.25	612.01	445.34	663.24	405.46	507.47	317.29
Achievement	3.93	2.08	4.44	2.38	4.04	1.53	3.70	1.63
Subjective Measures								
SUS	84.64	10.36	84.48	9.44	80.80	17.32	79.25	9.24
NASA-TLX Total	23.68	11.03	25.20	12.77	19.16	12.23	28.12	13.43

Note. *M* = Mean; *SD* = Standard Deviation

Objective performance measures - duration

As mentioned before, all participants who spent less than 100 seconds in the web

based training modules were excluded. This course of action was chosen because a duration of less than 100 seconds indicates an inadequate activity level during the work with the web based training module. Due to a skewed left distribution shape the measured durations were transformed into logarithmic values to achieve a normal distribution. With this procedure the requirements for an analysis of variance (ANOVA) were fulfilled.

To examine differences between the duration of the four presented WBT modules, a one-way ANOVA for unrelated samples was used. The modules German/open routes, German/prescribed routes, English/open routes, English/prescribed formed the independent variable. This analysis was not significant, $F(3, 121) = 1.081$, $p = .360$, indicating that duration was equivalent in the four WBT modules.

To obtain more precise results, the influence of the language of the WBT module (German/English) on the duration was analyzed separately using a one-way ANOVA for unrelated samples. This analysis was not significant, $F(1, 121) = .166$, $p = .684$. Another analysis examined the influence of the navigation used in the WBT module (prescribed routes/open routes) on the duration. This analysis was also not significant, $F(1, 121) = .346$, $p = .557$. The average duration in the different conditions is shown in table 5.

Table 5

Average Duration in s in the Different Conditions

	German		English		Open routes		Prescribed routes	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Duration	582.43	420.86	585.35	369.08	601.13	397.94	569.24	398.62

Note. *M* = Mean; *SD* = Standard Deviation

Objective performance measures – achievement

These data showed no normal distribution. Therefore Kruskal-Wallis one-way analysis of variance was used to examine differences between the numbers of achievement in the

knowledge test of the presented four WBT modules. The four modules were used as the independent variable. This analysis was not significant, $H(3, 121) = 2.07$, $p = .55$.

To receive more precise results Kruskal-Wallis one-way analysis of variance was applied, to analyze the influence of the language of the WBT module (German/English) on the achievement. This analysis was not significant, $H(1, 121) = .98$, $p = .322$. Furthermore the influence of the navigation of the WBT module (prescribed routes/open routes) on the achievement was tested. This analysis was also not significant, $H(1, 121) = .08$, $p = .774$.

Subjective measures – subjective assessment of usability with SUS

These data showed also no normal distribution. Therefore Kruskal-Wallis one-way analysis of variance was used to examine differences in the subjective assessments of usability between the presented four WBT modules. The modules served again as independent variable. No statistically significant differences were found, $H(3, 121) = 6.53$, $p = .088$.

Single comparisons for language and navigation using Kruskal-Wallis showed a significant effect $H(1, 121) = 4.14$, $p = .042$ for language. Participants which worked with a German version of a WBT module assessed the usability higher, whereas subjects who used an English version rated the usability lower. Comparing the influence of the navigation of the WBT module on the subjective assessment of usability no statistical differences were revealed, $H(1, 121) = .59$, $p = .442$.

Subjective measures – subjective assessment of the mental workload with NASA-TLX

To examine differences between the subjective assessments of mental workload of the presented WBT modules a one-way ANOVA for unrelated samples was used. The mental workload was measured by the mean score of the six NASA-TLX subscales. The different modules served as the independent variable. This analysis showed no significant effects, $F(3, 121) = 2.479$, $p = .065$. Table 6 shows the values of the six NASA TLX subscales and the mean score of all subscales.

Table 6

NASA-TLX Mean Score and Average for each Web Based Training Module

	German/open routes		German/prescribed routes		English/open routes		English/prescribed routes	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Mental Demand	38.60	20.86	40.06	23.89	33.75	24.22	43.44	25.20
Physical Demand	10.14	13.55	9.51	14.02	1.5	3.88	7.07	9.04
Temporal Demand	22.69	21.43	20.97	22.22	19.20	21.26	35.14	26.43
Effort	19.50	17.77	20.52	20.05	20.81	17.03	35.92	20.83
Own Performance	39.23	23.35	43.16	22.01	22.81	22.00	28.24	23.97
Frustration Level	11.91	11.86	17.01	22.51	16.88	24.31	18.94	22.42
Nasa TLX Mean	23.68	11.03	25.20	12.77	19.16	12.23	28.12	13.43

Note. *M* = Mean; *SD* = Standard Deviation

Single comparisons for language and navigation using one-way ANOVA showed no significant differences, $F(1, 121) = .158$, $p = .691$ for language. However, for navigation a significant effect appeared, $F(1, 121) = 4.712$, $p = .032$. The subjective assessment of mental workload was lower in the open routes condition compared to the prescribed routes condition.

After taking the subscales into closer account the following differences between the four conditions were noticeable. The temporal demand differed between the four conditions, $F(3, 121) = 2.79$ $p = .04$. The participants of the English/prescribed routes condition rated the temporal demand higher than the subjects who worked with the other conditions.

Conducted single comparisons for the influence of language and navigation on the temporal demand using a one-way ANOVA showed no significant differences, $F(1, 121) = 1.65$, $p = .201$ for language and $(1, 121) = 1.85$, $p = .176$ for navigation respectively.

The self-assessment of each participant's own performance differed between the presented four WBT modules, $F(3, 121) = 5.33$ $p = .002$. The participants who worked with an English web based training module rated their performance better than the subjects who worked with another language, $F(1, 121) = 14.84$ $p = <.001$

Another difference between the four conditions appeared in the assessment of the effort, $F(3, 121) = 4{,}70$ $p = .004$. The participants who worked with an English web based training module rated their effort higher than the subjects who worked with another language, $F(1, 121) = 5.325$ $p = .023$.

Discussion

The aim of this study was to identify if the language used and the navigation style used impacts the effectiveness and efficiency as well as the subjective assessment of mental workload and perception of the usability. Analyzing the results of the German speaking sample, there were no significant differences within the presented web based training modules regarding to duration, achievement of knowledge, mental workload or perception of usability. However, by comparing the different characteristics of the conditions some differences appeared. It was hypothesized that elements presented in the first language of a user will affect the performance and the satisfaction more positively than web based training modules presented in English. Language variation appeared to cause no difference concerning duration or the achievement of knowledge. But the language influenced the subjective assessment of usability. The web based training modules presented in German resulted in a higher assessment of the usability. Another impact of the language used was found during the analysis of the NASA-TLX subscales. Participants working with an English version of a web based training module rated their performance and their effort higher than subjects worked with a module presented in their first language. It is presumed that the good English skills of the participants had an impact on the objective measures. Scoring module usability higher than the other groups, it seems likely that the participants in the German conditions did so on account of their increased familiarity and efficiency when working with their first language. Whorf (1952) assumed that our first language is the “shaper of ideas” (p.5) and Steinfatt (1989) suggested that our first language formed our pattern of thought.

Perhaps the greater demands of working with English text decreased usability. These same aspects could be responsible for the results of the NASA-TLX subscales. Due to working with a foreign language, the participants perhaps thought that they had made greater efforts and performed more strongly, rating themselves higher in both of these categories.

Another aspect of this experiment was to examine the differences between the used navigation styles. It was assumed that navigation with open routes affects participants, like the German speaking sample, belonging to a culture with a low power distance level in different ways. A positive effect on performance and satisfaction was expected. The analysis showed that the chosen navigation style had no effects on the performance measured by the objective aspects duration and achievement. Furthermore there existed no differences between the two navigation styles and the assessment of the usability. However, the kind of navigation showed an effect of the mental workload. Participants working with the open paths showed a lower assessment of mental workload than subjects working with a web based training module with prescribed paths. This result seems to be contradictory, because open routes navigation should request a higher effort for memorizing the chosen path and the visited contents whereas a prescribed route minimizes this effort. However, Marcus (2005) and Caroli (2005) suggested that low power distance cultures would prefer open routes navigation and light explorative learning environments. Maybe this preference had an effect on the mental workload. Furthermore it can be assumed that the participants who worked with an open routes condition are able to recognize the volume and end of a specific topic due to the segmented presentation. This could possibly be because the participant can close the specific topic mentally whereas subjects of the prescribed routes must continue to bear the read contents in mind.

The translation of software is one of the most important steps for the localization of a software product. Depending on the number of target languages and the volume of the used

content financial and time aspects get more relevant. With regard to the German sample group and taking economical aspects into consideration an English version of a web based training module seems to present the best cost-benefit ratio. No differences appeared between the objective measures and the subjective measures differed only minimally.

The navigation style showed no effect on the objective measures either. However, it can be assumed that with the addition of more content the needed time to complete an open-navigation module will increase, and that the chance of missing important content will increase as well.

Study limitations and further research

This study examined the effects of selected navigation styles and language on subjective measurements, like the achievement of knowledge and the needed duration of work with the web based training module as well as the influences on subjective assessment of usability and mental workload. The chosen navigation styles and the languages are only a small part of the elements influencing the success of cultural oriented e-learning products. There is a need to investigate all elements of the approaches of Marcus and Caroli and to take every cultural dimension of Hofstede into account. Therefore the efforts in the research area of cultural influences in the field of human-computer interaction and instructional design should be increased. Due to the growing international markets and target groups from all over the world, cultural oriented design is becoming more and more important.

Another interesting question concerns the dropout rate and low number of participants from Spain and Thailand. Before launching a study in several countries it is important to know how to design an online survey to minimize the dropout rate and maximize the number of participants from other cultures. Further research should therefore try to identify the culturally influenced reasons for a dropout and motives and conditions for persons who are willing to join and finish an online study.

References

Adobe Systems Incorporated. (2008, December). *Adobe - Flash Player Version Penetration.* Retrieved April 1, 2009, from Adobe: http://www.adobe.com/products/player_census/flashplayer/version_penetration.html

Aykin, N., & Milewski, A. E. (2005). Practical Issues and Guidlines for International Information Display. In N. Aykin (Ed.), *Usability and Internationalization of Information Technology* (pp. 21-50). London: Lawrecne Erlbaum.

Bangor, A., Kortum, P. T., & Miller, J. T. (2008, August). An empirical evaluation of the System Usability Scale. *International Journal of Human-Computer Interaction 24 (6)* , pp. 574-594.

Brooke, J. (1996). SUS: a "quick and dirty" usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & A. L. McClelland (Eds.), *Usability Evaluation in Industry* (S. 189 - 194). London: Taylor and Francis.

Caroli, F. (2005). Studieren im globalen Dorf? [Studying in the global village?]. In J. Beneke, & F. Jarman (Eds.), *Interkulturalität in Wissenschaft und Praxis* (pp. 191-209). Hildesheim: Universitätsverlag Hildesheim.

Crystal, D. (2003a). *English as a Global Language* (2nd ed.). Cambridge: Cambridge University Press.

Crystal, D. (2003b). *The Cambridge Encyclopedia of the English Language* (2nd ed.). Cambridge: Cambridge University Press.

Day, D. (1996). Cultural vases of Interface Acceptance: Foundations. *Proceedings of the British Computer Society Human Computer Interaction Specialist Group, People and Computers XI* , pp. 35-47.

del Galdo, E., & Nielsen, J. (Eds.). (1996). *International User Interfaces.* New York: Wiley Computer Publishing.

Dormann, C., & Chisalita, C. (2002). *Cultural Values in Web Site Design.* Retrieved April 12, 2009, from http://www.cs.vu.nl/~martijn/gta/docs/Hofstede-dormann.pdf

Esselink, B. (2000). *A Practical Guide to Localization.* Amsterdam: John Benjamins Publishing Company.

European Commission. (February 2006). *Europeans and their languages.* Retrieved April 10, 2009 from Eurobarometer Speacial Surveys: http://ec.europa.eu/public_opinion/archives/ebs/ebs_243_en.pdf

Fernandes, T. (1995). *Global Interface Design.* San Diego: Academic Press Professional.

Glaser, E. (2003). Fremdsprachenkompetenz in der interkulturellen Zusammenarbeit [Foreign language competency in intercultural cooperation]. In A. Thomas, E.-U. Kinast, & S. Schroll-Machl (Eds.), *Handbuch Interkulturelle Kommunikation und Kooperation Band1: Grundlagen und Praxisfelder* (pp. 74-93). Göttingen: Vandenhoeck & Ruprecht.

Görlach, M. (2002). *Still More Englishes?* Amsterdam: John Benjamins Publishing Company.

Graddol, D. (2006). *English Next.* London: British Council.

Graddol, D. (1997). *The Future of English.* London: British Council.

Hall, E. T. (1959). *The Silent Language.* New York: Doubleday.

Hart, S. G. (2006). NASA-Task Load Index (NASA-TLX); 20 years later. In *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting* (pp. 904-908). Santa Monica: Human Factors & Ergomics Society.

Hart, S. G., & Staveland, L. (1988). Development of NASA task load index TLX: results of empirical and theoretical research. In P. A. Hancock, & N. Meshkati (Eds.), *Human Mental Workload* (S. 139 - 183). Amsterdam: Elsevier Science.

Hofstede, G. (1980). *Culture's Consequences – International Differences in Work Related Values.* London: Sage Publications.

Hofstede, G. (1997). *Cultures and organizations: Software of the mind.* New York: McGraw-Hill.

Hofstede, G. (2001). *Lokales Denken, globales Handeln - Interkulturelle Zusammenarbeit und globales Management (2. Aufl.)[Cultures and Organizations - Software of the Mind (2nd ed.)]*. München: Deutscher Taschenbuch Verlag.

Hofstede, G., & Bond, M. H. (1984). Hofstedes's Culture Dimensions: An Independent Validation Using Rokeach's Value Survey. *Journal of Cross-Cultural Psychology 15 (4)*, S. 417-433.

Jagne, J., & Smith-Atakan, S. G. (2006, November). Cross-cultural interface design strategy. *Universal Access in the Information Society 5(3)* , pp. 299-305.

Kamppuri, M., Bednarik, R., & Tukiainen, M. (2006). The expanding focus of HCI: Case culture. *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles* (S. 405-408). Norway: ACM.

Lommel, A., & Ray, R. (2007). *LISA: Primers.* Retrieved April 12, 2009, from Localization Industry Standard Association: http://www.lisa.org/Globalization-Primer.600.0.html

Marcus, A. (2005). User Interface Design and Culture. In N. Aykin (Ed.), *Usability and Internationalization of Information Technology* (pp. 51-78). London: Lawrence Erlbaum.

Marcus, A., & Gould, E. W. (2000). Crosscurrents: cultural dimensions and global Web user-interface design. *interactions 7(4)* , pp. 32 - 46.

Marschan-Piekkari, R., Welch, D., & Welch, L. (1999). In the shadow: the impact of language on structure, power and communication in the multinational. *International Business Review 8* , pp. 421-440.

Marschan-Piekkari, R., Welch, D., & Welch, L. (1997). Language: The Forgotten Factor in Multinational Management. *European Management Journal 15 (5)* , pp. 591-598.

Mayer, R. E. (2009). *The Cambridge Handbook of Multimedia Learning* (2nd ed.). Cambridge: Cambridge University Press.

Meierkord, C., & Karlfired, K. (2002). Approaching lingua franca communication. In C. Meierkord, & K. Karlfired (Eds.), *Lingua franca communication* (pp. 9-28). Frankfurt: Peter Lang.

Nielsen, J. (Ed.). (1990). *Designing User Interfaces for International Use.* Amsterdam: Elsevier.

Schell, M. (2007). How to Globalize Online Course Content. In A. Edmundson (Ed.), *Globalized E-Learning Culture Challenges* (pp. 155-16). Hershey: Information Science Publishing.

Smith, A., Dunckley, L., French, T., Minocha, S., & Chang, Y. (2004). A process model for developing usable cross-cultural websites. *Interacting with Computers 16 (1)*, pp. 63-91.

Steinfatt, T. M. (1989). Linguistic relativity: A broader view. In S. Ting-Toomey, & F. Korzenny (Eds.), *Language, Communication, and Culture: Current Directions* (pp. 35-75). California: Sage.

The Chinese Culture Connection, (1987). Chinese Values and the Search for Culture-Free Dimensions of Culture. *Journal of Cross-Cultural Psychology 18 (2)* , pp. 143-164.

Trompenaar, F. (1993). *Riding the waves of culture.* London: Nicholas Brealey Publishing.

Tullis, T., & Stetson, J. (June 2004). A Comparison of Questionnaires for Assessing Website Usability. *In Usability Professionals' Association Conference* . Minneapolis, Minnesota, USA.

Weber, G. (1997). The World's 10 most influential languages. *Language Today* , pp. 12-18.

Weber, G. (2008, May). *Top Languages*. Retrieved April 11, 2009, from Andaman Association, Lonely Islands - The Andamanese: http://www.andaman.org/BOOK/reprints/weber/rep-weber.htm

Whorf, B. L. (1952). *Collected Papers in Metalinguistics.* Washington, DC.

Young, P. A. (2008). Integrating Culture in the Design of ICTs. *British Journal of Educational Technology 39(1)* , pp. 6-17.