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WEB-BASED INSTRUCTION FOR HIGH SCHOOL STUDENTS: EXPLORATION OF INDIVIDUAL AND CULTURAL LEARNING STYLES

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ABSTRACT
This study explored learning styles from both individual and cultural perspectives using web-based instruction for high school students as the context. Two web-based instructional systems teaching the same concept and theory of the Global Positioning System (GPS) were developed, each of the instructional systems accommodating different media attributes such as text, audio, and animation. To explore the role of learning styles as individual and cultural attributes, two ethnic groups, European-American (EA) and African-American (AA), were selected as the participants of the study. The Felder-Solomon Learning Style Questionnaire (FSLSQ) was used to measure the individual learning style. Questionnaires administered within a focus group setting were used to measure understandability, motivation, excitement, and ease-of-use for the two different interface designs. As results, AA students preferred a web-based tutorial designed with interface design guidelines that were compatible with their cultural learning preferences. It was observed that no learning style dimensions differed significantly between the two ethnic groups. Also, active and visual learners reported benefit from the AA-based instructional system, which employed multimedia elements such as animation and sound effects involving a greater amount of human-computer interaction.

KEY WORDS
Cultural ergonomics, distance learning, web-based instruction, learning style, individual difference,

1. Introduction

Interest in accommodating diversity in learning environments has increased with the rapid growth of multimedia, hypermedia, and distance learning facilities. Learning environments using these technologies make it possible for instruction to accommodate a wider range of individual learner differences than do conventional learning environments. Although few findings address how best to implement various technologies in the learning environment, most attempts involving empirical studies have focused on college-level engineering education using hypermedia [1, 5].

Individual differences that may contribute to learning processes, other than physical differences such as age and gender, can be categorized as learning styles, cognitive styles, personality types, and cultural differences. Among those, cultural differences and individual learning styles were selected as the elements to be explored for the design of instructional material in this study.

Learning styles are defined as "cognitive, affective, and physiological traits that are relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" [3]. Several learning style inventories are available, such as Kolb's Learning Style Inventory, Myers-Briggs Inventory, and Felder-Solomon Index of Learning Style Questionnaire (FSILSQ). The FSILSQ was designed for use in engineering education and is also easy to answer. Thus, the FSILSQ was used in this study as the learning style measurement tool. Considering the individual learning style inventory and the implications for possible cultural learning styles, two different versions of a unit of web-based instructional material were evaluated through focus group sessions with two ethnic groups of high school students – African-American (AA) and European-American (EA).

2. Method

2.1 Participants

Four sessions of focus groups were conducted to explore and evaluate the two versions of the web-based GPS

tutorials. Two groups consisted of five EA students and three AA students from a high school in Virginia. Another two groups consisted of six EA students and six AA students from a high school in Arkansas. Thus, a total of 20 students participated. Criteria for participation required participants to have completed Algebra 1 and be currently enrolled in any of the local high schools.

2.2 Equipment

Two different versions of the web-based GPS tutorial were prepared. Each version had three different groups of topic contents and delivered the same instructional content, although media attributes were different. One version, called EA-based, presented most information through text and the other, called AA-based, incorporated mostly sound and animation. Several culture-based guidelines were identified and used to design the two versions. A total of 25 different sources were reviewed to identify cultural learning preferences among AA and EA students and to design the tutorial [4]. The example set of guidelines identified and used for the design of tutorial is shown (Table 1).

Table 1. Examples of culture-centered design guidelines [6]

Ethnicity	Category	Culture-Centered Interface Design Guidelines
European American (EA)	Less Humanistic, More Mechanical	Emphasize math and science abstractions.
	Specific Perception	Focus on details of a concept first and then present the global concept
	Analytic, Deductive, Inductive Reasoning	Use less segmentation of information in web-based systems.
	Inquiry and Independent Study	Use many graphics and formulae.
African American (AA)	Humanistic	Use many graphics and formulae.
	Global Perception	Present the overall view or general topic first.
	Holistic Reasoning	Use short page and segmented condition where the information is more explicitly structured.
	Seek Guidance from Teacher	Present lesson clearly with steps toward solution delineated.

The tutorials were developed using Macromedia Flash MX and supportable by web browsers. The FSILSQ, which assesses four learning style dimensions, including active/reflective, verbal/visual, sensitive/intuitive, and global/sequential, was used to measure the learning styles of the participants. The FSILSQ consists of 44 questions with dichotomous choices for answers. The score on each of the eight modalities ranges from 1 to 11.

2.3 Procedure

Before the focus group sessions, parents' permission forms were distributed. The participants also read and signed informed consent forms. The purpose of the focus group was explained to the participants. Each participant was provided with a laptop computer. The two versions were also displayed on a screen using an LCD projector, allowing the moderator to highlight specific portions for discussion.

Prior to the focus group session, the paper-based FSILSQ was administered to all participants. The two versions of the tutorial were placed on the computer screen at the same time in a split screen (one on top and the other on the bottom). The placements were alternated when the topics were changed to minimize order effects. Participants were given 5-7 minutes to explore a group of pages for a topic. After the exploration period, they were asked to complete a questionnaire measuring understandability, excitement, motivation, and ease-of-use for each version of the tutorial on a 5-point scale. A 5-minute discussion followed the questionnaire, allowing participants to discuss the design of the tutorial.

3. Result

European American (EA) and African American (AA) students did not show significantly different preferences on EA-based tutorial. Also, EA students had no significant difference on preference between EA-based tutorial and AA-based tutorial. However, EA and AA students had significantly different satisfaction ratings (cumulative scores from the four questions, e.g., understandable, exciting, motivating, and easy-to-use) on the AA-based tutorial, t (13.2) = 2.36, p<.0342. AA students preferred AA-based tutorial (M = 50, SD = 3.3) to EA-based tutorial

The results of the FSILSQ provided polar scales for four dimensions, with the score of each scale ranging between 1 and 11. For example, the active/reflective dimension has two 1-to-11 point scales, an active and a reflective dimension. Active 11 and reflective 11 have the greatest distance, while active 1 and reflective 1 are immediately proximate. **Figure 1** shows the overall learning style measurements of the 20 participants; the learning styles of the participants are generally more toward active, sensitive, visual, and sequential. The dots represent the average and the grey boxes represent standard deviations. According to t-tests, no dimensions differed significantly between ethnic groups.

shows the categorization of the participants according to the learning style dimensions. There were eight different combinations of each dimension and both AA and EA students have Active/Sensitive/Visual/Sequential learners as the majority group, four and five respectively.

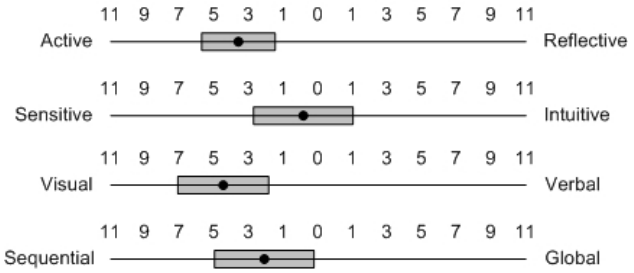

Figure 1. Overall learning style measurements

To investigate relationships between learning style dimensions and the responses to the questionnaire for the two versions of the tutorial, mean rating values were obtained (Table 3). Although AIVeG learner showed some level of difference in ease-of-use, it was not significant because of the small number of observations. Since only AIViG, AIViS, and ASViS learners had multiple participants, a *t*-test was conducted only for those learners. ASViS learners showed a significant difference only in motivation between the two tutorials, $t(16) = -2.46$, $p<.0256$. AIViG learners also showed the significant difference in motivation, $t(4) = -4.15$, $p<.0070$. AIViS learners did not show significant difference on any questions.

4. Discussion

It is noteworthy that, given the small sample size and the fact that our culturally-centered design guidelines for the tutorials are themselves still exploratory, our findings are preliminary. However, these data provide a foundation to continue applying user-centered learning system design using cultural ergonomics as the research approach.

According to a comparison of conventional and hypermedia delivery of instruction [8], the learning style preference showed that active, sensitive, visual, and global learners preferred hypermedia instruction to conventional instruction. The difference between that study and our study is that we compared two versions of hypermedia instruction. One version (EA), based upon culturally-centered learning guidelines, employing text and static graphics along with hyperlinks, while the other (AA) used more animation, sound, and interaction, and less text.

Active/Reflective

Active learners work best in groups and reflective learners work best alone. This assertion agrees with the idea that African-American students seem to work well in groups [7] and shows that the African-American group was closer to active learner designation relative to European-American students. The mean ratings in Table 3

Table 2. Categorization of the participants according to learning style and ethnicity

No	Learning Style Dimension				AA Students	EA Students
1	Active	Intuitive	Verbal	Global	1	0
2	Active	Intuitive	Visual	Global	1	2
3	Active	Intuitive	Visual	Sequential	1	2
4	Active	Sensitive	Visual	Global	1	0
5	Active	Sensitive	Visual	Sequential	4	5
6	Reflective	Intuitive	Visual	Global	0	1
7	Reflective	Sensitive	Verbal	Sequential	1	0
8	Reflective	Sensitive	Visual	Sequential	0	1
Total					9	11

Table 3. Mean ratings of questions based on participants' category according to learning style

Category	EA-based				AA-based			
	Understandable	Exciting	Motivated	Ease of use	Understandable	Exciting	Motivated	Ease of use
AIVeG (*n*=1)	2.33	2.00	2.33	3.67	4.00	4.00	4.00	4.67
AIViG (*n*=3)	2.89	1.67	2.00	4.44	3.33	2.67	3.22	4.44
AIViS (*n*=3)	3.00	1.67	2.00	3.67	3.67	2.89	3.22	3.67
ASViG (*n*=1)	2.33	2.33	2.00	4.33	3.67	4.33	4.33	5.00
ASViS (*n*=9)	3.70	3.41	3.41	4.74	4.11	3.93	4.00	4.78
RIViG (*n*=1)	2.00	1.67	2.00	3.00	4.00	3.67	4.33	4.33
RSVeS (*n*=1)	4.67	2.33	2.00	3.33	4.67	3.67	3.67	4.33
RSViS (*n*=1)	3.67	2.00	1.67	4.00	3.00	3.67	3.33	3.67

*A=Active, R=Reflective, I=Intuitive, S=Sensitive, Ve=Verbal, Vi=Visual, G=Global, S=Sequential

show that active learners benefited more (understandable, exciting, and motivating) than reflective learners (exciting and motivating) from the animated tutorial.

Sensitive/Intuitive
Felder and Silverman [2] indicated that most engineering courses emphasize concepts rather than facts, so intuitive learners are favored. However, this point could not be confirmed in this study, since sensitive learners reported higher understandability than intuitive learners for EA tutorials, t (14.2) = -2.84, p<.0129).

Visual/Verbal
In conventional classrooms, most teaching is delivered through verbal or visual representations of verbal information. In this study, the EA-based tutorial (more text-based) was expected to favor verbal learners, and the AA-based tutorials (more animation-based) favor visual learners. Visual learners rated the AA-based tutorials better in understandability over the EA-based tutorials, t (34) = -2.14, p<.0397.

Sequential/Global
In formal education, most materials are presented in a sequential manner. The characteristic of the sequential/global dimension does not relate directly to the different ways of presenting the two tutorials, since the contents were sequential for both tutorials. Both sequential and global learners rated the AA tutorial better in excitement and motivation. They did not rate either of the tutorials as superior to the other regarding understandability.

5. Conclusion

In this study, ethnicity and culture were presumed to relate to each other. While this assumption may not be valid in other user-centered design contexts, it is socially valid for this specific exploratory context. Active and visual learners reported benefit from the AA-based tutorial, which employed multimedia elements such as animation and sound effects involving a greater amount of human-computer interaction. Also, AA students preferred a web-based tutorial designed with interface design guidelines that were compatible with their cultural learning preferences. Thus, guidelines and principles for the design of computer-based learning environments should be developed to accommodate the needs of students who have different cultures and learning preferences.

Beyond ethnicity, learning styles may very well be the most reliable user attribute to consider when designing web-based learning tools for high school students. From a human factors perspective, the use of learning style may be a more socially acceptable variable to elicit when conducting user testing than ethnicity. Other factors, beyond learning style, may significantly impact the likelihood of equitable benefits of design for all groups. Therefore, continued research from a cultural ergonomics perspective is important. Also, further research should measure students' performance to investigate how successfully the students absorb the information presented in the tutorial in terms of compatibility with their cultural and learning styles.

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