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A Learning Style Perspective to Investigate Students' Perceptions in Choosing the Most-Beneficial Educational Systems

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Abstract: I n recent years, researchers have been engaged in the development of adaptive learning systems that provide the best way for helping individual students improve their learning performance. Among various personal data in student profiles, learning styles have been considered as being one of the factors that need to be taken into account in developing adaptive learning systems. Several studies have shown that, by taking learning styles into account, learning systems can benefit students more owing to the provision of personalized learning procedures or contents that match the cognitive processes of individuals. However, few studies have been conducted on investigating if students have the ability to choose the most-fit e-learning systems for themselves in terms of the learning style perspective; moreover, it is interesting to investigate the factors that affect students in choosing e-learning systems. In this paper, we aim to investigate these issues by using two versions of an educational gamed developed based on the sequential/global dimension of the learning style proposed by Felder and Silverman. A total of 288 students participated in the study. The experimental results showed that, the choices made by the students were not related to their cognitive process or learning styles; instead, most students chose e-learning systems by intuitions based on personal preferences. Such findings not only imply that students might not have the ability to choose the most-beneficial educational systems on their own, but also reveal the importance and necessity of providing scaffoldings and developing adaptive learning systems for guiding the students to learn in a more effective way.

Keywords: learning styles, cognitive process, human factors, educational computer games, adaptive learning

1. Background and Objectives

The provision of personalized or adaptive learning support for individual students has been recognized as being one of the most important features of e-learning systems [1]. By referring to the personal information, the adaptive learning systems can either present personalized content for individual students or guide them to learn by providing a personalized path [2-3]. In the past decade, lots of personalized or adaptive learning systems have been developed based on various personal information of students, such as their profiles (e.g., gender, age, knowledge level, and background data), learning portfolios, and preferences [4-5]. For example, Huang and Yang (2009) designed a semantic Web 2.0 system to support different types of knowledge and adaptive learning [6]. They found that

combining the advantages of blogs and wikis were able to comprehend various types of knowledge and improve students' learning performance. In the meantime, Romero, Ventura and Bra (2009) proposed an advanced architecture for a personalization system to facilitate Web mining [7]. They developed a recommender engine and integrated it into the learning system for recommending to individual students the most appropriate links or Web pages to visit next. Furthermore, Klašnja-Milićević, Vesin, Ivanović and Budimac (2011) proposed a recommendation module of a programming tutoring system, which could automatically adapt to the interests and knowledge levels of learners [8].

Among those factors that affect the provision of personalized learning contents or paths, learning styles have been recognized by researchers as being an important factor [9]. Keefe (1987) stated that "learning style is a consistent way of functioning that reflects the underlying causes of learning behavior"[10]. He further indicated that learning style is both a student characteristic indicating how a student learns and likes to learn, as well as an instructional strategy informing the cognition, context and content of learning [11]. Previous studies have reported that the students' learning performance could be improved if proper learning style dimensions can be taken into consideration when developing adaptive learning systems [9]. For example, Graf, Liu and Kinshuk (2010) investigated the navigational behavior of students in an online course within a learning management system to look at how students with different learning styles prefer to use and learn in such a course. It was found that students with different learning styles used different strategies to learn and navigate through the course [12]. Hauptman and Cohen (2011) examined whether students with a certain learning style would benefit more from earning 3D geometry than other students. Their findings indicated a differential impact of virtual environments on students with different modal and personal learning styles [13].

Although adaptive learning has been widely discussed and has been recognized as being an effective approach for helping students improve their learning performance, few studies have been conducted to investigate whether students can choose the most-fit e-learning systems for themselves. In this study, an experiment has been conducted by providing students two versions of an educational computer game based on the sequential/global dimension of the learning style proposed by Felder and Silverman (1988) to investigate the following research questions [14]:

(1) Can students choose the educational computer games that fit them best from the learning style perspective?

(2) Is there any difference between male and female students in choosing the educational computer games?

(3) What are the factors that affect the students in choosing the educational computer games?

2. Literature Review

There have been several learning style theories proposed by researchers, such as those proposed by Keefe (1979) [15], Kolb (1984) [16] and Felder and Silverman (1988) [14]. Several previous studies have demonstrated the use of learning styles as one of the parameters of providing personalized learning paths or contents. For example, Tseng, Chu, Hwang and Tsai (2008) developed a personalized learning system by taking both the knowledge levels and the learning styles of students into account [3]. Later, Kinshuk, Liu and Graf (2009) propose an adaptive learning approach by analyzing the interactions between students' learning styles, behaviors, and their performance in an online course that was mismatched regarding their learning styles to find out which learners need more help, such that proper learning supports could be provided accordingly [17]. Furthermore,

Bolliger and Supanakorn (2011) examined the effects of learning styles on learner perceptions of the use of interactive online tutorials. Learners were categorized into five learning style categories and four learning modalities. The responses to a questionnaire in terms of survey dimensions were analyzed in order to ascertain differences based on learning style dimensions, gender and class standing [18].

Among those learning style theories, the Felder–Silverman learning style has been widely adopted and has been validated by various studies [19-20]. For example, Filippidis and Tsoukalas (2009) developed a web-based adaptive educational system based on the sequential–global dimension of Felder–Silverman's learning style theory [9]. The adaptive learning system provides different versions of images to present the same content with different detailed levels; that is, a detailed version of the images is given for the sequential learning style students, while a non-detailed version is presented to the global learning style students. Therefore, in this study, two versions of an educational computer game are developed based on the sequential/global dimension for investigating the students' ability and decision-making process in choosing the most-fit learning system.

3. Experiment Design

3.1 Participants

As the educational computer games were developed for an elementary school natural science course, a total of 288 in an elementary school of southern Taiwan voluntarily participated in the study. All of the students were taught by the same instructor who had taught that natural science course for more than ten years.

3.2 Measuring Tools

The measuring tool adopted in this study was the Index of Learning Styles (ILS) Questionnaire developed by Soloman and Felder (2001) [21]based on the learning styles proposed by Felder and Silverman (1988)[14]. The ILS measure consists of four dimensions, that is, sensing/intuitive, visual/verbal, active/reflective and sequential/global, each of which contains 11 items. In this study, the "sequential/global" dimension was adopted. Some of the questionnaire items of this dimension are "I tend to (a) understand details of a subject but may be fuzzy about its overall structure. (b) understand the overall structure but may be fuzzy about details." and "Once I understand (a) all the parts, I understand the whole thing. (b) the whole thing, I see how the parts fits." Choosing "a" indicates that the tendency degree of "sequential" is increased; otherwise, the tendency degree of "global" is increased.

3.3 Sequential and Global Style Educational computer games

In this study, two versions of an educational computer game are developed for the "knowing the plants on school campus" unit of an elementary school natural science course based on the sequential/global dimension of the Felder–Silverman learning style. The objective of the subject unit is to foster the students' competence in identifying and differentiating a set of target plants.

The game was implemented by employing the RPG Maker developed by Enterbrain Incorporation. The background of the game is about an ancient kingdom in which the people are infected by poisoned water in a river. Following the hints from an ancient medical book, the king decides to look for the plants that are able to cure his people.

The game designed for sequential style learners provides a "step-by-step" interface to guide the students of this style to complete the learning missions since they tend to think linearly and learn in small incremental steps [14]. Figure 1 shows the interface of the sequential style game. The learners are guided by this version of the educational computer game to the next mission only after the present mission has been completed.

Figure 1. The sequential style game

On the other hand, the global style game provides a "global mission map" that enables the students to select any mission or jump to any game scene since they tend to learn with holistic thinking processes in large leaps [14]. Figure 2 shows the interface of the global style version of the educational computer game.

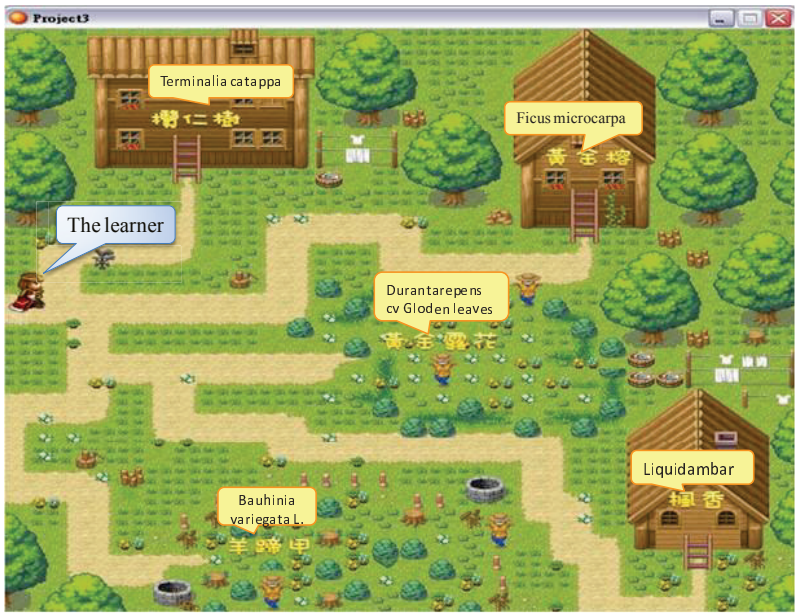

Figure 2. The global style game

3.4 Experiment Procedures

Before the experiment, the students took the learning style questionnaire for categorizing them into sequential or global style. Following that, a one-hour presentation was made by the teacher to show them the two versions of the educational computer game, including the differences and similarities between the two versions; moreover, the students were informed that the two versions of the game had identical content related to the "knowing the plants" unit of the natural science course. After the presentation, the students were asked to make the choice between the two versions of the game and write down the reasons for the choice.

4. Results

4.1 Relationships between students' learning styles and their choices of the e-learning systems

From the learning style questionnaire result, it was found that 134 of the participants were sequential style students, while 154 of them were of global style. Table 1 shows the ratio of the choices made by the different learning style students. It is found that 86.1% of the students chose the global style system, while only 13.9% of them chose the sequential style system; that is, most of the students prefer the global style version of the educational computer game. Moreover, 86.5% of the sequential style students chose the global style system and only 14.3% of the global style students chose the sequential style system.

Table 1. Descriptive data of students' learning styles and their choices of the educational computer game

		Choices of the educational computer game		Total
		Sequential	Global	
Students' Learning Style	Sequential	18 (13.5%)	116 **(86.5%)**	134
	Global	22 (14.3%)	132 (85.7%)	154
Total		40 (13.9%)	248 **(86.1%)**	288

To further investigate the relationships between students' learning styles and their choice of the educational game, the Chi-Square analysis was applied to the questionnaire data, as shown in Table 2. It is found that the correlation between the students' learning styles and their choice of the learning systems was not statistically significant ($r = 0.44$, $p>.05$). Consequently, it is concluded that the choices made by the students were not related to their learning styles; that is, the students did not choose the educational games by considering the underlying needs for learning effectiveness.

Table 2. The Chi-Square result of students' learning styles and their choices of the educational games

	Value	df	Asymp.Sig. (2-sided)
Pearson Chi-Square	.044	1	.835
Likelihood Ratio	.044	1	.835
Linear-by-Linear Association	.043	1	.835
N of Valid Cases	288		

4.2 Relationships between genders

Table 3 shows the descriptive data of male (N = 158) and female (N = 130) students in choosing the two versions of the educational computer game. It is found that 137 out of 154 male students and 121 out of 130 female students chose the global style system, indicating that both the male and the female students prefer the global style version of the educational computer game. Moreover, it was found that 81.1% of the male sequential style students (60 out of 74) and 93.3% of the female sequential style students (56 out of 60) chose the global style game.

Table 3. Descriptive data of students of different genders in choosing the educational computer games

			Choices of the educational computer game		
Gender			Sequential	Global	Total
Male (N = 154)	Learning Style	Sequential	14 (18.9%)	60 (81.1%)	74
		Global	17 (20.3%)	67 (79.7%)	84
Female (N = 130)	Learning Style	Sequential	4 (6.7%)	56 (93.3%)	60
		Global	5 (7.2%)	65 (92.8%)	70
	Total		40 (13.9%)	248 (86.1%)	288

By applying the Chi-Square analysis, it is found that the correlations between the choices of the educational computer games and the learning styles of male and female students are $r = 0.43$ ($p>.05$) and $r = 0.11$ ($p>.05$), respectively, which were not statistically significant. Consequently, it is concluded that, for both genders, the choices of the educational computer games were not related to their learning styles.

4.3 The factors that affect the students in choosing the educational computer games

In order to investigate the factors that affect the students in choosing the educational computer games, the feedback from the students were analyzed. Table 4 shows descriptive statistics of the feedback from the students in stating the reasons for making the choices. It was found that 73.9% of the participants response that "The game I chose looks more interesting than the other"; 71.7% of the participants made choices because they felt that "The game I chose looks more relaxing"; 65.2% of the participants addressed that "Such an operational interface conforms to my previous experiences of playing game" and 66.7% of the participants stated that "The design of the game seems to be easier to operate".

To sum up, the factors that affect the students in choosing the educational computer games include "interesting", "relaxing", "ease of use" and "conforming to previous experiences", which are irrelevant to the cognitive process of individual students with different learning styles. Consequently, it is necessary to develop adaptive learning systems for guiding the students to learn in an appropriate way, including proving personalized learning interface or paths to present learning content in the most beneficial manner for individual students with different learning styles.

Table 4. Descriptive statistics of factors that affect students in choosing educational computer games

Factors		Global style students who chose sequential style game (N = 116)		Sequential style students who chose Global style game (N = 22)		Total (N=138)	
1.	The game I chose looks more interesting than the other.	86	(74.1%)	16	(72.7%)	102	(73.9%)
2.	The game I chose looks more relaxing.	84	(72.4%)	15	(68.2%)	99	(71.7%)
3.	Such an operational interface conforms to my previous experiences of playing game	74	(63.8%)	16	(72.7%)	90	(65.2%)
4.	The design of the game seems to be easier to operate.	75	(64.7%)	17	(77.3%)	92	(66.7%)

5. Discussion and Conclusions

In this study, we investigate students' perceptions in choosing the most-beneficial educational systems from the perspective of learning styles. The participants were asked selected one of the two versions of an educational gamed developed based on the sequential/global dimension of the learning style proposed by Felder and Silverman. The experimental results on 288 students showed that, the choices made by the students were not related to their cognitive process or learning styles; instead, most students choose e-learning systems based on intuitions or preferences, such as "interesting", "relaxing", "ease of use" and "conforming to previous experiences". Such findings provide a possible explanation to what was reported by Wang and Chen (2010) that choosing educational computer games based on preferences does not benefit the students since the choices did not comply with the students' cognitive process or learning styles [22].

Furthermore, the findings also reveal the importance of providing learning supports and developing adaptive learning systems to help the students learn in a most beneficial scenario by taking the cognitive process or learning styles of individual students into consideration. That is, this study gives an evidence for supporting the development of adaptive learning systems; in particular, for those studies that employ learning styles as a factor for adapting learning content, presentation styles and learning paths for individual students.

On the other hand, although this study showed some significant experimental results, the use of the computer educational games in this study might not be able to represent the common features of most learning systems; moreover, the implication of this study is limited owing to the investigation was conducted on only one dimension of a learning style. In the future, more studies are needed for investigating relevant issues using various learning systems by taking different learning dimensions into account.

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