

Effects on Cognitive Styles in Student Achievement for Context-Aware Ubiquitous Learning

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Abstract: In recent years, with the steady development of mobile and sensor technologies, the method of e-learning has gradually migrated to mobile learning, and even to context-aware ubiquitous learning. However, few evidence to show that all students can benefit from this new type of ubiquitous learning. This could therefore be an issue worth discussing further. Meanwhile, cognitive styles have often been regarded in much of the research as a factor which could impact learners' efficacy in the e-learning environment. Hence, a butterfly-identification learning activity was designed to lead students to identify butterflies in an authentic environment embedded with sensors and wireless technology. Based on the purpose of the study, we attempt to investigate what differences there are among the distinct cognitive styles of the learners. As the experimental results shown, field-independent learners have superior learning achievement to field-dependent learners. Thus, a proper learning activity needs to be designed for field-dependent learners once a context-aware ubiquitous learning environment is introduced.

Keywords: cognitive style, field independence, field dependence, mobile learning, context-aware ubiquitous learning

1. Introduction

Educationalists believe that knowledge is derived from interaction with the authentic world, allowing the accumulation and construction of personal experiences. Thus, constructivists argue that learning meaningful knowledge has a strong connection with the context in which people are located [1]. Within an authentic context, learners can practice and operate by themselves with learned theories and concepts. It is critical for learners to obtain experiences through learning by doing. That is, this process not only helps learners to reflect on what they have learned before, but also enhances their problem-solving abilities when they meet similar problems or contexts. Practice and operation might be carried out in the classroom through simulation, but the learning effect would not be as good as if it took place in an authentic context [2-3].

With the advancement of wireless communication and mobile techniques, such as Radio Frequency Identification (RFID), have been used to sense environmental conditions (e.g. temperature, humidity, etc.) and personal conditions (e.g. temperature, location, etc.), which can be used to identify the situations of individual learners in the real world [4]. In such a learning environment, learners are allowed to access digital materials via the mobile device with wireless communication facility; moreover, the system can detect learners' conditions and context parameters, and offer personalized service (e.g. teaching materials, assessment, etc.) to individual learners accordingly. Researchers have called such a learning scenario *context-aware ubiquitous learning* (context-aware u-learning) [4, 5, 6].

However, there is few evidence to show whether all students or some specific feature group which participates in context-aware u-learning activities can obtain benefits when the new type of learning is introduced, which is an issue worth further discussion.

Therefore, we attempt to investigate whether or not a person's cognitive style will affect his/her learning efficacy in the context-aware u-learning environment. In terms of cognitive styles, researchers [7] have described how the individual acquires knowledge (cognition) and processes information. Cognitive styles are related to mental behaviors which individuals apply habitually when they are solving problems. In general, they affect the way in which information from the real world is obtained, sorted, and utilized [8].

In much of the research on cognitive styles, field dependence and field independence (Field Dependent/Independent, FDI) are most noted by researchers, and are often applied to deal with educational issues [9]. FDI are two opposing cognitive behaviors that can be identified by independence. The differences between field dependence and field independence are described as follows [10, 11]:

- (1) Separation between the self and the environment: Field-dependent learners notice a lack of structure in the environment (field) and are more affected by it than other people. On the contrary, field-independent learners have the ability to discern their own identity of self from the field.
- (2) Social interactions: People who are field-dependent are frequently described as being very interpersonal and like to work collaboratively on tasks with classmates, and prefer teachers' assistance. By contrast, individuals who are field-independent prefer to work alone without teachers' assistance.
- (3) Learning behaviors: The learning course must be explained more explicitly to field-dependent learners who favor a story-telling approach. On the other hand, field-independent learners emphasize the conceptualization of the course and prefer the discovery learning approach.
- (4) Learning motivation: Field-dependent learners can be motivated by praise from teachers or classmates, while Field-independent learners can be motivated by competition between classmates, exploring new tasks and self-encouragement.

The differences between FDI could have strong links with the new type of learning. In this study we attempt to investigate the learning effects of FDI students in the context-aware u-learning environment.

2. Research Design

Totally 21 fifth-grade elementary school students participated as subjects in the experiment, including 10 field-independent and 11 field-dependent learners. The learning activity took place in the butterfly ecology garden. The students were guided to observe the ecology of butterflies with a PDA equipped with a RFID reader, which can sense the RFID tags on the butterfly food plants, as shown in Figure 1.

After observing the butterflies and the corresponding food plants, the students were asked to produce a summary of their findings. During the observation process, the system shows hints or traits that experts suggest to students (Figure 2), and shows butterfly information to students for reference (Figure 3). The students have to complete all of the descriptions of the traits for each butterfly and the relevant food plants (Figure 4). Figure 5 shows an illustrative example of a completed learning mission.



Figure 1. PDA-based Learning Scenario in Butterfly Ecology Garden



Figure 2. Show hints for observing appointed butterfly.



Figure 3. Show butterfly information for reference.

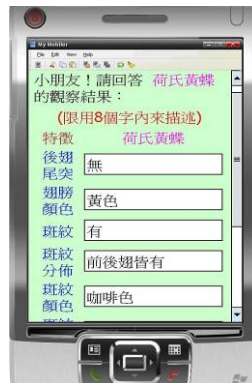


Figure 4. Complete all of the traits for each butterfly.



Figure 5. A completed personal repertory grid.

3. Experimental Results and Analysis

The study paid much attention to the differences between field-dependent (FD) and field-independent (FI) students in the context-aware u-learning environment. The experimental results for the two groups were analyzed statistically using the Independent-Samples t-test, and the confidence interval reached 95%, as shown in Table 1. As for the pretest, the mean score for FI and FD were 79.4 and 76.91, respectively. Although the score for FI was higher than the score for FD, it was not significant ($p > 0.05$). However, in terms of the posttest, the score means of FI and FD were 78.4 and 67.64, respectively. Obviously, the FI students made greater progress than the FD students. Moreover, it is significant statistically ($F = 7.299, p < 0.05$). That is, the FI students have achieved significant greater learning efficacy than the FD students in the context-aware u-learning environment.

Table 1. Independent-Samples t-Test of pretest and posttest for the FI and FD groups

	Cognitive style	N	Mean	Std. deviation	F	t
Pre-test	FI	10	79.40	11.078	1.036	0.563
	FD	11	76.91	9.181		
Post-test	FI	10	78.40	13.426	7.299	2.434(*)
	FD	11	67.64	4.105		

* $p < 0.05$

4. Conclusion

With the steady development of mobile and sensor technologies, the method of e-learning has gradually migrated to mobile learning, and even to context-aware ubiquitous learning. However, there has been no evidence to date to indicate whether all students can benefit from this new type of ubiquitous learning. Meanwhile, cognitive styles, especially field-dependent (FD) and field independent (FI) styles have often been regarded as a factor affecting learners' efficacy in the e-learning environment. In this study, we have attempted to investigate the differences between FD and FI students in terms of their learning efficacy in a context-aware u-learning environment. For the purpose of the study, a butterfly-ecology u-learning context was constructed, and the students used the repertory grid (RG) technique to facilitate knowledge construction. The experimental results indicate that FI students have more significant improvement than FD students in this environment, a result which is consistent with the results of much of the past research in traditional education [12]. Meanwhile, the results of this study also suggest that more consideration for FD students in a context-aware u-learning environment must be shown, in order to facilitate their adaptation to this new type of learning.

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