The Relationship between Learner Characteristic and Interest in Teachable Agent

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Abstract The traditional intelligent teachable system has mainly focused on knowledge and cognition. It has overlooked motivational aspects of learners. Motivation is an important factor in learning making learners to have interests in a given task and persist it. Although the systems include cognitive as well as motivational factors, the effects of ITS on interest are not equivalent depending on individual characteristics. This study is to investigate how influence learners' response patterns to their interests and also examined effects of individual characteristics on interest in teachable agent (TA). In this experiment, we used KORI which is a new type of ITS that learner teach computer agent based on the instructional method of 'learning by teaching'. In the beginning of experiments, metacognition, achievement goal orientation and self-efficacy were measured as individual characteristics. Then, participants were asked to use KORI at home during 10 days. After using KORI the level of interest were measured. The result showed that metacognition was positively related with interest, whereas performance goal orientation and mastery goal orientation were negatively related to interest. It suggests that different individual characteristics should be considered to promote learners' intrinsic motivation in TA.

Key words: Intelligent tutoring system; motivation; individualization; individual difference

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1. Introduction

The researchers in the field of cognitive science and learning science suggest that intelligent tutoring system induces the effective learning. It helps learners to assess and use knowledge effectively so that it improves learning outcomes (Corbett & Anderson, 1995). However, the traditional intelligent tutoring system has a limitation in that it mainly focused on knowledge and cognition (Baker, Roll, Corbett & Koedinger, 2005). Also it makes learners to process the upcoming information passively; it has overlooked motivational aspects of learners.

In recent year, lots of research findings have shown the effects of motivation, attitudes, and learning environments. Motivation plays a critical role to persist on learning, and shows the task interest, so it is more beneficial in ITS. In order to motivate the learners offering them a chance to take an active role in learning is important.

One way of providing the learners opportunities to attain motivation is the learner to have a tutor role which gives responsibility, a feeling of engagement, and situational interest to persist in learning (Kim et al., 2003). Bargh and Schul (1980) reported that teaching activity could induce elaborative and meaningful learning and enhance motivation to learn. According to the beneficial effects of teaching activity on motivation, teachable agent (TA) has developed to enhance cognition and motivation in learning. TA is one of the new concept of ITS that students teach computer agent based on the instructional method of 'learning by teaching'. Through TA, the learner was provided an active role and gained positive attitude toward the subject matter. So, the agent offers learners to acquire deeper learning and it leads learners to motivate (Davis et al., 2003).

In addition, to encourage the learners' motivation to learn in TA, motivational factors should be included when interface in teachable agent is designed. According to motivation theory (Deci & Ryan, 1985), autonomy and self-efficacy are basic needs that affect motivation. At first, to enhance the user's autonomy and self-determination, various choice situations are given to make a decision by themselves. For example, providing learners choices of what they learn and which condition or stage they take makes them be more motivated. Also, controllability encourages learners to determine how long they persist in the learning process. Those motivational factors were included in TA make the users engage in learning activity more deeply persist it longer.

Also self-efficacy is known to be directly related to intrinsic motivation or interest (Bandura, 1982; Deci, 1975). The concept of self-efficacy is the belief in oneself having a capability. Self-efficacy is or can be affected by feedback. For instance, the negative feedback is known to reduce self-efficacy, especially the normative feedback. Thus, to motivate learners, interface of TA has to focus on task-related feedback or informative feedback rather than normative feedback.

Another limitation of the traditional ITS is that it did not consider individual differences of various levels of cognitive ability and motivation. Even though TA was well-structured including cognitive and motivational factors, the effects of the system are not equivalent for all learners.

For example, depending on the level of metacognitive ability, the effects of TA draw different influences, such as a learner who has low metacognition suffer and feel difficulty to organize teaching and monitor their own learning using the same interface with a learner with high metacognition.

Also, individual differences of motivational characteristic might affect interest as using TA. One of the individual characteristics, achievement goal orientation is critical factor influencing on intrinsic motivation or interest. The concept of achievement goal orientation is about individual personality and preference toward motivation to learn. Dweck and Leggtt (1988) classified two major goal orientations: performance goal orientation and mastery goal orientation. The learner who has performance goal orientation desires to demonstrate their own ability by comparing to others and they tend to avoid negative feedback. On the other hand, mastery goal orientated people focus on the development of skill and task itself. Two types of goal orientation are expected to have different effects on interest in TA. And as mentioned above, self-efficacy is also an essential individual characteristic on motivation to learn. According to previous researches, levels of self-efficacy caused different performance achievement and intrinsic motivation differently (Bandura, 1982; Deci & Ryan, 1987).

In order to enhance interest of each learner and encourage motivation, first, individual differences should be measured (Kim et al., 2005). And consider the individual differences when designing interface of ITS.

2. Experiment

The experiment was conducted in order to investigate what kinds of learners' response patterns predict their interests in a given task. Also, the effects of individual characteristics on interest in TA were examined.

2.1 Method

2.1.1 Participants

Forty (20males, 20females) fifth graders participated in this experiment.

2.1.2 Material

KORI (KOREa university Intelligent agent) was used in this study as the TA. KORI is the intelligent agent that is developed to enhance learners' motivation and to facilitate learning. The content of KORI is constituted of 'rock and rock cycle' and it was revised to be suitable for fifth graders. KORI program has a way to motivate users through 'learning by teaching' instructional method which gives learners an active role as a tutor in order to make the user engage in the learning. A learner becomes a teacher of KORI who is an artificial tutee.

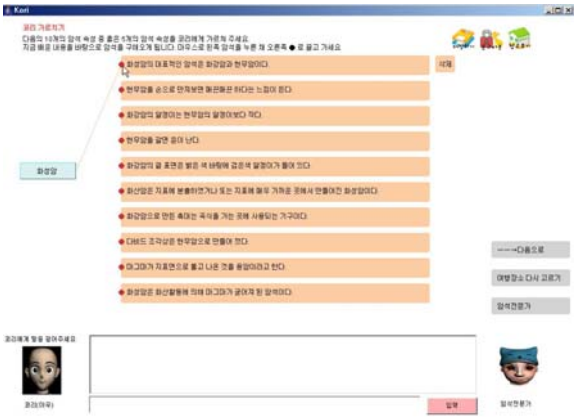

Figure 1: The interface of KORI (teaching stage)

To promote motivational aspects, it also has narrative structure with fantasy. It causes the user to have greater situational interest and motivation (Cordova & Lepper, 1996).

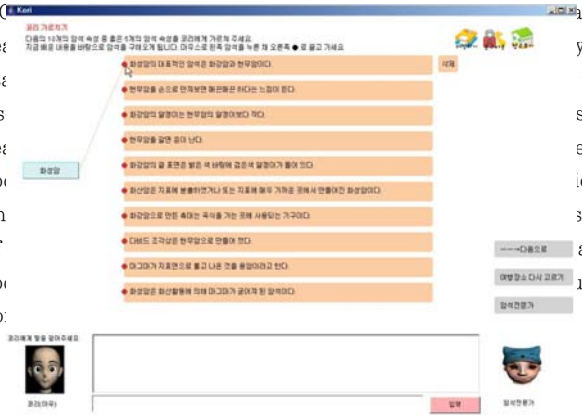

Figure 1: The interface of KORI (teaching stage)

ts the building using collected rocks.

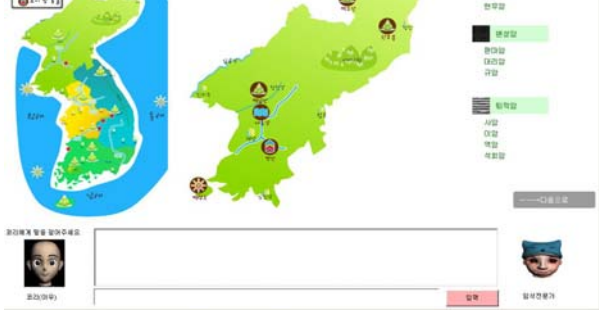

Figure 2: the interface of KORI (planning stage)

2.1.3 Procedure

Before the experiment, individual characteristics of participants were measured by questionnaire such as metacognition, performance goal orientation, mastery goal orientation and self-efficacy. Participants took the instruction how to use KORI program for 30 minutes. After the explanation they exercise the KORI themselves. During the experiment, participants were asked to take the program at least 20 minutes every day at home during 10 days. While participants used KORI program, log data were collected through the network. After the experiment, the levels of interest were asked by a questionnaire on KORI program and contents.

2.1.4 Measures

Learner responses were collected by log data as KORI program usage. It was measured by two types of behaviors: frequency and duration. Frequency was calculated by how often they logged in the KORI program and duration was computed how long they engaged the program during the experiment.

For individual characteristics, four variables were assessed. The measurement of metacognitive skill consisted of a set of self-report questions including 14 items and the reliability was .87. Both achievement goal orientations (Performance goal orientation & mastery goal orientation) were measured using each subscale of achievement goal orientation measure (Park & Lee, 2005). Measurement of performance goal orientation included 5 items and its reliability was .70, and that of mastery goal orientation included 6 items and reliability coefficient was .74. Self-efficacy was measured by using a scale for self-efficacy (Kim & Park, 2001). It has 10 statements which is the belief in oneself as capable of producing desired outcomes. Its reliability was .87. All of the measurements were adjusted for children.

The post experimental questionnaire to measure the level of interest included 10 items. 6 items asked enjoyment and interests in the activity and content, and 4 items asked the feeling of the satisfaction and challenge. Reliability coefficient of interest questionnaire was .89

2.2 Results

2.2.1 Log-data analysis

In the first analysis, the model tested the learner's behaviors on interest. Independent variables explained 21% of variance in interest (F= 4.86, p<.05). Through the multiple regression analysis, both frequency and duration on program made a unique contribution to prediction of interest (see Table 1).

Table 1: regression analysis with behaviors of learner

Independent variables	β	t
Frequency of login	0.13	0.76
Duration	0.37	2.22*

Dependent variable: interest, *p<.05, $R^{2=}$0.21, F= 4.86. Independent variables appear in the order in which they were entered into the model.

2.2.2. Regression analysis

To evaluate what kind of individual characteristics predict interest, the multiple regression analysis was conducted including all of individual characteristics. The 40% of variance in interest was explained by the individual variables. Interest was shown to be relate to three individual characteristics which are metacognition, mastery goal orientation, and performance goal orientation (F= 5.93, p<.05). Metacognition (β =.09, p<.05) was positively related to task interest, whereas performance goal orientation (β =.-.35 p<.05) and mastery goal orientation (β =-.70, p<.05) were shown to be negatively related to interest (see Table 2). However, self-efficacy did not make a significant contribution to the prediction of interest (p>.05).

Table 2: regression analysis with individual characteristics

Independent variables	β	t
Metacognition	0.90	4.22*
Performance goal orientation	-0.35	-2.62*
Mastery goal orientation	-0.70	-3.20*
Self-efficacy	0.01	0.08

Dependent variable: Interest, *p<.05. $R^{2=}$0.40, F= 5.93. Independent variables appear in the order in which they were entered into the model.

3. Discussion

Interest was explained by learners' responses such as frequency of login and duration as they using KORI. It accounted that the higher frequency a learner shown and the longer time a leaner spent to engage in the learning program, the more opportunities the learner felt interest. How frequently engaged in and how long persist in the program could explain the level of learners' interest. It indicated that when the learners are interested in using program, they were explored more. Thus, one way of measuring the interest is to find out the learner response in the system.

In addition, it was examined the effects of individual characteristics on interest by multiple regression analysis. As the result, the effects of KORI on interest were different depending on the individual characteristics. Metacognition emerged as one of the predictor of interest. Metacognitive skill is a critical factor in learning process. It consists of planning, monitoring, strategy use, and evaluation on their learning process. When they engaged in KORI program, learners organized activities by themselves. For examples, they set up strategies such as where they trip and what kinds of rocks they purchase, and what kinds of buildings they construct and so on. Through these activities, the learner with high metacognition feels interest.

On the other hand, interest was found to have negative correlation with performance goal orientation and mastery goal orientation. In particular, the learner with performance goal orientation focused on the outcomes of learning rather than processes (Elliot & Dweck, 1988). Therefore, they are willing to know information directly rather than perform additional activities. However, they have to do diverse activities to get the information when they use KORI. Through the extra activities, task interest might be reduced on learners with high performance goal orientation. Another possible account for why performance goal orientation was correlated negatively to interest is that performance goal oriented learners like to demonstrate their worth and ability externally and concern the social comparison (Dweck & Leggtt, 1988). In KORI program, regardless of getting feedback, they had fewer opportunities to display their levels of achievement to others and could not compare with other, because they used KORI at home. Therefore, highly performance oriented learners who desire to demonstrate their ability might find less interest when they use KORI program.

On the other side, mastery goal orientated people seeks

challenges and show high persistence in learning. Also, they tend to engage more deeply in learning. Though intelligent agent provides the opportunities to see the additional information by hyperlink, the information could be not enough for them, and more advanced level of information might be needed.

Developing teachable agent is a key concept to make an high metacognitive skills might experience interest through the interface consisting of diverse activities such as planning and monitoring module. On the contrary, it will be too difficult to control for learners with low metacognition. Then interface has to be altered by decreasing the activities which demands too much metacognitive ability. Also, when considering the characteristics of highly performance oriented learner, the interface should be simple as much as they gain learning outcome easily and display their performance well in order to maintain their interest. Conversely, to satisfy learning goal oriented learner, the interface should be equipped with more diverse levels of task that enables learners to be involved in deep learning.

It suggests that recognizing individual differences in learners' motivation and trying to design the interface in accordance with these variances may lead to make better motivational design in TA.

4. Conclusion

This study investigated learners' behavior patterns indicating their interests in a given task, such as the frequency they logged in and the time they spent in a program. However, the results of experiment showed that the effects of TA could vary depending on participants' individual differences in meta-cognition, performance goal orientation and mastery goal orientation. It also indicated that individual characteristic influenced user' s interest when using the TA. In order to design interface of TA motivating all of learners, individual differences should be primarily considered.

4.1 Acknowledgments

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As discussed above, the effects of TA on interest are dissimilar depending on individual differences. The learners with

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