<Enhancing learners' motivation through the Intelligent Tutoring System>

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Abstract

The major limitation of the traditional Intelligent Tutoring Systems (ITS) is that interface is mainly focused on the cognitive factors. However, the new direction of ITS is shifting form the cognitive perspectives to the motivational perspectives reflecting the individual differences. In this study, the specific design guidelines for motivational interface of ITS are proposed to promote learner's motivation to learn during the interaction with the ITS. First, ITS should be able to reflect individual differences in cognitive abilities, interest and motivation, and ongoing changes of the interestingness and comprehensibility during learning activities. Second, it is essential for ITS to guarantee learner controllability, diverse learning activities, curiosity, self-relevance, and challenge to enhance the level of motivation and situational interest. Third, the game-like properties are also needed to maximize the motivational effect of learning with ITS.

Keyword : Intelligent Tutoring System, Motivation, Interest

1. INTRODUCTION

As the technologies and computer skills have been developed, a lot of learning scientists, cognitive scientists, and computer scientists have tried to use computer and network technologies in learning and develop intelligent learning tools. Intelligent Tutoring System (ITS) is one of those tools. ITS makes new environment in classroom situation, which is adaptive to each learner's level. ITS is a powerful and effective tool in human learning (Chen, 2005). It contributed to better understanding of cognitive process that is related to learning specific skills and knowledge. As a result, ITS was developed as adaptive instructional systems. Because of developing ITS, learners can learn by doing, receive feedback and understand new knowledge adaptively (Barron et al., 1998). Computer performing the cognitive role led learners to make, enrich, manipulate and change their thoughts through the ITS.

Most of ITS have mainly focused on developing and enhancing cognitive aspects in learning such as metacognition, knowledge acquisition and working memory (e, g., Papanikolaou, 2002; Wild, 1998; Brusilovsky, 1999; Lin, 2001; Liu et al., 1999), whereas the motivational aspects of learning have been overlooked relatively.

However, recent theories on motivation such as self-efficacy and goal orientations are found to be a good predictor for learning behavior. (Yi, 2002).

The aim of learning is not only causing cognitive change (Wild, 1998), but also encouraging learning

persistence deeply. Intrinsic motivation is associated with deep level learning (Ryan & Deci, 2000; Cordova & Lepper, 1996). Thus, developing ITS should be designed and implemented with motivational factors such as individual differences, situational interests and game like properties as well as cognitive factors. This is related to be adaptive to each individual learner enhancing and promoting motivation and interest during learning.

In order to increase motivation in ITS, the specific design guidelines and variables were proposed and described in terms of three dimensions: individualization, motivation and situational interest, and the game-like properties.

2. INDIVIDUALIZATION

In ITS environment, teaching activity facilitates not only deeper understanding of the learning but also enhances learning motivation (Bargh & Schul, 1980). Although these activities of tutoring situation enhance cognitive ability of learners, effects of the system are not the same for the all learners. Regardless of the individual differences, the identical interface might not only be less effective in cognitive aspects of learning but also less interesting in terms of motivational aspects of learning. At the level of the individual learner, it is important to understand learners' learning styles to make individualized ITS. Learning is decided based on learner's background, including acquire knowledge (Wild & Quinn, 1998) and individual learner prefer to do differently depending on their achievement ability (Baker, 2004). Therefore, individualization is the key concept in ITS in order to respond adaptively to individual learner, which reflects individual differences in the level of cognition and motivation, and its ongoing changes.

The developing ITS would be an adaptive system to maximize the motivation to learn and to optimize the learning by providing appropriate information and affordance to each user. Then, the important questions are what kind of individual differences might play a critical role in learning and motivation, and how to measure those individual differences even if they are identified. In this study, the individual differences are categorized in terms of three dimensions: individual differences in cognition, motivation, and ongoing level of interestingness and comprehension during learning. In addition, the several guidelines for the motivational interface for individualized learning are also prescribed (See Table 1).

2-1. Individual differences in cognition

Among many other cognitive variables, prior knowledge, working memory, and metacognitive skills were described in this study because they are not only the most extensively studied variables in terms of individual differences but also they have lots of implications in designing the individualized ITS environment.

There are several different ways of measuring individual differences in various cognitive abilities by using the standardized test or direct observation of the particular performance. These measurements at the beginning or at the end of the learning session might interfere with the learning process.

Domain specific knowledge

Learners decide their posterior learning experience based on their prior knowledge. Prior knowledge of the domain substantially related with interest in the subject. Thus considering the domain specific knowledge can contribute improving the learners' cognitive interest individually. Every learner has different level of prior knowledge and responds differently depending on prior knowledge (Kim & van Dusen, 1998). Also, prior knowledge of which was needed for learners' achievement has

been demonstrated in many studies (e.g., Abramson & Kagen, 1975). Also according to Baker (2004), learners' prior knowledge of one domain is good predictor of their posterior achievement. In order to be adaptive to the individual learner, E-learning system should differentiate the level of information, and the difficulty level of task and so on, depending on the degree of prior knowledge of individual learner. Since the level of gap among learning materials can affect learner's interest (Kim, 1999), so that the number of text-provided elaborations would be different. To help learning more efficiently for the learner with high prior knowledge, many powerful search tools and hyperlink structure such as Google search engine should be constructed. Also information should be omitted and the gap among the learning materials should be filled in by learner themselves. In contrast, it should provide direct information to need the learning activity to learner having low prior knowledge.

Working memory

Working memory is an active system for temporarily storing and manipulating information needed in the execution of complex cognitive tasks including learning, reasoning, and comprehension. According to theory of working memory "controlled attention" working memory capacity related to attentional ability to maintain goal relevant information as controlled mechanisms (Engle, 1992). The individual differences in working memory capacity have implications for designing the user interface including menu design, number of icons, chunk size of information, task complexity and complexity of menu functions to optimize their cognitive functions and lead to the feeling of competence rather than frustration. For instance, the user who has small working memory capacity cannot deal with even the complex menus and tools in the system and the learning material. For this type of user, the menu bars and icons should be constructed simply to leave enough capacity for the learning materials, whereas the user who has large working memory capacity could be provided with more complicated menu systems and functional tools to explore the additional knowledge. In order to maximize the adaptiveness of ITS, number of sub-menu or task complexity needs to be increased as the user gets accustomed to the system and the automatic processing occurs

Metacognitive skill

Metacognition is a critical skill for learning. The learner with higher metacognitive skill shows better learning achievement. Metacognitive processes are composed of planning, monitoring, strategy use, and evaluation. If the individual differences in each of these sub-metacognitive processes are to be found, we can provide the appropriate situation to improve deficient metacognitive skill. Metacognition is essential skill for making plan and keeping it during learning. Metacognitive knowledge and skill are developed after many challenging learning experience (Ormrod, 1995). Self-explanation by analyzing student explanations of problem-solving steps, recognizing type of omissions, and providing feedback can support metacognition processes.

In order to provide the differential interface depending on the metacognitive level of learners, we might consider the type of feedback to monitor their performance. Monitoring can affect leaning outcome (e. g., Tabatabai, 2005). To facilitate monitoring, the system can provide situation that learners with low monitoring skill should estimate the level of upcoming performance. For example, there might be the gage bar indicating learners' performance level, or notes for memo to let them know what they are doing. For the leaner with high monitoring ability, additional activity should be provided to monitor their performance applying their acquired knowledge in previous stage.

Table 1. Design guidelines for motivational interface of ITS

Dimension	Factor	Variable	Example of guidelines
Individualization	Individual differences in cognition	Domain-specific knowledge	To differentiate the gap between learning material
		Working-memory	To differentiate the number of submenu
		Metacognition	To provide differential type of feedback to monitor their performance
	Individual differences in motivation	Self-efficacy	To differentiate the level of complexity with high probability of success
		Goal orientation	To manipulate the proportion of failure
	Individual differences in interestingness and comprehensibility	Interestingness	To differentiate the amount of information
		Comprehension	To manipulate the level of difficulty
Situational Interests	Learning Activity	Learner Control / Self-determination	To provide more choices
		Interactivity	To provide diverse ways of interact or communicate
		Curiosity	To use metaphors and to make a gap between information for inference
		Novelty	To provide new task in novel situation
	Learning Material	Self-relevance	To provide real life examples To give meaningful and valuable learning context
		Challenge	To monitor progress of achievement of learner
	Immediate feedback and reward	Informative feedback	To inform learners of immediate feedback on their performance
		Reward	To change from extrinsic rewards to verbal reinforcements
Game like Properties	Narrative structure With Fantasy	Endogenous fantasy	To construct learning scenario relevant to learning content
	Online community	Collaboration and competition	To assign a common mission

2-2. Individual differences in motivation

Self-efficacy

Self-efficacy is a student's evaluation on his or her ability to perform a given task (Bandura, 1997). Self-efficacy affects behavior, choice activity, effort, persistence and achievement of individual learner (Bandura, 1991). The higher self-efficacy the learner has, the better performance and the higher learning motivation the learner shows. High self-efficacy learners prefer to engage in the challengeable task and persist at a task even in the face of initial failures, whereas low self-efficacy learners try to avoid failure, challengeable situation. As a result, they show low persistence in learning (Pajares, 1996). Therefore it is necessary to differentiate the level of task complexity and the challenge level with constraints of high probability of success. If learners are highly self-efficacious, ITS should provide more complex tasks and choice situation (e.g., to use or avoid learning tool) to engage learning by themselves. Whereas ITS need to provide simple and relatively easy task to learners with low self-efficacy,

which make they feel competent. Since the perceived competence promotes interest and intrinsic motivation (e.g., Deci & Ryan, 1987), providing positive feedback about the performance and giving many hints are also useful way to enhance the level of self-efficacy to feel the competence achieving goal.

Goal orientation

According to Dweck and Leggett (1988), learners can be divided into the two types of goal orientation in terms of motivation: learning goal orientation and performance goal orientation. Learners with a learning goal orientation do not tend to be afraid of failure, and experience of failure does not hurt the learners' competence or self-efficacy. They seek challenges and show high persistence in learning. Thus, for this type of learners, ITS should provide more challengeable tasks and let them focus on the learning itself and have deeper engagement, or provide more abundant knowledge.

On the other hand, learners who have a performance goal orientation tend to demonstrate their worth and concern the social comparison with others. In particular, those who have performance goal orientation and low ability show learned helplessness and they try to avoid failure and challenging task. In addition, they do not stay on the task. Thus for this type of learners, ITS should avoid the normative evaluation. Instead, it should provide informative feedback and minimize the failure experiences. It is important to manipulate the proportion of failure depending on the goal orientation.

2-3. Individual differences in interestingness and comprehensibility

The current level of interest and comprehension of a learner during learning determines the future behavior of learner. Thus, it is important to measure the learner's level of interest and comprehension, and to provide differential interface based on the level of the interestingness and the comprehensibility. One way of measuring the level of interest indirectly is to find the behavioral correlates such as the frequency of logging in tutoring system, duration of active interaction, and mouse-clicking pattern. If the learners are interested in learning, they are going to explore more information, pay continuous attention, and produce positive outcomes. Since interest is more strongly related to the indicators of deep-level learning than to surface-level learning, the system should react adaptively depending on the level of interest to make a differential level of challenge such as adding the quiz and information that requires the extra cognitive process. These factors reflect learner's interest at that time instantaneously.

On the other hand, if the system recognizes that learner's interest is decreasing, it should provide extra and attractive events such as providing voices, music, and humor or pop up window at particular point of time, to get more attention or to increase emotional interest. But these events or stimuli should be relevant to the learning topic. The adaptive interface on the task difficulty also can be provided depending on the comprehensibility of the learner

3. SITUATIONAL INTERESTS

Many previous education and psychology studies show that interest plays an important role in learning (Herbart, 1806; James, 1890; Dewey, 1913).

We need to consider the situational interests as a second way to improve the learners' motivation in ITS. The specific design guidelines for motivational interface are proposed at three different factors: learning activity, learning material and immediate feedback and reward.

3-1. Learning Activity

Learner control / Self-determination

In traditional ITS, the role of learners are very restricted and passive. They just receive information and practice the drills which ITS provides. Learners do not take initiatives and experience the feeling of autonomy

or self-determination during learning. The passive nature of learning activities makes the learner lose their interest in learning. Deci and Ryan (1987) proposed that learners were intrinsically motivated and felt interest in their learning activities when they had a sense of autonomy and self-determination. It is necessary to make the interface of ITS which can increase the level of autonomy and self-determination of learners. It would be good examples to provide the learner an active role during learning or to provide more choice situations. For instance, in a Teachable Agents program which is a kind of ITS, the learner plays a role of a tutor and the computer plays a role of a tutee. The learners can determine what to teach and how to teach by themselves. Through this process, the learners feel that they have the controllability for their learning activities and take initiatives. As a result, learners would be more interested and motivated and would persist in the learning.

Interactivity

Various interactions make the learning more interesting and natural because learners construct their knowledge through the endless interactions with the environment. In the interesting learning situation, the learners always interact with the artifact or person (teacher or peer) by performing the learning activity or having a conversation. However, in traditional ITS, there is little interaction between the learner and the system so that the learner simply responds to the task that the system asks. Hence the future ITS needs to be designed to increase the level of interactivity by providing the avatar-like intelligent agent, interactive learning tasks, and diverse communication channels between the learner and the system. This interface would lead the learner to feel that they are interacting with the real things and to use the system as a communication tool, which will enhance situational interest and motivation.

Curiosity / Novelty

When learners meet the novel events that are incongruous with their prior knowledge, they feel surprising and curious about the cause or effect of the event. This discrepancy would induce the learners to make inferences to resolve the incongruity, which would in turn generate the cognitive situational interest (Kim, 1999). In order to arouse the learners' curiosity and novelty during learning in ITS environment, the system should provide the surprising events relevant to the learning topics without providing the cause or make the gap among the learning materials, so that the learners can generate their own inferences to find the answer or fill in the gap. Because metaphors can awake learners' curiosity, providing various metaphors is one way to increase learners' inference and curiosity.

3-2. Learning Material

Self-relevance

The interest is a function of knowledge and value, I = K x V. Self-relevance is one of the significant values. It can make learning materials meaningful and increase the situational interest in learning environment (Geller & Shaver, 1976). So, we suggest that the new version of ITS should reflect the self-relevance of learning materials. Therefore, learning materials should be related to learners' everyday life and provide the real life examples or the meaningful learning context to make the learning more interesting.

Challenge

Challengeable tasks promote the learning motivation (Harter, 1978). The difficulty levels of challengeable tasks are intermediate so that the learners would perceive tasks as being achievable with moderate efforts. The system needs to be able to make the task or problem to be challengeable to each learner. To do so, the system has to be individualized and be adaptive to the individual learner.

3-3. Immediate feedback and Reward

Immediate feedback

In the learning situation, immediate feedback and reward are one way to increase motivation level of the learners (Morrison et al, 1995). Especially, when learners get immediate feedback and reward after each stage, they can confirm their goal and change their strategies depending on feedback during learning. Therefore, immediate feedback and reward are the good way to increase learners' motivation and interest in ITS environment.

Reward

Rewards can be divided into two types: intrinsic and extrinsic reward. It should be different to use the type of rewards and to determine the timing of introducing each type of rewards, depending on the intrinsic motivational level of the learner. And also, the excessive use of reward and feedback should be reconsidered seriously. For example, for learners who have low level of motivation, the use of extrinsic reward has good effects on learners' motivation at the beginning of learning. However, as the learning progresses, the extrinsic rewards need to be changed to intrinsic rewards such as verbal reinforcement. On the other hand, the learners who have high level of motivation should not be given the extrinsic rewards because they tend to make an over justification even for the intrinsically motivated responses in terms of external rewards. In this case, it is enough that they receive intrinsic rewards intermittently.

4. GAME-LIKE PROPERTIES

Why do most students prefer the games to the learning? What are the similarities and differences between the game and the learning? One evident fact is that the computer game does have several distinctive properties that the ITS does not have. If the game-like properties were found and applied to the ITS, students would be more likely to be engaged in learning like game.

Based on the previous studies on game (e.g., Gredler, 1996), the two important properties of games were extracted: the narrative structure with fantasy and online community. According to these properties of game, the specific design guidelines for motivational interface of ITS were proposed.

4-1. Narrative structure with Fantasy

Endogenous fantasy

Many popular games have a narrative structure with fantasy. This fantasy context leads the user to have greater situational interest and motivation (Cordova & Lepper, 1996). It is mainly because fantasy can provide an analogy or metaphor for the real world that allows the user to experience the learning situation from a variety of new perspectives.

However, if the narrative structure focuses only on fantasy, it would interfere with the learning. For this reason, the narrative structure with fantasy should be related to learning subject, which is called endogenous fantasy. For example, if the learning material is about rock and rock cycle, narrative structure should be also related to rocks. And according to Mayer (2001), in order to make the learners be interested and motivated, sensory stimuli like pictures, sound effect, and dynamic graphics are more efficient than the traditional text-based interface in ITS. For example, when learners' interest and motivation are decreasing, ITS can make the learners be more interested and motivated by presenting multi-modality. For these reasons, the next type of ITS should have narrative structure with fantasy and multi-modality.

4-2. Online Community

Group collaboration / Competition

Recently, the most ITS allows many users to participate simultaneously based online community.

Thus learners can collaborate or compete with other learners or agents. This property came from computer and video games. In order to achieve goals in ITS environment, learners should share some strategies with other learners or monitor strategies of others. Previous study shows that these collaborative and competitive learning environments make learners be more engaged in their learning activities. Therefore, the new version of ITS should offer common missions or goals to learners based network online community so that they can collaborate and compete with another learners. Through this process learners are also able to feel novelty and satisfy their needs for social affiliation. Finally, they get more motivated and interested about own learning.

5. CONCLUSION

The previous ITS system have mainly focused on improving the cognitive abilities of learners. However, new direction for motivational interface of ITS is proposed to promote motivation of learners. In this study we suggested that it is essential to develop the individualized and adaptive ITS in order to maximize the effects of learning through the system.

First, ITS should reflect individual differences in cognitive abilities, interest and motivation, and ongoing change of the interestingness and comprehensibility during learning activities. It is important to note that providing an individualized interface is the single best way to enhance the learners' interest and motivation.

Second, new type of ITS should change the learning activity, the learning material, and reflect the immediate feedbacks in order to enhance the level of motivation and situational interest. It is essential to guarantee learners' controllability, diverse learning activities, curiosity, self-relevance, challenge, and rewards to enhance the level of motivation in ITS.

Finally, Narrative structure with fantasy and collaboration and competition in online community should be introduced for meaningful learning.

These factors would make ITS more interesting and attractive so that the motivation of learners would be promoted. The new type of ITS are shifting form the cognitive perspectives to the motivational perspectives reflecting the individual differences. It is the ITS developer's task that provides learners with chances to enjoy their learning.

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REFERENCES

Abramson, T., & Kagen, E. (1975). Familiarization of content and different response modes in programmed instruction. *Journal of Eucational Psychology*, 67, 83-88.

Baker, R. S., Corbett, A. T., Koedinger, K. R., Wagner, A. Z. (2004). Off-Task behavior in the cognitive tutor classroom: when students "game the system". *Conference on Human Factors in Computing Systems, 6(1)*, 383-390.

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-regulaton. *Journal of Personality and Social Psychology*, 41, 586-598.

Bandura, A. (1997). *Self-Efficacy: the Exercise of Control*. New York. Freeman.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organizational Behavior and Human Decision Processes*, 50, 248-287.

Barron, B.J., Schwartz, D. L. Vye, N.J., Moore, A., Petrosino, A., Zech, L., Brasford, J.D. & Cognition and Technology Group at Vanderbilt (1998). Doing with understanding: lessons from research on problem and project based learning. *Journal of Learning Science, 7(3 and 4)*:271-312.

Carroll, J. A. (1963). Model for school learning. *Teachers College Record, 64*, 723-733.

Cordova, D. I., & Lepper, M.R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology, 88*, 715-730.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, 125, 627-668.

Dweck, C. S., & Legget, E. L. (1988). A social-cognitive approach to motivation and personality, *Psychological Review*, *95*, 256~273.

Engle, R. W., Cantor, J., & Carullo, J. J. (1992). Individual differences in working memory and comprehension: A test of four hypotheses. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18, 972-992.

Geller, V., & Shaver, P. (1976). Cognitive sequences of self-awareness. *Journal of Experimental Social Psychology*, 12, 99-108.

Gredler, M. E. (1996). Educational games and simulation: A technology in search of a (research) paradigm. In D. H. Jonassen(Ed.), *Handbook of research on educational communication and technology*. New York: Macmillan.

Harter, S. (1978). Effectance motivation reconsidered: Toward a developmental model. *Human Development, 21*, 34-64.

Herbart, J. F. (1806). General theory of pedagogy, derived from the purpose of education. In J. F. Herbart (Ed.), *Writings on education* (1965, Vol. 2, pp. 9-155). Dusseldorf: Kuepper.

James, W. (1912). The principles of psychology (3rd ed.) New York: Holt, Rinehart & Winston.

Kim, S., Yun, S. H., Choi, D. S., Yoon, M., So, Y., Lee, M. J., Kim, W., Lee, S. Y., Hwang, S. Y., Han, C. W., Lee, W., & Lim, K. (2005). Design and implementation of the individualized intelligent teachable agent. ICNC'05-FSKD'05, Lecture Notes in Computer Science, 3610, 797-805.

Kim, S. (1999). Inference: A cause of story interestingness. *British Journal of Psychology, 90*, 57-71.

Kim, S. & van Dusen, L. M. (1998). The role of prior knowledge and elaboration in text comprehension and memory: A comparison of self-generated elaboration and text-provided elaboration and text provided elaboration. *American Journal of Psychology, 1*, 353-378.

Mayer, R. E. (2001). *Multimedia Learning*. New York: Cambridge University Press.

Ormrod, J. E., (1995) *Human learning*. Englewood Cliffs, New Jersey: A Simon & Schuster Company.

Pajares, F. (1996). Self-efficacy beiliefs in academic settings. *Review of Educational Research*, 66(4), 543-578.

Papanikolaou, K. A., Grigoriadou, M., Magoulas, G. D., & Kornilakis, H. (2002). Towards new forms of knowledge communication: the adaptive dimension of a web-based learning environment. *Computers & Education*, 39, 333-360.

Pressley, M., Woloshyn, V., Lysynchuk, L. M., Martin, V., Wood, E., & Willoughby, T. (1990). A primer of research on cognitive strategy instruction: The important issues and how to address them. *Educational Psychology Review*, *2*, 1-58.

Ryan, R. M., & Deci E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well being. *American Psychologist*, 55, 68-78.

Tabatabai, D., & Shore, B. M. (2005). How experts and novices search the Web. *Library & Information Science Research*. 27, 222-248.

Yi, M. Y., & Hwang, Y. (2003). Predicting the use of web-based information systems: self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. *Int. J. Human-Computer Studies*, 59, 431-449.