Basic Consideration to Improve Self-Regulatory Skills Using Mobile Devices

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Abstract: Our research goal is to develop a system that can support learners in elementary education to acquire self-regulatory skills. Learners can enhance their learning motivation and build a foundation for life-long learning by developing self-regulatory skills as early as possible in elementary education. However, it is not easy for them to acquire such skills. In our research, we analyze factors of difficulties in displaying self-regulatory skills and clarify support functions to reduce these difficulties. Then we develop a support system to encourage learners' continued self-regulated learning.

Keywords: Mobile device, emotional states, learning strategy, self-regulated learning

Introduction

Our research goal is to develop a system that can support learners to acquire self-regulatory skills. Zimmerman defined self-regulated learning: "students can be described as self-regulated to the degree that they are meta-cognitively, motivationally, and behaviorally active participants in their own learning process [2]."
Learners with proficient self-regulatory skills can perform appropriate, well-structured learning activities by adapting their own learning strategies in various personal situations: achieving their personal goals enhances their feelings of self-efficacy. Consequently, such learners become able to motivate their own learning activities [1][2][3].
A skill is trained by displaying the skill, in general, although training of self-regulatory skills is not embedded into the current school curriculum. In our research, we analyze factors of difficulties in displaying self-regulatory skills and clarify support functions to reduce these difficulties. We then develop a support system to encourage learners' continuous self-regulated learning by making them conscious of driving cyclic self-regulated learning processes in elementary education.

1. Self-Regulated Learning

Learners are well-known to be able to enhance their learning motivation and construct a foundation for life-long learning by developing their self-regulatory skills as early as possible during elementary education [3]. One characteristic feature of self-regulated learning is that learners must not only control their own learning activities but also must truly control their emotional state.
Emotional states of a learner significantly affect learners' application of learning strategies: it is a main factor for displaying self-regulatory skills. If learners feel uneasy about their learning, for instance, they typically fill their cognitive capacity with worry: they become

unable to allocate sufficient cognitive resources to perform learning processes. Consequently, they become unable to use adequate learning strategies that are appropriate to their own situation. Furthermore, in cases where learners have low self-efficacy, they continue using their own strategies even if they know of more proficient adequate strategies: they have no confidence to perform any different but adequate strategy.

Emotional states and learning strategies have bidirectional relations: emotional states contribute to learners' use of appropriate learning strategies, although using appropriate learning strategies improves their emotional states. Consequently, learners must combine their learning strategies with their emotional states to acquire self-regulatory skills.

Self-regulated learning processes consist of three phases: forethought, performance and self-reflection phases [5].

If the learners can perform following appropriate activities at each process, then they can drive self-regulated learning processes properly. Consequently, learners acquire self-regulatory skills.

- **Forethought:** Learners' conscious setting of their own learning goals enhances their own awareness of achieving the goal. It therefore contributes to improving personal performance.
- **Performance:** Performing meta-cognitive activities that include conscious allocation of their attentional resources contribute to improving the performance of personal learning activities.
- **Self-reflection:** If learners can infer reasons of having gotten desired outcomes as a result of personal effort, it improves the learners' feelings of self-efficacy and learning motivation. Consequently, successful learners can drive active circulation of self-regulated learning processes, adopt useful learning strategies, and improve later learning processes.

2. Design Rationale of Our System to Support Self-Regulated Learning

The design rationale of our system to develop self-regulated learning support system is to support learners to drive learners' self-regulated learning processes by themselves. To achieve this goal, the system requires embedding of support functions to eliminate the following factors of difficulties in acquiring self-regulatory skills:

(a) It is difficult for learners with immature self-regulatory skills to recognize their own learning experiences as targets of their monitoring on a self-regulated learning model.

In such cases, even if learners try to devote attention to them, then the following might be true.

(b) They no longer have sufficient information related to their experiences to learn effectively because of their forgetfulness.
(c) It is difficult to understand what activities they should perform and how they should perform them.
(d) It is difficult to acquire meta-cognitive knowledge related to using strategies because they cannot easily understand that their effects attributable to the learning processes that are influenced by many unconscious factors.

Our system supports learners by eliminating these problems. Design rationales of our system are as described below.

- **For (a):** the system provides viewpoints to induce learners to be conscious of displaying self-regulatory skills according to each process.
- **For (b):** the system provides an interface to record their learning activities easily by themselves during the performance phase.

- **For (c) and (d):** the system provides graphical information with messages to prompt their monitoring and analysis processes of their learning experiences to make causal attributions during the self-reflection phase.

3. i-SERENITY: Self-Regulated Learning Support System

We adopt iPhone/ iPod touch to support learners' self-regulated learning: mobile devices offer the great potential to follow a learner's learning contexts outside of a classroom closely, and to realize suitable and sophisticated support because of their ease of mobility and convenience. This point is important to support learners' successful self-regulated learning processes: it is necessary to analyze their learning processes in as great detail as possible. To do so, learners should record their own learning processes at every opportunity. We embed support functions into the mobile system to facilitate learners' awareness of self-regulated learning and to reflect on their own learning activities with appropriate information in individual life situations. Our system, named the i-Self-Regulated Learning Support System (i-SERENITY), supports learners as they participate in enhanced self-regulated learning at each phase.

(A) Forethought process
Enhancing learners' consciousness of adopting learning strategies is the key at this process. Learners enhance their consciousness to demonstrate their self-regulatory skills by choosing menu items. More concrete functions embedded into the system are as follows.
  (1) Providing viewpoints as selection menus that learners should know in starting self-regulated learning, such as setting learning goals and learning strategies.
  (2) Providing learning strategies and their explanations based on self-regulated learning task ontology, such as time management strategy, social interaction strategy, memorization strategy, rehearsal strategy, and connecting strategy. These have consistently proved to be effective for self-regulated learning.
These functions prompt learners' activities at this phase by eliminating difficulties of (a) and (c) described in section 2.

(B) Performance process
It is important for learners to enhance their self-efficacy by apprising themselves of it: this knowledge contributes to stimulation of their learning motivation.
The system prompts them to input their feelings of expectation to themselves after performing learning processes, e.g. the score they expect to get on the next exam. This step facilitates their recognition of their own self-efficacy and helps them to grasp their own states of understanding objectively. This feeling of expectation represents an important emotional state of a learner. These functions prompt learners' activities at this phase by eliminating difficulties associated with (a) and (b).

(C) Self-reflection process
The self-reflection process is crucial to encourage learners' self-regulated learning. The important point is that (i) learners must recognize and analyze their own learning experiences consciously and objectively to develop self-regulated skills, (ii) they must construct explicit knowledge by externalizing the acquired knowledge with relation to objective evidence related to their own learning experiences.
Causal attributions in this process drive circulation of self-regulated learning processes. It is important to provide useful information to facilitate the learner's appropriate awareness and causal attributions.

We embed the following support functions into the system to prompt externalization and combination of meta-cognitive knowledge for self-regulated learning based on a learner's experience of his learning processes.

    (1) Providing various visualized information of the learner's learning processes appropriately so that the learner must recognize this process

    (2) Providing viewpoints to analyze a learner's own learning processes based on self-regulated learning task ontology

Figure 1 shows a screen image of function (1). This is presented according to a learner's requests. It shows three lines. The top line at the left side of the screen represents changes of the target scores of weekly exams that the learner set. The middle line shows marked scores. The bottom shows the goal score of next exam that the learner set. The bar graph at the bottom represents the total learning time each week. This information triggers learners' reflections. In addition, two buttons, "Success" and "Failure" are shown under the graph to encourage the learner's self-reflection.

Figure 2 portrays a screen image of function (2) showing the assignation of causal attributions: it appears when the learner pushes the "Success" button. In this case, results show that frequency data of using each learning strategy that are related to success of her learning and viewpoints as selection menus to make causal attributions based on a self-regulated learning task ontology. Therefore, the learner can objectively review personal learning experiences as evidentiary data and make causal attributions.

Furthermore, the system displays a message to encourage the learner's continuous use of this strategy in case that the learner chose the "Success" button. This encourages the learner's recognition of the value of the strategy: it improves the learner's emotional state (self-efficacy) by combining it with the strategy. These functions prompt learners' activities by eliminating difficulties of (a), (c), and (d) described in section 2.

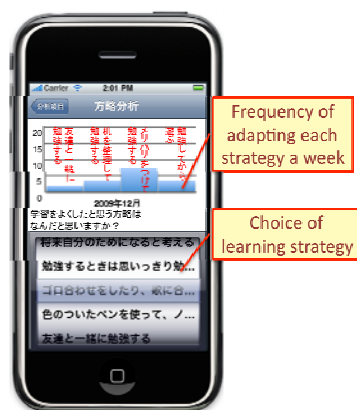Figure 1: Providing visual information to facilitate the learners' awareness.

Figure 2: Providing visualized information about learning experiences with learning strategies to make causal attributions.

4. Self-Regulated Learning Task Ontology

We briefly explain the self-regulated learning task ontology as a basis of our system development. It specifies a system of concepts for performing self-regulated learning task, e.g., self-regulated learning strategy, self-regulated learning action, self-regulated learning processes, and factors of difficulties in acquiring self-regulatory skills.

The meaningfulness of building this ontology is the following.

- The system can give learners a viewpoint of what kind of data they should record as learning resources for self-regulated learning.

- The system can encourage learners to reflect on their experiences from their behavior information by specifying domain-independent behavior strategies.

- The system can provide useful information from recorded data for the learner to make causal attributions.

Figure 3: A portion of self-regulated learning task ontology.

Figure 3 presents a part of the self-regulated learning task ontology (is-a hierarchy) that we have been building. It specifies what the self-regulated learning task is. For example, self-regulated learning strategy is specified to cognitive strategy, behavior strategy, and motivational strategy. Cognitive strategies are also specified to "rehearsal strategy," "connecting strategy," "chunking strategy" and others.

5. Related Works

Many researchers have sought to develop learning support systems using mobile devices. Mobile devices offer the great potential to change real life situations to the situated learning resources: we can recognize such efforts as challenges to find a new world. For instance, Ogata et al. are developing CLUE, which can support language learning out of classes in a ubiquitous computing environment [4]. It poses questions to learners for acquiring vocabulary according to their situations by reading RFID tags attached to objects in daily life situations.

Most such approaches are intended to support learners to learn knowledge about subjects. In our research, i-SERENITY is aimed at supporting learners to improve self-regulatory skills that control their emotional states in their individual learning contexts. There are not many approaches yet to facilitate learners' meta-cognitive skill acquisition using mobile devices.

6. Concluding Remarks

This paper presented discussion of a self-regulated learning support system named i-SERENITY, which enables learners to combine their learning strategies with their emotional states through their learning experiences, thereby developing their adoption of life-long learning. Learners can recognize effects of behavioral learning strategies that affect their emotional states using our system.

We plan to conduct an experimental study in an elementary school and to evaluate the usefulness of the system in the near future.

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