# Supporting Student Self-regulation in Unsupervised Learning Environments

**Paul Salvador INVENTADO, Masayuki NUMAO**
*Institute of Scientific and Industrial Research, Osaka University, Japan*
inventado@ai.sanken.osaka-u.ac.jp

**Abstract:** Technology has made it convenient for students today to learn outside of the classroom. However, learning in this kind of setting introduces challenges such as proper time management, maintaining motivation and avoiding distractions. This research investigates how student learning progresses in this unsupervised learning environment and proposes an automated support mechanism that promotes self-regulation to help students learn. The proposed system is not bound to any domain and its methodology supports learning in naturalistic settings. Results gathered from students' use of a system prototype confirmed the problems students encounter when learning in this environment and their need for support. It also showed that helping students self-regulate made them aware of their learning behavior and helped them identify ways to improve their learning efficiency.

**Keywords:** learning, unsupervised learning environment, feedback, self-regulation

## Introduction

Student learning is not bound to formal learning settings in classrooms. Students continue to learn on their own in the library, in their homes or with their peers. Technology has made it even easier for them to learn because it gives them easy access to information anytime and anywhere. However, informal learning settings introduce challenges such as the need to self-motivate, manage time and resist distractions to learn effectively.

In formal learning settings, students are discouraged from engaging in non-learning activities such as chatting with friends or playing games. Students are also required to use certain skills and solve problems within given time frames. However, informal learning settings give students more control over their time and goals. Students can engage in non-learning activities freely which may benefit them by helping them de-stress and disengage from feelings of frustration and helping them move into more positive emotional states which allow them to regain motivation and resume learning [5]. The duration, frequency and type of non-learning activity will have different effects on students thus there also has to be a certain configuration for non-learning activities to be helpful. Students know themselves best so they are also the best persons to identify what is most effective for them. Our goal is to improve students' learning efficiency as they learn in informal learning settings by helping them self-regulate.

## 1. Literature Review

Self-regulation is a systematic process for promoting the attainment of goals and is composed of the cyclic phases of *forethought*, *performance* and *self-reflection* [6]. Forethought involves the formulation of goals for the learning session which serve as guides

on what activity to do. Performance involves doing activities that will accomplish the previously defined goals and monitoring progress to identify if there is a need to adjust goals or strategies. Self-reflection involves the assessment of the learning session, attribution of the causes of unfavorable behavior during the learning session and the identification of possible strategies to increase learning efficiency in succeeding learning sessions.

Self-regulation facilitates good learning behavior and its benefits have not only spawned research in traditional classroom settings, but also in more modern settings such as in computer-based learning environments. Systems like MetaTutor [1] and Process Coordinator [4] allow students to keep track of the self-regulation strategies they use and also suggest strategies that can help them accomplish their goals as they learn in computer-based formal learning settings. However, these systems expect students to engage only in learning related activities during the session. Research has shown that students use and actually prefer learning activities outside of the classroom apart from classroom-based activities [2]. Students' preference for learning in this domain and the challenges they encounter highlight the need to support them.

## 2. Proposed Research and Preliminary Research Questions

This research investigates the interplay between students' learning and non-learning activities while learning in an informal learning setting and the support that can be given to help students self-regulate and increase learning efficiency. We limit our work to informal learning settings that involve the use of a computer because work done on or in front of a computer can be logged automatically and because computer systems can provide automated support to help students self-regulate.

We use the term *unsupervised learning environment* to refer to informal learning settings wherein students learn by using a computer without supervision from a teacher. In this environment they need to identify their own goals, manage their learning, avoid distractions and self-motivate to learn efficiently. We aim to accomplish the research's goals by answering the following general and specific questions:

*How do we help students self-regulate in an unsupervised learning environment to improve learning efficiently?*

1. How can we help students define and prioritize their learning goals?
2. How can we help students become more aware of their activities while learning and encourage them to change their behavior that is not helpful to learning?
3. How can we help students self-reflect and identify ways to improve their learning?
4. Does helping students self-regulate when they learn in an unsupervised learning environment improve their learning efficiency?

## 3. Architectural Framework

The framework we are using for this research consists of three cyclic phases with elements based on the three aforementioned self-regulation phases and is illustrated in Figure 1. In the *interaction phase*, students are asked to identify and input their goals at the beginning of a learning session. After which, students start the learning session wherein information about their actions such as applications used, timestamps and screenshots of the desktop and webcam are recorded and stored in an interaction database. The system provides timely feedback to help students keep track of their activities and progress and to help them identify if there is a need to adjust them. In the *annotation phase*, students review their learning session with the help of the desktop and webcam screenshots recorded. Students

then annotate their activities on the computer (e.g., browsed a web page, read a textbook), identify if it is related to their learning goals or not and indicate when they felt distracted from their learning goals. Students are also asked to comment on the system's feedback during the learning session and rate their learning efficiency for the session. In the *modeling phase*, a machine learner will be used to create a predictive model from the annotated data to identify which conditions cause students to become distracted. Another machine learner will be used to incrementally adjust a feedback model to fit the students' feedback preferences. Feedback adjustments result in changes in feedback type, frequency and conditions. The updated distraction and feedback models are used by the system in the next learning session to decide when and what type of feedback should be given to the student. Over time, the adjustments will result in better models of the students' behavior and feedback preference thus, improving the feedback mechanism.

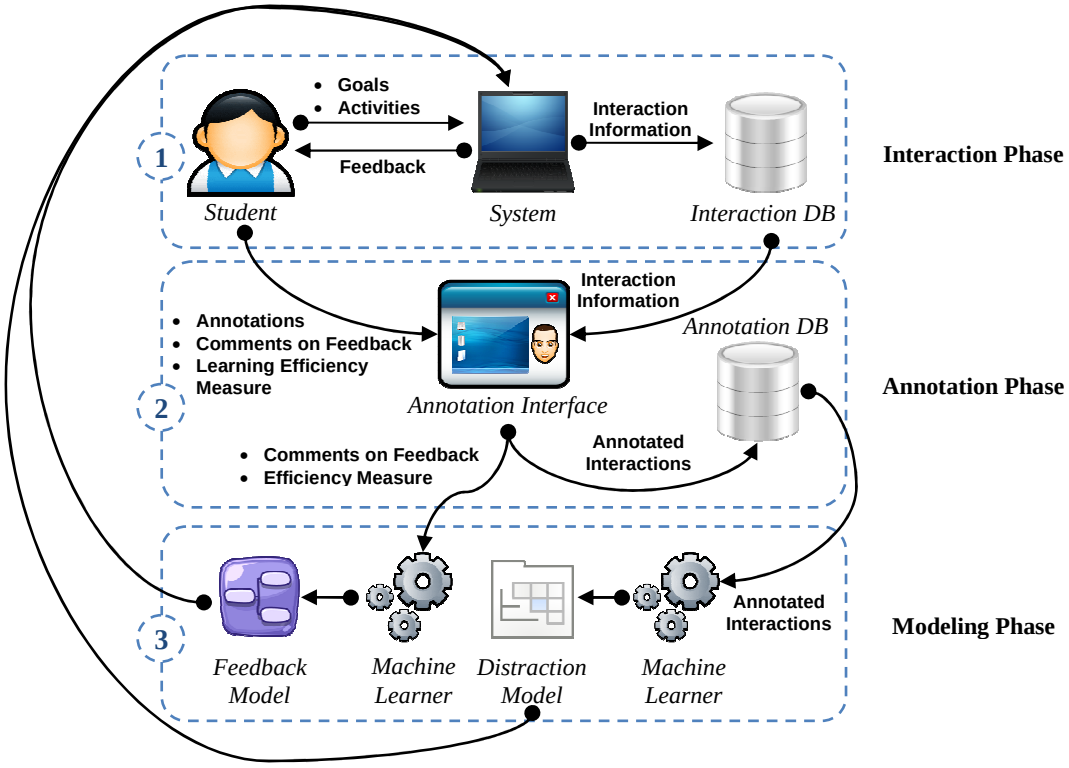


**Figure 1. Architectural Framework of the Proposed System**

## 4. Preliminary Results

An initial prototype of the system with both the interaction and annotation phases was created and tested on four students doing academic research [3]. The subjects were mostly graduate students working on different domains (i.e., computer science and physics) but were all required to do research and present results to their respective supervisors once a week. Academic research was considered an unsupervised learning environment because students did their work on a computer, managed their own learning and didn't receive direct guidance from their supervisor. Each student used the system for approximately two hours in one learning session per day over the period of five days resulting in 10 hours of data per student. After each learning session, students spent about an hour to annotate their data, which is around half of the learning session's duration. Surveys and informal interviews were also conducted to further verify and understand the students' learning behavior.

A transition likelihood metric was used on the annotated data to identify the likelihoods

of transitioning between states, wherein each state consisted of a student's emotion and intention (i.e., learning or non-learning). The results showed that students transitioned between feelings of engagement and confusion which were indicative of cognitive disequilibrium, a state commonly experienced by students when learning. Students were also constantly shifting to non-learning activities which may have served as distractions. However, students shifted back to learning which indicated that non-learning activities may also have served as rewards and de-stressors that helped motivate students to resume learning at a later time. Both effects of non-learning activities were also reported by students in the survey results collected. During the interview, we found out that students used varying measures for learning efficiency which included the number of completed learning goals, the amount of time spent in learning activities and the difference between what they learned from the session and their self-expectations. Furthermore, students said that they were able to identify what caused them to learn inefficiently and also what they could do to improve their learning behavior.

The next step in our research is to use our preliminary results to design and automate feedback provision based on the students' annotations, learning efficiency ratings and proposed solutions for improving their learning behavior. This feedback also needs to be verified if it translates to actual learning improvements through pretests and posttests.

## 5. Conclusion

This research investigated learning in an unsupervised learning environment and proposed a self-regulation based automated support mechanism to help students learn. The designed methodology allows students to learn in a naturalistic environment and helps them become more aware of how often, how long and which non-learning activities were helpful or harmful to their learning. The methodology also allows students to self-reflect and identify how they can improve their learning efficiency. The kind of support given by the system is not domain dependent so it is able to provide support for learning as long as it is done on or in front of a computer. Self-regulation is an important skill for life-long learning which the system promotes through honing students' self-regulation skills outside formal learning settings without the need of human supervision.

## References


[1] Azevedo, R., Johnson, A., Chauncey, A., and Burkett, C. (2010). Self-regulated learning with MetaTutor: Advancing the science of learning with MetaCognitive tools. In Khine, M. S. and Saleh, I. M., editors, *New Science of Learning*.

[2] Dahlstrom, E., de Boor, T., Grunwald, P., and Vockley, M. (2011). ECAR study of undergraduate students and information technology, 2011. Technical report, Boulder, CO: EDUCAUSE Center for Applied Research.

[3] Inventado, P. S., Legaspi, R., and Numao, M. (to appear). Student learning behavior in an unsupervised learning environment. In *Proceedings of the 20th International Conference on Computers in Education.*

[4] Manlove, S., Lazonder, A. W., and Jong, T. (2007). Software scaffolds to promote regulation during scientific inquiry learning. *Metacognition and Learning*, 2(2).

[5] Sabourin, J., Rowe, J., Mott, B., and Lester, J. (2011). When Off-Task is On-Task: The affective role of Off-Task behavior in Narrative-Centered learning environments. In Biswas, G., Bull, S., Kay, J., and Mitrovic, A., editors, *Artificial Intelligence in Education*.

[6] Zimmerman, B. J. (2002). Becoming a Self-Regulated learner: An overview. *Theory Into Practice*, 41(2).