

Successful Learning at University – an Adaptive Online Learning Strategies Training for Freshmen

Tino Endres¹, Jasmin Leber², Alexander Renkl³

Abstract

There are two different ways to improve teaching and learning at university. The traditional way is teaching orientated: This way involves optimizing university seminars by improving the teachers' instruction. A second, complimentary way is to encourage students to use learning strategies, which help them to learn more from the teachers' instruction. For the latter purpose, we have developed a computer-based, adaptive learning environment for freshmen students to train their learning strategies. Our online learning-strategy training aims to: 1) teach declarative knowledge about learning strategies; 2) consolidate this knowledge; 3) support students to apply these learning strategies when working on the university course. We conducted several experimental studies to optimize this learning environment with respect to how motivating it is, how the declarative knowledge about learning strategies can be effectively consolidated, and how the formation of effective intentions for applying the learning strategies (Implementation Intentions) can best be prompted. We found that motivation while working with the learning environment can be fostered by using sketched explanation videos (i.e. video containing sketched symbols and human hands). For consolidating students' knowledge about learning strategies, a retrieval practice-based arrangement that uses different types of test questions for learners with different prior-knowledge levels is best. These prior-knowledge levels are assessed in the learning environment. The learning environment automatically adapts the type of questions so that they are most beneficial for the individual learner. Finally, we found that it is important to guide the students to form very specific Implementation Intentions for applying learning strategies. A contrasting cases guidance was most efficient. We implement our strategy training presently in a freshman courses on a long-term basis.

Keywords: *learning strategies, computer-based learning, retrieval practice, adaptivity, motivation;*

1. Why do freshman students need learn strategies?

University programs usually confront students with much greater challenges as compared to previous demands in high school. Self-regulated learning strategies are one key to successfully cope with this step-up. As compared to high school, it is much more important for university students to keep in mind that effective learning requires two aspects. It is the educators' task to present the to-be-learned information as good as they can and to provide favorable learning opportunities for their students. It is the students' task to take in an active role and to make use of the provided information and learning opportunities [1].

In comparison to teachers in a school, educators at universities have a smaller influence on learning processes, as their contact and supervision of students is limited, and they are not able to support all students individually. For students, the time frames in which content must be learned have become smaller, there are relentless deadlines for essays and exams, and students have to independently reach a much deeper level of understanding of their subject [2]. Due to this increased level of difficulty and need for independency and self-regulation it is necessary that students understand the importance of good learning strategies and of how to put these learning strategies best into play in order to succeed in their studies. However, even when students were successful learners in high school, they fail to engage in appropriate strategies for learning and understanding at university. For example, it is often the case that students use inefficient learning strategies, such as "re-reading" of learning materials [3], [4].

As students spontaneously often engage in inefficient strategies, it is sensible to provide them a training invention fostering the application of effective learning strategies. As the students have to cope with a leap of demands when they come to university, as already discussed, it is best to provide such support is best at the start of a university program. Beyond better learning outcomes due to appropriate strategy use, students attending strategy training interventions are less likely to drop out of university programs [5].

¹ Albert-Ludwig University Freiburg, Germany

² Albert-Ludwig University Freiburg, Germany

³ Albert-Ludwig University Freiburg, Germany

A problem when implementing strategy-training interventions at university is that teachers often do not have sufficient time and resources to offer promising interventions in addition to teaching the required contents. In addition, the frequently offered courses on learning strategies are just chosen by a restricted number of students. Thus, we have developed an online strategy training intervention that is adaptive to individual students needs in order to address the problem of student heterogeneity. By providing the training online, the number of students can be easily up-scaled and lecture time is not lost for teaching the required contents.

2. The Strategy Training Intervention: Basic Design

The strategy training intervention is based on empirically proven, general principles [6]. In general, it is designed as *informed training*. Within the training intervention, comprehensive, concrete and accessible (declarative) knowledge about learning strategies is imparted. One focus is on communicating the advantages and disadvantages of strategies in different application situations (meta-knowledge). In addition, the students get to know different *authentic application contexts* in order to be able to apply the strategies learned independently and effectively. Furthermore, the principle of *scaffolding* is used. Learners are first supported by very structured interventions to learn and practice the contents. Gradually more responsibility is handed over to the students, up to the independent application of the strategies in everyday learning situations. To assure that application we combined our training with a psychology course. A special feature of this intervention is the adaptation to the learners' prior-knowledge. This type of adaptation has already proven to be a successful factor for later learning success in other learning strategy-related support approaches [3].

3. Prototypical Training Procedure and Evaluation

The training consists of three phases: the learning phase, the practice phase and the transfer phase. The learning phase begins with assessing prior-knowledge and the presentation of declarative knowledge about learning strategies. The practice phase includes adaptive retrieval practice to consolidate what has been learned. In the transfer phase, the learner receives help to learn how to put the strategies into place in his or her specific field of studies within current university courses.

3.1 Learning Phase

At the beginning of the training, students' prior-knowledge is assessed by scenario tasks. Within these tasks, authentic learning contexts are provided. The student rate different options of learning strategies with respect to how useful they are in the given situation. This task types has already been successfully used in similar forms for learning strategy assessment in previous studies as well as in large scale assessments such as PISA [3].

Subsequently, learners acquire declarative knowledge on learning strategies in three learning modules on different types of learning strategies: cognitive strategies, metacognitive strategies, and resource-oriented strategies. In the beginning, a video is presented. This video is a type of advanced organizer and it explains the three types of strategies and their interactions on a general level. The three modules can then be started independently.

Hence, the learners decide for themselves how many components they would like to work on in a single session. Thereby learning sessions can be adapted to the individual students' available time resources.

Each learning module also starts with an introductory video on the respective strategies.

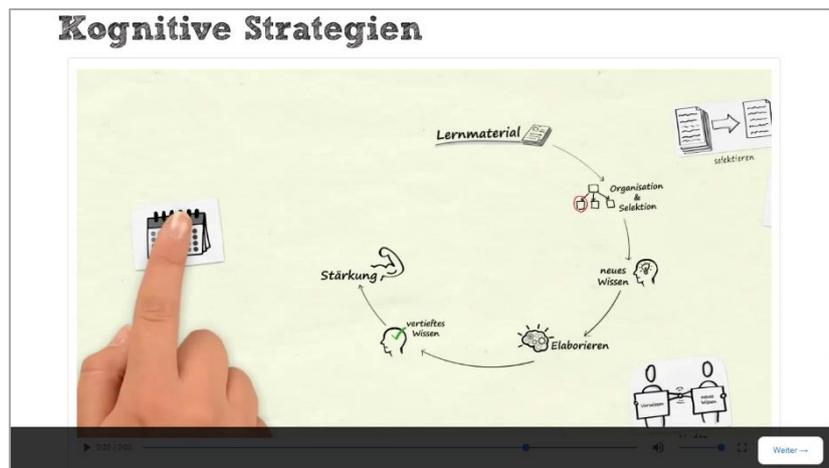


Figure 1. Screenshot of the instructional video on cognitive strategies.

Subsequently, the contents are explained in more detail in short, individually selectable text sections (including picture and videos). These sections are designed according to the principles of multimedia learning [7]. For example, we used the principle of personalization: a virtual older student guides learners through the program and explains the individual strategies, and the learners are addressed personally.

Formative Evaluation. For the formative evaluation of the learning phase, learning videos with different personalization principles were created. In an empirical study, we found that the personalized videos increased the students' motivation and, simultaneously, the acquisition of knowledge about learning strategies. Hence, we included the personalized videos in the learning modules. Furthermore, we were able to determine different levels of prior-knowledge between the different modules within a single learner. We assessed prior-knowledge-levels separately for every modules to enable adaption on a fine-grained level.

In vier Wochen findet eine wichtige und thematisch sehr umfangreiche Klausur statt. Dein Dozent kündigt an, dass die Klausur eine große Anzahl an geschlossenen Fragen beinhalten wird und man in der vorgegebenen Zeit nur dann alle Fragen beantworten können wird, wenn man sich so gut vorbereitet hat, dass man schnell und automatisiert eine Antwort geben kann. Wie bewertest du im Rahmen dieses Kontexts die folgenden Vorgehensweisen?

Du schließt dich für die Klausurvorbereitung mit Kommilitonen zusammen und gemeinsam diskutiert und elaboriert ihr die wichtigsten Konzepte der klausurrelevanten Themen.

Du bearbeitest nur Beispielaufgaben, die der Dozent bereitgestellt hat. Diese übst du solange, bis du schnell und automatisiert die richtigen Antworten geben kannst.

Du besuchst das Begleitseminar zur Vorlesung, in dem die Beantwortung der Fragenformate geübt wird, die in der Klausur dran kommen werden. Hierfür gibt der Tutor Zeitvorgaben, die vergleichbar mit denen der Klausur sind.

Du gehst alte Klausuren und Beispielaufgaben durch, um dir einen Überblick über die Fragenformate zu verschaffen und diese zu gruppieren. Anschließend übst du die Beantwortung der Fragen gruppiert nach Fragenformaten.

[Weiter](#)

Du besuchst im neuen Semester ein Seminar, in dem jede Woche ein Text kritisch in der Seminargruppe diskutiert werden soll. Die Texte hat die Dozentin in einem Skript für alle zusammengestellt, die Literaturrecherche kannst du dir also sparen. Nun sitzt du vor dem ersten Text und beginnst damit ihn so durcharbeiten, dass du im Seminar direkt gut kritisch mit diskutieren und interessante Redebeiträge beisteuern kannst. Wie bewertest du im Rahmen dieses Kontexts die folgenden Vorgehensweisen?

Bevor du den Text im Detail liest, überfliegst du ihn, um dir einen groben Überblick über die zentralen Inhalte und die Struktur des Textes zu verschaffen.

Du liest den Text im Detail durch und notierst dir die zentralen Inhalte. Diese gehst du anschließend noch einmal durch und überlegst dir, wie du sie in der Diskussion mit Beispielen verdeutlichen könntest.

Du liest den Text mehrmals hintereinander durch, um dir die Inhalte zu merken und im Seminar gut parat zu haben.

Beim Durchlesen des Textes nutzt du unterschiedliche Farben, um dir die zentralen Inhalte, diskussionswürdige Punkte und offene Fragen im Text zu markieren. Die zentralen Inhalte versuchst du anschließend in einer Mind-Map grafisch zu veranschaulichen.

[Weiter](#)

Figure 2. Examples of scenario tasks for prior-knowledge assessment.

3.2 Practice Phase – Adaptive Retrieval Practice

In the following practice phase, we consolidated the acquired knowledge by using the method of retrieval practice (often examined under the label "testing effect"); [8]. This method uses retrieval of previously learned content as practice activity. It is important that each learner can successfully recall the relevant contents for individual questions, but ideally s/he has to use much mental effort in this recall [9]. Therefore, the individual level of practice questions for each learning module is determined according to the prior-knowledge assessed in the learning phase. This procedure makes sure that

every student gets mentally challenged and can profit from the retrieval questions. The practice phase takes place in several spaced intervals that increase in time (*spacing*). This spaced practice leads to a better long-term consolidation of what has been learned [10]. The used spacing intervals are based on prior-studies [11].

Formative Evaluation. Multiple empirical studies were conducted. One study revealed an interaction between prior-knowledge and different types of questions: Learners with little prior-knowledge benefitted from other types of tasks than learners with high levels of prior-knowledge. [12]. We took this aptitude-treatment interaction into account when designing our adaptive retrieval practice procedure.

3.3 Transfer Phase - Implementation Intentions

In this phase, we begin to foster transfer to everyday learning. The students were required to translate their declarative (theoretical) knowledge into concrete application intentions, and the students learn how they can independently optimize their everyday learning with the help of their new strategies. More specifically, we used the method of "implementation intentions" [13]: The students were encouraged to formulate if-then sentences to facilitate the application of learned strategies (then part) in specific learning situation (if part) and to finally automate their learning strategy application. Connecting learning strategies to concrete trigger situations makes it easier for learners to achieve transfer to everyday learning.

Formative Evaluation. We examined the specificity of the learners' implementation intention. We found that the learners need support to formulate not only specific trigger situations (if part) but also to detail concrete learning strategies (then part). We empirically tested several support procedures. We found that a strongly supported introduction and formulation of implementation intention was most successful. However, even this type of support did not lead to fully satisfactory strategy application.

References

- [1] K. R. Koedinger, P. Pavlik, B. M. McLaren, and V. Aleven, "Is it better to give than to receive? The assistance dilemma as a fundamental unsolved problem in the cognitive science of learning and instruction," *Proc. 30th Annu. Conf. Cogn. Sci. Soc.*, pp. 2155–2160, 2008.
- [2] K. Wäschle, A. Allgaier, A. Lachner, S. Fink, and M. Nückles, "Procrastination and self-efficacy: Tracing vicious and virtuous circles in self-regulated learning," *Learn. Instr.*, vol. 29, pp. 103–114, 2014.
- [3] R. Schwonke, S. Hauser, M. Nückles, and A. Renkl, "Enhancing computer-supported writing of learning protocols by adaptive prompts," *Comput. Human Behav.*, vol. 22, pp. 77–92, 2006.
- [4] D. Jairam and K. A. Kiewra, "An Investigation of the SOAR Study Method," *Journal of Advanced Academics*, vol. 20, no. 4, pp. 602–629, 2009.
- [5] B. W. Tuckman and G. J. Kennedy, "Teaching Learning Strategies to Increase Success of First-Term College Students," *J. Exp. Educ.*, vol. 79, no. March 2015, pp. 478–504, 2011.
- [6] D. Gijbels and S. M. M. Loyens, "Constructivist learning (environments) and how to avoid another tower of Babel: Reply to Renkl," *Instr. Sci.*, vol. 37, pp. 499–502, 2009.
- [7] R. E. Mayer, *The Cambridge handbook of multimedia learning (2nd ed.)*. Mayer, Richard E.: Cambridge University Press, 2014.
- [8] J. D. Karpicke, "Retrieval-Based Learning: Active Retrieval Promotes Meaningful Learning," *Curr. Dir. Psychol. Sci.*, vol. 21, no. 3, pp. 157–163, May 2012.
- [9] T. Endres and A. Renkl, "Mechanisms behind the testing effect: an empirical investigation of retrieval practice in meaningful learning," *Front. Psychol.*, vol. 6, no. July, pp. 1–6, 2015.
- [10] S. H. K. Kang, R. V Lindsey, M. C. Mozer, and H. Pashler, "Retrieval practice over the long term: Should spacing be expanding or equal-interval?," *Psychon. Bull. Rev.*, pp. 1544–1550, 2014.
- [11] S. K. Carpenter, N. J. Cepeda, D. Rohrer, S. H. K. Kang, and H. Pashler, "Using Spacing to Enhance Diverse Forms of Learning: Review of Recent Research and Implications for Instruction," *Educ. Psychol. Rev.*, vol. 24, no. 3, pp. 369–378, Aug. 2012.
- [12] T. Endres, J. Leber, and A. Renkl, "Adaptive Retrieval Practice to Enhance Learning," in *JURE 2016 Education in a dynamic world*, 2016.
- [13] P. Gollwitzer and P. Sheeran, "Implementation intentions and goal achievement: A meta analysis of effects and processes," *Adv. Exp. Soc. Psychol.*, vol. 38, no. 2006, pp. 69–119, 2008.