ACTrain@School: Can we bring AI to the classroom to foster self-regulated learning?

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Learning requires a multitude of metacognitive activities that support knowledge acquisition and direct the learning process. These include selecting and planning goals, applying, observing and evaluating learning strategies as well as regulatory efforts required for goal achievement. We introduce an example of how learners can be supported to set goals, implement periods of focused work and integrate a meaningful break management by using the AI-based training software ACTrain. Metacognitive feedback based on principles of machine learning conveys the value of staying focused on goal-related activities. Pilot results already indicate positive effects of the presented approach and suggest further investigation. We will explore potentials for integrating such approach in school settings and how this could affect the role of teachers.

Keywords: Artificial intelligence, Computer-assisted learning, Educational technology, Self-regulation

Extended Summary

Most of us probably know situations like this: An article or essay deadline is approaching, we should focus on writing, but we have a hard time concentrating on the task. Our mind keeps wandering, and suddenly the funny online video seems far more interesting and worthwhile. At least in the short run, as we are well aware that in the long run the successfully published article or good exam performance offers the greater benefit. Situations like these vividly demonstrate the high presence of self-regulation demands when coping with our daily duties. In a world of constantly changing professional requirements, clever strategies supporting the lifelong and sustainable skill acquisition form an essential competence beyond knowledge-based contents. This further emphasizes the necessity to build strong skills in self-regulated learning across the educational career path. How can we promote them early on in our students? And what role can smart technologies play in this?

A core characteristic of self-regulated learning processes is that learners systematically orient their thoughts and actions towards their own, self-selected learning goals and keep them aligned (Locke & Latham, 2002; Zimmerman, 2000). Related executive functions activate the inhibition of distracting stimuli and the top-down control of attention towards goal-relevant information (Hofmann, Schmeichel & Baddeley, 2012). Hence, strong attentional control skills form a prerequisite of self-regulated learning that benefits learning performance (Wirzberger & Rey, 2018). These skills can be strengthened by cognitive training (Karbach & Verhaegen, 2014), however, transferring the acquired skills to everyday life contexts remains challenging (Smid, Karbach & Steinbeis, 2020).

Inspired by this challenge, the AI-based training software ACTrain (Wirzberger, Oreshnikov et al., 2020) has been developed to promote attention control skills in regular study and work activities, turning everyday life into a gym for the mind. It is effective across all phases of self-regulated learning (Zimmerman, 2000): In the *forethought phase*, it can be used to plan target activities in advance, including required programs and websites. Breaking down the workflow into units of focused work that alternate with short breaks enables an intelligent break management, aligned with established productivity techniques (e.g., “Pomodoro technique”, Cirillo, 2006). Formative feedback during the *performance phase* allows learners to monitor invested resources relative to a predicted optimum (Shenhav, Botvinick & Cohen, 2013), and adjust their focus according to their target activities. Based on principles of machine learning (Ng, Harada & Russell, 1999), embedded audio-visual messages communicate the value of

staying focused on the previously defined goal, if a learner's focus derails, and trigger a metacognitive process of strategic reflection. Reflection processes in the *self-reflection phase* are further supported by retrospective self-assessment and summative feedback at the end of each focus unit. By means of a Kalman filter (Kalman, 1960), learners can keep track of how their attention control skills evolve over time. A pilot study with 99 students compared the effectiveness of ACTrain with a placebo version without feedback (Wirzberger, Lado et al., 2020). Participants in both conditions used the software during their regular study activities on six of eight days during the study. Approximately 54% of all participants provided log files at the end and the majority of them had used the software for at least 10 hours. Taken together, the results showed that getting feedback resulted in a more focused performance. Likewise, the data indicated a more intense use of the software with feedback, obvious by longer and more frequent focus units.

How can we utilize the benefits of a software like this in the classroom to support both teachers and students? Can we leverage this tool for diagnosing learning difficulties, resource overload or insufficient learning techniques? Based on such knowledge, teachers could take on a guiding role and together with their students work on underlying causes, analyze and refine supportive learning strategies or reflect on sources for distraction. We will open the floor to discuss possibilities of structural and curricular integration. Bringing AI and education together should be a further step on the way to empower all learners to develop their full potentials.

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References

Cirillo, F. (2006). *The Pomodoro technique (the Pomodoro)*.

Hofmann, W., Schmeichel, B. J. & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Science, 16*, 174–180.

Kalman, R. E. (1960). A new approach to linear filtering and prediction problems. *Journal of Basic Engineering, 82*, 35–45.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist, 57*, 705–717.

Ng, A. Y., Harada, D., & Russell, S. (1999). Policy invariance under reward transformations: Theory and application to reward shaping. In: *Proceedings of the 16th Annual International Conference on Machine Learning* (pp. 278–287).

Shute, V. (2008). Focus on formative feedback. *Review of Educational Research 78*, 153–189.

Shenhav, A., Botvinick, M. M., & Cohen, J. D. (2013). The expected value of control: an integrative theory of anterior cingulate cortex function. *Neuron, 79*, 217–240.

Smid, C. R., Karbach, J., & Steinbeis, Nikolaus (2020). Toward a science of effective cognitive training. *Current Directions in Psychological Science, 29*, 531–537.

Wirzberger, M., Oreshnikov, I., Passy, J.-C., Lado, A., Shenhav, A., & Lieder, F. (2020). ACTrain: Ein KI-basiertes Aufmerksamkeitstraining für die Wissensarbeit [ACTrain: An AI-based attention training for knowledge work]. In GfA, Dortmund (Ed.) *Frühjahrskongress 2020, Digitaler Wandel, digitale Arbeit, digitaler Mensch?* (C.8.8). Dortmund: GfA Press.

Wirzberger, M., Lado, A., Eckerstorfer, L., Oreshnikov, I., Passy, J.-C., Stock, A., Shenhav, A., & Lieder, F. (2020). How to navigate everyday distractions: Leveraging optimal feedback to train attention control. In S. Denison., M. Mack, Y. Xu, & B.C. Armstrong (Eds.), *42nd Annual Meeting of the Cognitive Science Society* (p. 1736). Cognitive Science Society.

Wirzberger, M., & Rey, G. D. (2018). Attention please! Enhanced attention control abilities compensate for instructional impairments in multimedia learning. *Journal of Computers in Education, 5*, 243–257.

Zimmerman, Barry J. (2000): Attaining self-regulation: A social cognitive perspective. In: M. Boekaerts, P. R. Pintrich, & M. Zeidner, (Eds.), *Handbook of self-regulation* (pp. 13–39), San Diego, CA.