Intelligent Support for Practice Goal Setting to Enhance Learning

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Abstract. Setting practice goals, which helps students regulate their effort toward achieving engagement and mastery, can enhance the benefits of active learning. However, traditional goal-setting approaches, such as homework contingency contracts, often lack frequent feedback and require substantial human intervention. The presented research investigates integrating intelligent and scalable goal-setting support within active learning environments. In recent research, we have evaluated the impact of goal-setting contracts, performance feedback, and scalable goal support with rewards on student effort and learning. The proposed research aims to study student achievement trajectories related to achievement and the distinct impact of adaptive goal feedback. To that end, we propose developing an adaptive goal-setting dashboard that automates feedback and recommendations to support students in setting and refining their goals. Findings from a 12-week study with 110 middle school students in a hybrid tutoring program show that data-supported goal setting led to a about 25% increase in weekly practice time and a about 40% increase in skills mastered per week. These results indicate that intelligent goal setting can enhance engagement and learning while minimizing teacher workload. This research contributes to practical advancements in AI-assisted active learning and theoretical insights into self-regulatory processes related to student effort in active learning.

Keywords: goal setting, hybrid tutoring, K-12, STEM, active learning

1 Problem Statement and Research Questions

Active learning—central to AIED systems such as intelligent tutors and teachable agents—engages students in problem-solving rather than passive instruction. When instruction is effectively tailored to individual learners, it improves learning outcomes across levels of prior knowledge [14]. However, the success of such instruction critically depends on students' motivation to engage in sustained, effortful practice—a principle supported across demographics and classroom settings through cognitive modeling studies [8, 14].

Practice goal setting—where students define quantified objectives tied to their effort (e.g., solving a certain number of problems or spending a set amount

of time)—has long been shown to improve engagement and achievement in education [13, 3]. Traditionally, these goals were implemented via paper-based contracts with accountability partners (e.g., parents or teachers) and accompanied by contingent rewards [3]. However, such implementations are often limited in scalability and lack integration with digital learning environments [17].

In contrast, scalable goal-setting solutions in AIED have largely emphasized support for self-regulated *learning processes*—such as concept mastery, applying a cognitive strategy, or consulting resources—typically once practice is already underway [15, 4]. Less attention has been paid to more foundational self-regulation activities relevant to goal achievement, including managing effort and performance reflection. Although these behaviors have been linked to academic outcomes, they are often examined through distinct literatures on performance management and goal attainment [16, 9], beyond the learning sciences [11].

This research argues for a stronger integration of foundational self-regulation support into AIED environments by leveraging their adaptive and data-driven capabilities. It explores scalable practice goal-setting solutions that require minimal human oversight, drawing on learner performance log data [17]. While prior efforts to foster self-regulation in AIED have typically employed non-adaptive interventions—such as growth mindset messaging [1]—research on self-regulated learning has shown the benefits of adaptive, just-in-time support [4]. The present research investigates how adaptive and data-informed elements can support self-regulation in the context of goal setting with contingent rewards. This approach has demonstrated success in behavioral health interventions [2]. For learners, adaptive goal support could improve effort calibration and goal adjustment [12, 10], part of the foundational self-regulation activities required for successful goal pursuit, identified in past work [16]. Three research questions guide the research:

RQ1: How does regular goal achievement feedback influence students' effort?
RQ2: How do intelligent goal-setting support compare to traditional goal-setting approaches and business-as-usual active learning in AIED systems?
RQ3: To what extent is data-driven goal-setting support effective in real-world classroom settings regarding learning and goal achievement?

2 Theoretical Framework

This research builds on foundational goal-setting theories [16] and self-regulated learning models [12]. Three key principles inform the research and tool design:

Principle 1: Feedback is effective for general domain learning but also for self-regulation [18]. Regularly provided feedback improves students' ability to regulate their effort toward goal achievement.

Principle 2: Goal recommendations should be adapted to students' historical performance averages [2]. These adjustments enhance the probability of goal achievement and its engagement benefits [19].

Principle 3: Goal-setting support should promote accountability and rewards through a human tutor, teacher, or another caregiver, similar to past research on goal-setting contracts, while remaining scalable [13, 3].

These principles inform the design and evaluation of intelligent practice goal-setting support during active learning in AIED systems, which provide real-time data for performance feedback and goal recommendations [17].

3 Proposed Solution

The proposed solution, incorporating design principles from past research, is an intelligent practice goal-setting support designed to:

- Actively involve learners in goal setting and retain learner control over goals, as desired by K-12 students [6]
- Regularly provide feedback on goal progress [17] and adjust goal difficulty based on performance [2] to increase the probability of goal achievement.
- Reduce the need for teacher or researcher intervention by automating goal recommendations and scaling tutoring [5, 6].

These three principles are hypothesized to improve student effort regulation and engagement, leading to more learning opportunities in AIED learning software, which are expected to lead to more content mastery (Fig. 1).

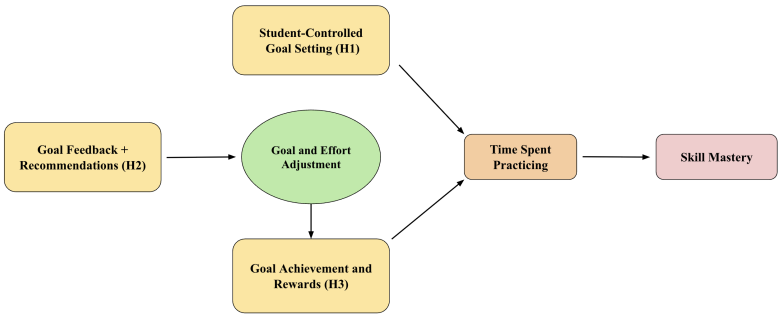

Fig. 1: Theory of change diagram with three hypotheses, where student goal setting (H1), goal adjustments (H2), and the impact of goal achievement (H3) are studied in relation to practice engagement and skill mastery outcomes.

The goal-setting support integrates with any learning system that tracks student activity, informing custom modules (built as part of this research) that dynamically suggest goals. An example goal recommendation based on a pen-and-paper implementation, extending past goal contracts [3], is in Fig. 2.

4 Methodology

This research follows a multi-phase research design:

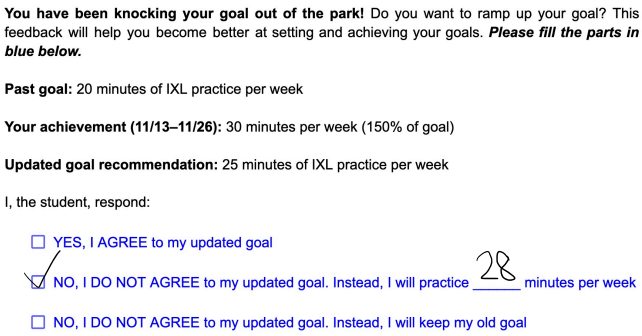

Fig. 2: Illustration of student interaction with an updated goal recommendation based on historical performance averages. Students retain final goal control.

- **Study 1:** A 12-week within-subjects quasi-experimental study with about 100 middle school students in a hybrid tutoring program, analyzed through an interrupted time series model (completed).
- **Study 2:** A randomized controlled experiment comparing adaptive goal setting to assigning a static goal to students (control condition) in an adaptive learning system, including about 150 students in a cross-over design.
- **Study 3:** Development and qualitative evaluation of an adaptive goal-setting dashboard with goal recommendations using design prototyping methods.
- **Study 4:** Process-level analysis of student trajectories in goal achievement based on reward factors and adaptive goal adjustments in Study 1+2 [19].

5 Hypotheses

Study 1 [5] and progress on Study 3 [7] are published in this year's AIED proceedings. For Studies 2 and 4, which are underway, based on the theoretical framework and proposed methods, we formulate the following hypotheses:

- **H1:** Student-controlled goal setting is more effective for practice time and skill mastery than static, assigned goals.
- **H2:** Goal feedback, recommendation, and adjustment opportunities will increase goal achievement compared to those in the control condition.
- **H3:** Rewards associated with goal achievement will moderate longitudinal trends in practice time and skill mastery, enhancing outcomes.

6 Expected Contributions

This research contributes to theoretical and practical advancements in AI-supported active learning, where engagement remains a fundamental challenge to improve learning outcomes for all students [14]. The anticipated contributions include:

- Theory-informed practice goal-setting support in AIED, bridging research on goal setting, self-regulation, and learning technologies [16, 2, 6, 14].
- Empirical evidence on how frequent, adaptive goal recommendations influence student engagement and learning outcomes [9, 12].
- A scalable goal-setting system that reduces teacher workload while maintaining student autonomy and personalized learning pathways [17, 6].
- Insights into how adaptive feedback loops shape self-regulation and enhance learning persistence during technology-supported active learning [10, 14].

7 Summary and Preliminary Findings

This research investigates the role of intelligent practice goal setting in fostering engagement and self-regulation in active learning environments. By integrating theoretical insights from goal-setting and models of self-regulation with empirical evaluations of intelligent tutoring, this work advances the understanding of how AI can support student engagement and achievement in effortful active learning. The findings contribute to the broader discourse on adaptive learning, offering a scalable framework for embedding goal-setting strategies into AI-assisted educational platforms. Future directions include refining adaptive algorithms, extending deployment to different learning contexts, and exploring long-term effects on student self-regulation, learning, and persistence.

Findings from Study 1 suggest that integrating goal-setting support into hybrid tutoring significantly boosts engagement and learning. A 12-week study with 110 middle schoolers showed a about 25% increase in weekly practice time and a about 40% rise in skills mastered [5]. These gains remained stable, indicating sustained engagement. Notably, skill mastery improved more than time spent, suggesting enhanced practice quality. The results highlight AI-assisted goal-setting's potential to improve learning with minimal teacher effort.

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