

Supporting Learners Beyond the Instruction: An Adaptive Learner Development (ALD) Framework for Educational Technology

Abstract

Adaptive educational technologies have traditionally focused on two primary objectives: adapting instruction to learners' needs and supporting educators' instructional decision making. Comparatively less attention has been given to how learner-facing supports can be systematically organized to foster learners' long-term development throughout the learning process. This paper introduces the Adaptive Learner Development (ALD) Framework, a developmental perspective for designing learner-support systems within educational technology. Drawing on literature on cyclical models of self-regulated learning and self-determination theory, the framework proposes learner development as an additional target for adaptive educational technology. It organizes learner-facing support around the cultivation of developmental learning capacities, including persistence, emotional regulation, strategic help-seeking, metacognitive awareness, and learner agency. The framework is illustrated through an initial prototype of Achievo, an AI-powered learning companion developed as an exploratory proof of concept within an Open Educational Resources (OER) environment. Achievo demonstrates one possible implementation of the framework through features that support goal setting, reflection, encouragement, learner choice, and strategic help-seeking. Learner experiences from three college students who used the prototype during a two-week deployment are presented as preliminary observations that inform future design. Finally, the implications of the ALD Framework for the design, implementation, and evaluation of developmental learner-support systems across educational technologies are discussed.

Supporting Learners Beyond the Instruction: An Adaptive Learner Development Framework for Educational Technology

Learning increasingly occurs across a diverse range of digital environments that extend beyond traditional face-to-face classrooms, providing greater flexibility in where, when, and how learning takes place. Advances in educational artificial intelligence have further contributed to the development of personalized learning and adaptive educational technologies, including adaptive learning systems, intelligent tutoring systems, automated feedback, generative AI, and learning analytics tools. These technologies seek to improve learning by optimizing different aspects of the educational process, including instructional adaptation and instructional decision making based on learners' characteristics and performance (Graesser et al., 2014; Ma et al., 2014; VanLehn, 2011; Zawacki-Richter et al., 2019; Zhang & Aslan, 2021). Findings from meta-analysis studies indicate that intelligent tutoring systems can significantly improve learning outcomes, although their effectiveness varies according to system design, comparison condition, and learning context (Ma et al., 2014).

Much of this work has focused on improving learning through more effective instruction or by supporting teachers' instructional decisions. Adaptive instructional systems personalize content, pacing, feedback, and practice according to learners' characteristics and performance, whereas learning analytics and teacher-support tools provide information that helps educators interpret learning processes and make more informed instructional decisions. These approaches have expanded the ways educational technologies can support teaching and learning. However, successful learning may also depend on how learners respond to the motivational, emotional, and behavioral challenges that arise throughout the learning process.

A large body of research suggests that learners' social-emotional competencies, such as self-regulation and emotion regulation, play important roles in sustaining productive engagement during learning. Independent and online learning, for example, place considerable demands on learners' ability to manage time, regulate effort, monitor understanding, and remain engaged without continuous instructor support (Broadbent & Poon, 2015; Lehmann et al., 2014; Zimmerman, 2002). But learners may experience frustration, uncertainty, declining motivation, procrastination, and disengagement while working through instructional activities. Research on self-regulated learning, academic emotions, and online learning consistently indicates that various motivational, emotional, and behavioral processes influence engagement, persistence, and academic success (Artino, 2009; Pekrun, 2006; Richardson et al., 2017). This literature suggests that learners could benefit from supports to navigate the psychological and behavioral challenges encountered during learning, more than supporting effective instruction delivery.

To address these needs, educational technologies have increasingly incorporated learner-facing support features such as encouragement, conversational agents, dashboards, reflective prompts, and other personalized interventions. Although these supports are becoming more common, they are typically developed as individual features or system components rather than viewed within a broader developmental perspective focused on supporting the development of effective learners (Araka et al., 2020; Prasse et al., 2024). Here, adaptive learner support refers to the process of providing learner support in relation to learners' developmental characteristics and experiences over time. Support decisions may be initiated by learners themselves, by the educational technology through inference of learner states, or through combinations of learner-configured and system-informed support. The defining characteristic of adaptive learner

support is the coordination of support decisions in response to learners' evolving developmental characteristics and learning experiences, regardless of who initiates those decisions.

This paper presents the Adaptive Learner Development (ALD) Framework as one perspective for organizing learner-facing support within adaptive educational technologies. The framework provides a way of considering how motivational, emotional, metacognitive, and behavioral supports can complement instructional adaptation while fostering learners' longer-term development. The learner-support features are viewed not as isolated interventions that improve immediate performance, but as opportunities to cultivate enduring learner characteristics, including persistence, resilience, emotional regulation, strategic help-seeking, and adaptive learning behaviors, that contribute to effective learning across contexts and over time.

The proposed perspective is illustrated through an initial prototype of Achievo, an AI-powered learning companion developed as an exploratory proof of concept within an Open Educational Resources (OER) environment. While Achievo incorporates a variety of learner-support features, its primary purpose here is to illustrate the developmental perspective that organizes these features rather than the individual features themselves. The following sections briefly review instructional adaptation, instructional decision support, and learner-facing adaptive support before describing the ALD Framework, its implementation through Achievo, followed by learner reflections from an early deployment, and implications for the design of future learner-support systems.

Instructional Adaptation

One major direction in adaptive educational technology has focused on improving learning by adapting instruction to learners' needs. This work encompasses intelligent tutoring systems, adaptive learning platforms, learner modeling, personalized content recommendation, automated feedback, and, more recently, generative AI (Ma et al., 2014; VanLehn, 2011; Zawacki-Richter et al., 2019). Across these approaches, a central design challenge has been determining how instruction should be adapted to best support learning.

Research in this tradition has focused on personalizing content, learning sequences, pacing, difficulty, explanations, practice opportunities, hints, and feedback according to learners' prior knowledge, performance, and inferred learning needs. These adaptive decisions rely on representations of learners' knowledge, performance, or other learning characteristics that guide decisions about what instruction or support to provide next. Intelligent tutoring systems, for example, commonly use representations of domain knowledge and learner performance to select appropriate problems, explanations, feedback, or instructional assistance (Ma et al., 2014; VanLehn, 2011). Although adaptation methods differ across systems, they share the common objective of tailoring learning experiences to better meet learners' needs.

Instructional Decision Support

A second major direction has focused on supporting instructional decision making through learning analytics, teacher dashboards, predictive models, and AI-assisted decision-support tools. Instead of adapting instruction directly, these technologies assist educators by providing information that can inform their instructional planning and intervention.

Teacher-facing learning analytics systems are designed to aggregate and present information about learners' participation, progress, performance, and learning processes to help teachers interpret classroom conditions and make more informed decisions (Kaliisa et al., 2022; van Leeuwen et al., 2022). Classroom dashboard systems further examine how real-time or

near-real-time information can help teachers identify students in need of assistance, coordinate classroom activities, and determine when intervention may be appropriate (Tissenbaum & Slotta, 2019).

More recently, these systems have expanded beyond academic performance to include indicators related to self-regulated learning. Teacher dashboards, for example, have been developed to help educators identify opportunities to foster learners' planning, monitoring, strategy use, reflection, and other self-regulatory processes (Michael et al., 2025). These technologies represent an important direction in adaptive educational technology by supporting educators' interpretation of learner data and instructional decision making.

Learner-Facing Adaptive Support

A third major direction in adaptive educational technology has focused on supporting learners directly through adaptive learner-facing supports. These supports are designed to respond to learners' motivational, emotional, metacognitive, and behavioral needs as learning unfolds. Examples include conversational agents, motivational messages, reflective prompts, emotional support, self-regulation prompts, and personalized feedback intended to encourage productive engagement during learning.

These approaches draw upon well-established research on self-regulated learning, academic motivation, academic emotions, and help-seeking, all of which demonstrate that learners' social emotional processes influence engagement, persistence, and academic success (Pekrun, 2006; Pintrich, 2004; Ryan & Deci, 2020; Zimmerman, 2002). Unlike instructional adaptation and instructional decision support, which focus primarily on adapting instruction or supporting teachers' decisions, learner-facing supports respond directly to learners' experiences during learning. They recognize that learners benefit from support that helps them manage frustration, sustain effort, regulate emotions, and remain engaged with challenging learning tasks.

In sum, these three major directions represent complementary targets for adaptive educational technology, each addressing a different aspect of the learning process. The following section introduces the Adaptive Learner Development (ALD) Framework, which extends learner-facing adaptive support by organizing learner support around the developmental learning capacities.

Adaptive Learner Development (ALD) Framework

Although learner-facing supports such as motivational prompts, reflective questions, virtual agents, self-regulation supports, and personalized nudges have become increasingly common, they are typically developed as individual interventions that address specific aspects of learning (Araka et al., 2020; Baylor, 2009; Graesser et al., 2014; Prasse et al., 2024).

The Adaptive Learner Development (ALD) Framework is a developmental perspective for organizing learner-facing support within adaptive educational technologies with improving learner's developmental learning capacities in mind. Whereas instructional adaptation focuses on determining how instruction should respond to learners' characteristics and performance, and instructional decision support focuses on determining what information educators need to guide instructional decisions, the ALD Framework focuses on determining what developmental learning capacity a particular learner-support decision is intended to cultivate. Framing learner support in this way shifts attention from individual support features toward the developmental purposes those features are intended to serve across repeated learning experiences.

Within the ALD Framework, developmental learning capacities refer to enduring capabilities that enable learners to regulate themselves, adapt to challenges, and engage productively across learning contexts over time. The framework builds on research suggesting that successful learning depends not only on effective instruction and knowledge acquisition but also on learners' ability to regulate motivation, emotion, cognition, and behavior (Pekrun, 2006; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002). It complements instructional adaptation and instructional decision support by extending their focus to learners' longer-term development.

Learners' cognitive, social, and emotional states and behaviors naturally fluctuate as learning unfolds, creating different opportunities for adaptive support (D'Mello & Graesser, 2012; Harley et al., 2015). From ALD perspective, the primary design question is not simply what intervention should be delivered, but what developmental learning capacity the support should cultivate at that moment. Depending on the learner's situation, support might strengthen emotion regulation, foster productive help-seeking, encourage persistence, promote autonomy through intentional goal setting, or reinforce effective learning strategies. Once an appropriate developmental objective has been identified, a suitable support strategy can be selected and implemented. Whether delivered through an AI conversation, reflective prompt, encouragement, or another intervention, the specific implementation is secondary to the broader developmental objectives it serves.

A developmental perspective also broadens how learning progress is conceptualized. In addition to assessment outcomes of content comprehension, meaningful progress may include changes in learners' developmental learning capacities, like their levels of persistence, adaptive help-seeking, emotional regulation, or confidence when encountering learning difficulty. Thus, instructional difficulty is not viewed solely as a barrier but also as an opportunity to strengthen learners' developmental learning capacities (Kapur, 2008, 2016; van de Pol et al., 2010; Wood et al., 1976), thereby helping learners engage more effectively with future learning challenges across contexts and over time.

The ALD Framework is broadly informed by existing models of self-regulated learning and motivation. Cyclical models of self-regulated learning, such as Zimmerman's (2002) forethought-performance-reflection cycle and Winne and Hadwin's (1998) model of studying as self-regulated activity, describe the cognitive and behavioral processes learners engage in while managing a learning session. On the other hand, self-determination theory (Ryan & Deci, 2020) emphasizes the importance of autonomy, competence, and relatedness in supporting autonomous motivation, engagement, and psychological well-being. The ALD Framework draws on these theoretical traditions but shifts the focus from modeling learners' internal processes to guiding the design of learner-facing support. Existing self-regulated learning models primarily describe how learners regulate their learning within a learning episode. In contrast, the ALD Framework considers how adaptive learner support can be organized across repeated learning experiences to foster the development of developmental learning capacities such as resilience, persistence, strategic help-seeking, and self-regulation. In other words, self-regulated learning is extended beyond the management of individual learning episodes to include the intentional development of the capacities that support learning over time. Learners' growing capacity to manage their own learning is treated not simply as a pathway to improved task performance but as a developmental outcome.

Accordingly, the ALD Framework is best viewed as a conceptual perspective rather than a prescriptive model for specific algorithms or intervention strategies. Instead, it provides an

expanded perspective for organizing learner-facing support around developmental objectives while allowing flexibility in implementation across different educational technologies and learning contexts.

The following section illustrates this perspective through Achievo, an AI-powered learning companion developed as an exploratory proof of concept within an Open Educational Resources (OER) environment. It should be noted that this version of Achievo represents an early prototype to explore the feasibility of the framework and therefore does not include all of its proposed capabilities envisioned for the application. Several features were simplified or deferred to future versions, particularly those involving more advanced system-informed learner support. Consequently, Achievo illustrates one possible implementation of the developmental perspective described here and should not be interpreted as a complete implementation or validation of the framework.

Achievo: Implementing the ALD Framework in an OER Environment

Achievo was developed as an exploratory AI-powered learning companion to demonstrate one implementation of the Adaptive Learner Development (ALD) Framework within an Open Educational Resources (OER) environment. It provides learner-facing developmental support alongside existing instructional materials without functioning as an intelligent tutoring system or adaptive learning platform.

This version of Achievo emphasizes learner-configured support. Learners determine, for example, how frequently they wish to receive check-ins, when to seek assistance, and whether to engage with optional supports. More advanced system-informed support based on learners' motivational, emotional, metacognitive, and behavioral states was intentionally deferred to future versions of the application.

Achievo organizes learner support around a recurring learning cycle consisting of goal setting, learning, progress monitoring, reflection, and celebration. At each stage of the cycle, learner-support features provide opportunities to strengthen developmental learning capacities such as persistence, self-regulation, emotion regulation, strategic help-seeking, and meta-cognitive awareness. Through repeated learning experiences, these capacities are expected to develop over time, helping learners become more active and effective participants in their own learning.

At the beginning of each study session, learners establish personally meaningful goals, whether based on study time, chapters, modules, or other self-defined objectives. Achievo encourages learners to identify what they hope to accomplish and why those goals are personally meaningful, while leaving goal selection to the learner. Throughout the session, learners can monitor their progress toward these goals, acknowledge meaningful milestones, and conclude with reflection on what they learned, how they responded to challenges, and how their efforts contributed to their goals. This recurring cycle of goal setting, engagement, monitoring, celebration, and reflection is intended to strengthen developmental learning capacities related to agency, purpose, and self-directed learning (Locke & Latham, 2002; Ryan & Deci, 2020; Zimmerman, 2002).

The remaining learner-support features were designed to foster complementary developmental learning capacities as learners work toward their self-identified goals. For example, encouragement messages were designed to reinforce persistence during moments of challenge without immediately providing assistance. Delivered during learner-selected check-in

intervals, these messages normalize challenge as a natural part of learning while reinforcing the value of sustained effort and continued engagement.

Stress-regulation strategies and optional break prompts support learners when frustration or fatigue may interfere with productive learning. These supports become available during learner-selected check-in intervals or whenever learners decide they are needed, allowing learners to regulate the pacing of their own study sessions. Here, the goal is not to eliminate struggle but to help learners distinguish between productive challenges and situations in which emotional or cognitive overload may reduce the effectiveness of continued effort (D'Mello & Graesser, 2012). This feature primarily targets the development of emotion regulation and adaptive persistence.

The help/check-in feature is similarly intended to foster strategic help-seeking. Learners decide when check-in prompts should appear during study sessions and remain free to request assistance whenever they consider it beneficial. By making intentional decisions about when to continue working independently and when to seek support, learners have repeated opportunities to strengthen their confidence in solving problems on their own while refining their judgment about when assistance is most beneficial (Aleven et al., 2003; Kapur, 2008; van de Pol et al., 2010).

The AI chatbot provides learner-initiated learning support whenever assistance is requested. Learners may choose the type and level of guidance they wish to receive, ranging from basic hints to more conceptual explanations. By allowing learners to decide when to seek assistance and how much support they require, the chatbot fosters strategic help-seeking while preserving learner autonomy. Future versions of Achievo will extend this learner-initiated approach by incorporating system-informed recommendations based on learners' motivational, emotional, metacognitive, and behavioral states while supporting the same developmental objectives.

The reflection section at the end of each study session encourages learners to examine their understanding, emotional experiences, and learning strategies following their learning activities. Before completing their reflection, learners can review a session summary displaying information such as study time, break time, and AI support usage. These repeated opportunities for self-monitoring support the development of metacognitive awareness and self-regulatory habits over time (Pintrich, 2004; Zimmerman, 2002).

Learner choice is embedded throughout Achievo to reinforce agency and ownership. Whenever appropriate, learners can choose whether to accept, postpone, modify, or decline particular forms of support. This design reflects the view that learner development depends not only on receiving effective support but also on repeatedly making meaningful decisions about one's own learning (Ryan & Deci, 2020).

Overall, these features demonstrate how the ALD Framework can coordinate learner-facing support across a learning cycle to foster multiple developmental learning capacities through repeated learning experiences. This initial implementation emphasizes learner-configured support while demonstrating how developmental learner support can be integrated throughout the learning process. Future implementations may incorporate system-informed learner support to personalize the timing, form, and intensity of support while preserving the same developmental perspective and meaningful learner agency.

Learner Experiences from an Early Prototype

To provide an initial understanding of how learners experienced the ALD-informed design, three students who used Achievo alongside a college precalculus course participated in semi-structured interviews following a two-week deployment. These learner experiences are presented to inform future design rather than to evaluate the effectiveness of the framework. The discussion is organized around the developmental learning capacities the framework is designed to cultivate to examine how learners experienced different forms of developmental support and what design considerations emerged from their feedback.

Persistence and Motivation

One learner described how the timer influenced her persistence during a two-hour study session before a precalculus final. As frustration increased near the end of the session, she explained: "I had looked at the timer, and I only had like 10-ish minutes left. So, I was like, okay, I just have 10 minutes left. Once I get through this, I'm done for the day."

The learner described the timer as helping transform a period of mounting frustration into a manageable, time-bounded goal. This experience is consistent with the framework's emphasis on supporting productive persistence while allowing learners to continue working through meaningful challenges.

Experiences with Achievo's motivational messages were more varied. Two participants described the messages as becoming static over time. One explained that the assigned message never changed and "doesn't mean anything new to me," while another suggested it "would be really cool if you could switch through quotes."

A third participant described the same feature as "a bit generic, but helpful" and identified it as the aspect of the system that most supported her engagement. This pattern highlights an important design consideration. Sustaining motivational relevance across repeated learning experiences may require adaptive or varied forms of encouragement instead of one-time personalization.

Agency and Learner Choice

Learners also differed in how the system's structure aligned with their preferred ways of studying. One participant found the timer helpful for maintaining effort during demanding study sessions while also observing that it conflicted with her usual study habits:

"I don't usually time myself... I now feel like I have to tailor my studying in a different manner, which made it difficult."

Although Achievo also allowed learners to establish goals based on chapters, modules, or other self-defined objectives, these alternatives may not have been sufficiently visible during use. This experience underscores an important design consideration for developmental learner support. Structures that promote self-regulation for some learners may reduce flexibility for others. Supporting agency therefore involves providing meaningful structure as well as preserving learner choice in how that structure is used.

Participants also differed in whether Achievo appeared to influence their confidence when approaching difficult material. One participant reported little change, another expressed uncertainty, and a third described feeling "a bit more comfortable" and experiencing "a bit more clarity" when working through unfamiliar content. These experiences suggest that learners differ in the types and intensity of support that are most beneficial at different stages of learning, reinforcing the importance of preserving flexibility within developmental learner support.

Metacognitive Awareness and Strategic Help-Seeking

Two additional design considerations emerged consistently across the interviews. Reflection-oriented features intended to support self-monitoring were underused or difficult to locate. One participant reported taking notes during study sessions but was unsure how to review them afterward. This feedback suggests that developmental supports intended to strengthen metacognitive awareness must be readily discoverable and naturally integrated into learners' study routines if they are to become meaningful parts of repeated learning experiences.

The AI chatbot also received relatively little use. Participants more frequently discussed structural features such as timers, goal setting, and encouragement than the conversational support itself. This finding suggests that simply providing opportunities for strategic help-seeking does not guarantee their use. The developmental value of learner-support features arises not simply from their availability, but from learners recognizing their purpose, understanding when they may be useful, and choosing to engage with them during authentic learning situations.

These learner experiences should be interpreted as preliminary design observations rather than evidence of the ALD Framework's effectiveness. The small number of participants and the early stage of Achievo's development made it difficult to conclude about the framework's impact on learner development. Even so, the interviews identified several opportunities for refinement, including sustaining motivational relevance across repeated use, improving the visibility and integration of reflection-oriented features, preserving flexibility for learners with different study preferences, and encouraging more meaningful engagement with learner-initiated support. These observations also reinforce a broader implication of the ALD Framework that the effectiveness of developmental learner support depends on the supports that are available as well as how naturally those supports become integrated into learners' ongoing learning experiences.

Implications for Educational Technology

The ALD Framework provides a developmental perspective for informing the design and study of learner-support features across a wide range of educational technologies. Learner-facing developmental support could be incorporated into learning management systems, homework platforms, adaptive learning environments, and other digital learning technologies. Although specific implementations would differ according to the learning context, learner population, instructional goals, and degree of teacher involvement, the central principle remains the same: learner-support features should be designed as coordinated developmental experiences that extend beyond addressing immediate learning needs.

One implication of the framework is the need to organize learner-support systems around coherent developmental processes, not just treating adaptive features as independent components. The ALD Framework proposes that learner support can help learners identify personally meaningful goals, exercise agency through meaningful choices, persist through challenges, reflect on their experiences, and gradually strengthen the motivational, emotional, metacognitive, and behavioral capacities that support future learning. This perspective shifts attention from optimizing individual support strategies toward understanding how multiple forms of learner support can function together as parts of a coherent developmental process that unfolds across repeated learning experiences.

A second implication concerns the implementation of adaptive learner support. Determining when support should be offered, what form it should take, and when it should be withheld remains a significant design challenge. Motivation, frustration, confidence, and

engagement cannot be directly observed, and behavioral indicators often have multiple interpretations (D'Mello & Graesser, 2012). Adaptive systems therefore can make support decisions under conditions of uncertainty while avoiding unnecessary intervention that could undermine learner autonomy or productive struggle. Achievo's initial implementation addressed this challenge by relying primarily on learner-configured choices, with automated learner-state inference intentionally reserved for future iterations. Future work on Achievo and developmental learner-support systems more broadly can investigate how learner modeling, adaptive decision-making, and personalization can be implemented in ways that supports learners' independent decision making (Azevedo & Gašević, 2019; Harley et al., 2015; Ryan & Deci, 2020).

A third implication concerns how learner-support systems can be evaluated. Educational technologies have traditionally emphasized outcomes such as learning performance, completion rates, and efficiency. The ALD Framework suggests that evaluation can also consider developmental outcomes, including learners' sense of agency, persistence when encountering challenges, strategic help-seeking, reflective thinking, emotional regulation, and ownership of learning. These capacities are unlikely to develop through isolated learning sessions, highlighting the need for longitudinal research that examines how repeated learner-support experiences influence learners' development over time. The learner experiences presented above provide an initial example of how developmental themes may emerge during use, particularly persistence and variation in learners' responses to the same forms of support. They do not, however, provide the longitudinal evidence needed to evaluate developmental change.

Finally, the proposed framework is intended to extend existing instructional and teacher-support technologies, not replace them. Learner-facing supports may provide guidance during independent learning, while teachers remain essential for interpreting learners' broader educational and social needs. Future research can examine how developmental learner-support systems can complement teacher expertise without unnecessary surveillance or minimizing learners' ownership of their learning (Kaliisa et al., 2022; van Leeuwen et al., 2022).

Conclusion

As digital learning environments continue to expand, educational technologies have increasing opportunities to support learners beyond the delivery of instructional content. Although significant progress has been made in adapting instruction and providing decision support for teachers, comparatively less attention has been given to how learner-facing support can be designed to foster learners' development throughout the learning process.

This paper introduced the Adaptive Learner Development (ALD) Framework as a developmental perspective for designing learner-support systems. Building upon cyclical models of self-regulated learning together with self-determination theory, the framework proposes that learner-facing support should be organized around learners' long-term development, allowing individual support features to function as coordinated parts of a broader developmental process instead of isolated interventions. In doing so, the framework expands adaptive educational technology by identifying learner development as an additional target for adaptive support alongside instructional adaptation and instructional decision support.

Achievo demonstrated one possible implementation of this perspective within an Open Educational Resources (OER) environment. Although the prototype incorporated only a subset of the framework's envisioned adaptive capabilities, it provided an initial opportunity to operationalize the conceptual perspective within a functioning learner-support system. Early

learner experiences identified several design considerations that may inform future refinement of developmental learner support, including sustaining motivational relevance, supporting learner choice, improving the integration of reflection-oriented features, and encouraging meaningful engagement with learner-initiated support.

The ALD Framework proposes that learner development can serve as an organizing principle for learner-facing support across educational technologies. Viewing adaptive systems from this developmental perspective opens opportunities to investigate how educational technologies can help learners become increasingly self-directed, persistent, reflective, and emotionally resilient across repeated learning experiences. Longitudinal empirical research is needed to determine when, for whom, and under what conditions developmental learner support contributes meaningfully to learners' experiences and long-term development. After all, an important part of education concerned not only with what learners know today, but also with developing the capacities that enable them to continue learning tomorrow.

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