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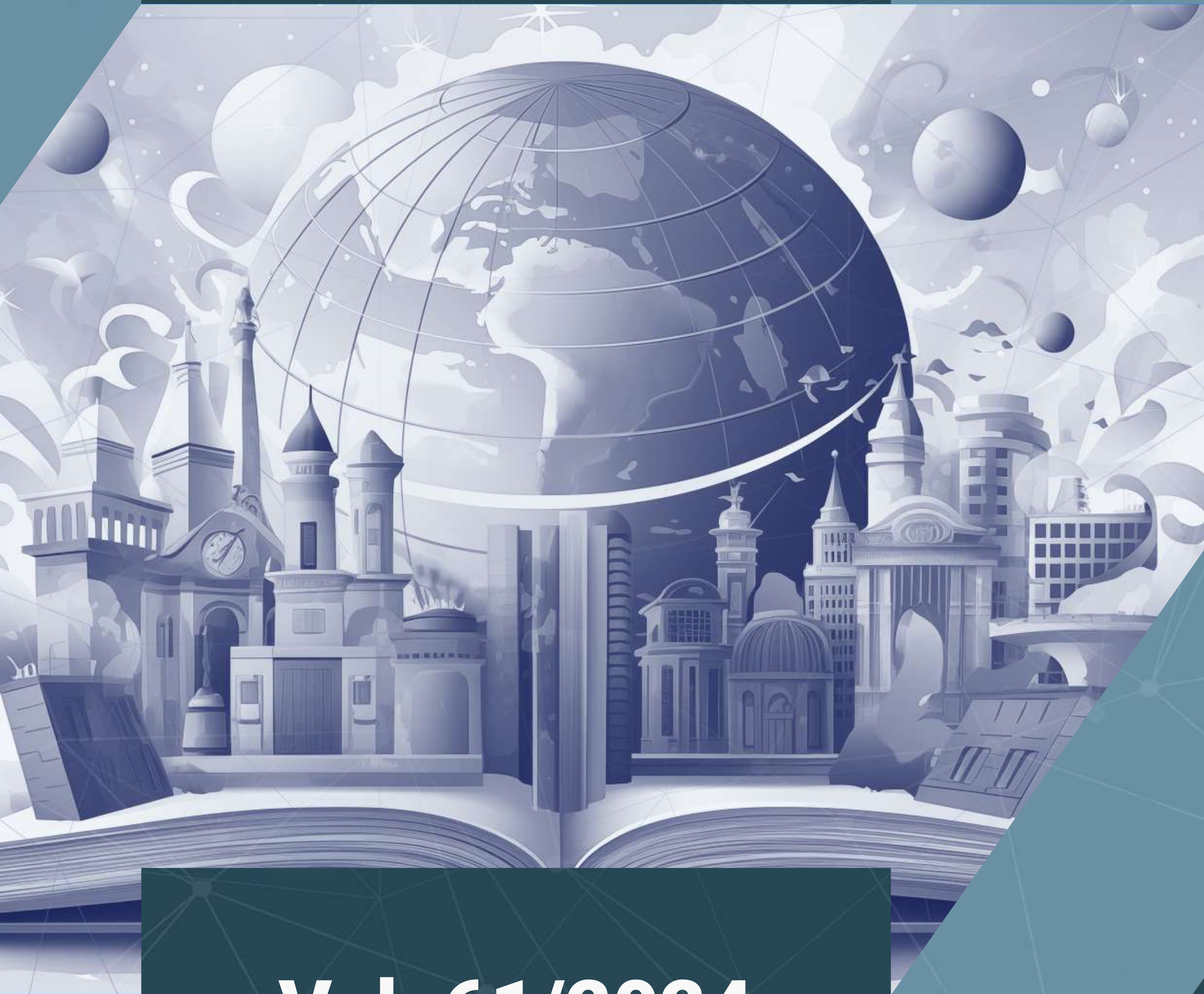

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Revisiting prompting in the age of digital pedagogy: a theoretical analysis of pedagogical techniques in contemporary educational technologies

Dana Rad[1], Alina Roman[1,*], Radiana Marcu[2,*], Ramona Tatiana Bennett[1,*]

[1]Center of Research Development and Innovation in Psychology, Faculty of Educational Sciences Psychology and Social Work, Aurel Vlaicu University of Arad, 310032, Arad, Romania, [2]Faculty of Social Sciences, Humanities, and Physical Education and Sports, Vasile Goldiș Western University of Arad, 310025, Arad, Romania

dana@xhouse.ro, romanalinafelicia@yahoo.com, radimarcu@yahoo.com, nia_1551@yahoo.com

Abstract. This research revisits the utilization of prompting as an essential teaching technique in digital pedagogy, taking into account its changing significance in response to technological progress. This study presents a paradigm that highlights the importance of prompting in supporting digital learning environments. It analyzes different types of prompting, their usefulness, and how learning progresses through strategies like fading and shadowing. Additionally, this study examines the practical consequences, implementation processes, and future research issues in the field of digital pedagogy.

Keywords. prompting, digital pedagogy, fading, shadowing, self-directed learning

Introduction

The rise of digital pedagogy in education has introduced novel approaches, technologies, and frameworks that question conventional teaching methods in the constantly changing educational environment. At the core of this change is the teaching technique referred to as prompting. Although prompting has been widely used in educational psychology to assist learners in developing cognitive, metacognitive, and problem-solving abilities, its significance in the digital domain requires a reassessment. In the realm of digital education, the act of urging has evolved beyond simple teacher-student interactions and now encompasses complex, technology-driven environments. These environments vary from adaptive learning systems that adapt to a learner's performance in real-time to immersive simulations that offer immediate feedback and direction. This research seeks to investigate the influential potential of prompting in digital pedagogy and its ability to enhance learner autonomy, engagement, and mastery.

Prompting, in its fundamental essence, denotes the provision of signals, suggestions, or structured guidance to learners with the aim of assisting them in attaining their learning objectives. Throughout history, the practice of prompting has been employed to support learning by providing learners with timely aid in developing problem-solving techniques, regulating cognitive demands, and maintaining motivation. Nevertheless, the utilization of prompting in digital pedagogy has significantly increased due to the progress made in artificial intelligence, adaptive technologies, and interactive learning platforms. These advancements have enabled educators and instructional designers to incorporate prompting more smoothly into digital settings, offering learners individualized and contextually appropriate assistance. Consequently, prompting is now not limited to in-person teaching but is integrated into many digital tools and platforms that enable both individual and group learning.

Schmidt-Weigand, Hänze, and Wodzinski (2009) emphasize the significance of prompting in complex problem-solving tasks. They highlight that strategic behavior prompts, which guide learners in adopting effective strategies, can greatly improve learners' capacity to effectively engage with and solve complex problems. This remark is especially pertinent in the digital era, as learners frequently need to explore extensive quantities of information, integrate various viewpoints, and employ their expertise in new situations. Digital settings, such as intelligent tutoring systems and educational games, have the distinct advantage of being able to deliver strategic prompts that provide learners with both cognitive help and the metacognitive tools needed for self-regulation and reflective learning.

The adaptability of prompting is a significant factor in its efficient utilization. Prompting in digital learning environments can manifest in various ways, ranging from subtle cues integrated into educational software to explicit instruction offered through interactive interfaces. In an adaptive learning platform, prompts can alter in real-time according to the learner's performance. This means that if a learner is struggling, they will receive more frequent or detailed tips to help them. As the learner improves and shows mastery, the level of support would gradually decrease. The adaptability of prompting in digital pedagogy is crucial for its success, as it enables tailored learning experiences that may cater to the specific needs and progress of each student.

Aside from adaptability, the timing and kind of stimuli are crucial determinants of their efficacy. Studies have demonstrated that appropriately timed cues can enhance profound learning by prompting learners to contemplate their comprehension, recognize deficiencies in their knowledge, and employ novel approaches to solve obstacles. Excessive use of prompts, particularly those that are very instructive, might impede learning by diminishing learners' autonomy and inhibiting the development of abilities required for independent problem-solving (Schmidt-Weigand et al., 2009). Therefore, the design of prompting systems in digital pedagogy must carefully find a balance between offering adequate assistance and motivating learners to take responsibility for their own learning.

Another crucial factor to consider in the implementation of prompting in digital education is the concept of fading. Fading refers to the gradual reduction of cues or reminders as learners get more skilled, enabling them to move from guided practice to performing tasks independently. This strategy is crucial for keeping learners from excessively depending on external assistance and promoting the internalization of skills and knowledge. Schmidt-Weigand et al. (2009) contend that the combination of fading and worked examples is highly effective. This approach enables learners to tackle complex problem-solving tasks while still obtaining the required support to facilitate their learning. In digital environments, fading can be achieved through different strategies, such as diminishing the frequency or specificity of prompts, granting learners the ability to determine when they get assistance, or escalating the complexity of tasks as learners advance.

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The consequences of fading in digital pedagogy are significant. Through a gradual reduction of external assistance, educators and instructional designers can facilitate the development of learners' autonomy, resilience, and self-assurance. The shift from guided learning to independent problem-solving is crucial in equipping learners with the necessary abilities to tackle the uncertainties of real-world activities. In such situations, learners are required to use their knowledge and skills without continuous direction.

Shadowing, a strategy in digital education, involves giving learners with examples of expert behavior or cognitive processes, adding another dimension to the use of prompting. Shadowing enables learners to closely observe and imitate the proficient execution of a task by experts, offering them a distinct model of what accomplished task fulfillment entails. Shadowing in digital settings can be achieved by utilizing interactive simulations, video demonstrations, or employing avatars or virtual agents that emulate expert behavior. Shadowing, when used in conjunction with prompting and fading, can augment learners' comprehension of complex tasks while simultaneously promoting active participation and autonomous problem-solving.

The incorporation of prompting, fading, and shadowing in digital education provides a robust framework for assisting learners in the acquisition of complex cognitive and metacognitive abilities. Teachers can help students overcome the challenges of digital learning environments and develop the critical skills necessary for success in an increasingly digitalized world by offering strategic direction, reducing external support gradually, and presenting models of expert conduct.

Upon revisiting the concept of prompting in the era of digital pedagogy, it becomes evident that this instructional method serves a purpose beyond being a mere tool for leading learners through complex tasks. Instead, it serves as a fundamental component of digital learning environments, providing tailored assistance, promoting independence, and equipping learners with the skills needed to tackle challenging real-world problem-solving. This study will examine several types of prompts used in digital pedagogy, the significance of fading in fostering learner autonomy, and the possibilities of shadowing as an additional strategy. The purpose of this investigation is to develop a conceptual framework that guides both research and practical application in designing and implementing techniques to inspire learning in digital environments.

Literature review: the evolution of prompting in digital pedagogy

The swift expansion of digital technologies in education has greatly transformed conventional teaching methods, providing fresh avenues to involve, assist, and structure student learning. Prompting has become a crucial technique in the scope of digital pedagogy. This literature review explores the development of prompting in this specific context, analyzing its different manifestations and purposes in digital educational settings.

Types of prompting in digital pedagogy

Prompting is a method used to direct learners towards certain goals by offering clues, suggestions, or planned interventions. It has progressed from basic instructional supports to sophisticated, adaptable mechanisms in the digital domain. Schmidt-Weigand, Hänze, and Wodzinski (2009) highlighted the importance of strategic behavior cues in assisting learners throughout complex problem-solving tasks. By supporting structured cognitive processes, these prompts help learners comprehend challenging concepts by encouraging the use of effective approaches. Prompts of this nature are essential for supporting learners in comprehending complex subjects, especially in digital settings where assignments frequently need advanced cognitive skills.

Within the realm of digital pedagogy, urging assumes several manifestations contingent upon the learning milieu and instructional objectives. Adaptive learning platforms, intelligent tutoring systems, and feedback mechanisms in educational games include prompts into their design to provide individualized support for learners. These digital environments provide a dynamic interaction between several sorts of prompts that are tailored to the specific needs of each student, maximizing their engagement and fostering a more profound comprehension. ALEKS and DreamBox are examples of adaptive learning systems that adjust prompts based on the learner's progress and offer targeted tips to help students traverse through information at appropriate levels of difficulty (Kulik & Fletcher, 2016).

Cognitive prompting

Cognitive prompting involves guiding learners' cognitive processes by providing hints or posing thought-provoking questions that move their focus towards important concepts or problem-solving steps. This form of prompting is especially efficient in facilitating learners' acquisition of critical thinking abilities and fostering more profound cognitive involvement. Real-time suggestions that target misconceptions or errors can be provided through digital learning systems, serving as cognitive prompts (VanLehn, 2011). As an illustration, a student using an intelligent tutoring system to solve a math problem may be given a suggestion that advises them to reconsider a specific step or to explore a different approach. Cognitive prompts promote analytical thinking and enhance comprehension by prompting learners to reflect on their problem-solving processes (Liu & Koedinger, 2017).

Metacognitive prompting

Metacognitive prompting involves going beyond simple prompting and instead encourages learners to engage in self-reflection over their own thought processes and tactics. The objective of metacognitive prompts is to enhance self-regulation, empowering learners to more efficiently assess their learning and adapt their strategies as necessary. Metacognitive cues in digital environments are typically expressed as reflection questions or progress-tracking tools. These prompts encourage students to think about their learning tactics and evaluate their comprehension of the subject (Azevedo & Cromley, 2004). For instance, a prompt could inquire a learner to contemplate the tactics they employed to resolve a certain challenge and assess the efficacy of those strategies. These prompts foster self-awareness and facilitate the growth of metacognitive skills, which are essential for continuous learning (Greene & Azevedo, 2007).

Metacognitive prompting is highly beneficial in digital pedagogy as it enables learners to assume authority over their learning process. Research has indicated that learners who actively utilize metacognitive prompts exhibit enhanced self-regulation and achieve higher levels of academic success (Bakhtiar & Hadwin, 2022). Digital platforms can offer a reliable means of metacognitive prompting by pushing learners to halt, contemplate, and modify their techniques before continuing with activities.

Motivational prompting

Motivational prompting aims to maintain student involvement and promote perseverance, especially when learners encounter arduous or demanding activities. Within digital learning settings, motivational cues might manifest as uplifting messages, progress reminders, or even gamified incentives that boost dedication and persistence. These prompts play a vital role in sustaining student motivation, particularly in self-paced digital settings where learners may experience feelings of isolation or discouragement (Baker et al., 2010).

Platforms such as Duolingo utilize motivational prompting to maintain student engagement. This involves the use of motivational messages and gamified prizes (Long & Aleven, 2017). Prompting learners when they face challenging tasks can effectively maintain their concentration by highlighting the progress they have already achieved and fostering a mindset that values growth. These impulses are very beneficial in maintaining learners' motivation, even in the presence of obstacles or difficulties (Dweck, 2006).

Integrating prompts into digital pedagogy has the potential to greatly enhance student learning. This is achieved by offering individualized and adaptive help that is responsive to the specific needs of learners. Through the use of cognitive, metacognitive, and motivational prompts, digital platforms can help students manage challenging assignments, encourage self-reflection and self-control, and keep them engaged. As digital pedagogy develops, prompting is still an essential method for supporting and guiding students through their learning. This method guarantees that students receive both support and the ability to take charge of their educational path.

Prompting in digital learning environments

Prompting has become a crucial pedagogical strategy in digital learning environments, as it ensures that learners actively engage in their education rather than passively receiving information. Strategically timed cues help to boost learners' cognitive involvement, leading to enhanced understanding, analytical thinking, and problem-solving skills. The role of prompting is becoming more integrated into adaptive learning systems, intelligent tutoring platforms, and gamified educational settings as educational technologies continue to evolve (VanLehn, 2011; Graesser et al., 2005).

Schmidt-Weigand, Hänze, and Wodzinski (2009) highlighted the capacity of prompting to strategically direct learners through activities that get increasingly difficult. Their research emphasizes the significance of organizing these prompts in a way that corresponds with learners' cognitive processes, therefore motivating them to utilize efficient problem-solving methods and providing assistance during crucial moments of learning. This scaffolding facilitates learners in effectively handling complex information, preventing them from being overwhelmed, and guaranteeing their sustained engagement and motivation throughout the learning process (Sweller, Ayres, & Kalyuga, 2011).

The importance of prompting becomes especially clear in adaptive learning platforms. These systems utilize algorithms and real-time data to modify the level of complexity and offer specific prompts according to the progress and requirements of each learner. This flexibility guarantees that learners are provided with customized support, which is crucial in avoiding both mental strain and disinterest. For example, prompts can range in complexity, from basic reminders to more profound reflection inquiries that push learners to critically evaluate their comprehension of the content (VanLehn, 2011; Koedinger, Aleven, Heffernan, & McLaughlin, 2013). This customized prompting is in line with learner-centered educational models that have become more prominent in recent years. These models emphasize the significance of personalization in facilitating effective learning experiences (Woolf, 2010).

Furthermore, the act of stimulating or encouraging in digital settings extends beyond tasks that solely involve mental processes. Additionally, it plays a crucial role in maintaining learners' drive and determination when confronted with difficult material. For instance, D’Mello and Graesser (2012) showed how incorporating emotional cues into digital educational platforms can effectively address student dissatisfaction and boredom, hence enhancing engagement and performance. Motivational prompts, such as encouragement, prizes, or feedback, are essential elements of these systems and have been proven to improve both persistence and accomplishment (Baker et al., 2010; Clark & Mayer, 2023).

In digital learning environments, prompting can be included into collaborative settings, such as peer-assisted learning platforms or group-based virtual learning environments. Within these particular situations, prompts serve the purpose of not only providing guidance to individual learners but also promoting efficient collaboration and communication among members of a group. Collaborative prompts, as shown in systems such as CSCL (Computer-Supported Collaborative Learning), serve to direct discussions, propose approaches for collective problem-solving, and promote the cultivation of advanced cognitive abilities (Roschelle & Teasley, 1995; Weinberger & Fischer, 2006). The utilization of prompts to improve group dynamics exemplifies the transition towards more participatory and socially constructed approaches in digital education.

Furthermore, prompting is important for adaptive educational games, especially when students are regularly required to complete challenging problem-solving tasks in digital environments. Long and Aleven (2017) found that educational games provide diverse cues to facilitate learning while yet preserving the game's immersive and captivating characteristics. These prompts serve to maintain a balanced cognitive load by offering timely interventions that prevent learners from getting stuck or losing interest, while also giving them the opportunity to explore and experiment with the learning content (Shute & Ventura, 2013).

The research conducted by VanLehn et al. (2007) provides evidence that timely and adaptive prompting is highly beneficial, especially in the context of intelligent tutoring systems (ITS). Their research showcased that students who were provided with suitable prompts in Intelligent Tutoring Systems (ITS) exhibited a higher likelihood of actively engaging in problem-solving and self-explanation, leading to enhanced learning results. The Intelligent Tutoring System (ITS) uses adaptive prompts to guide students depending on their replies and behaviors. This approach ensures that students are neither overwhelmed nor too supported, striking a balance between directed learning and autonomy (Kulik & Fletcher, 2016).

In conclusion, using prompts in digital learning environments is a versatile and adaptive strategy that enhances motivation, metacognitive skills, and cognitive abilities, among other elements of learning. By actively immersing them in the learning process and providing tailored support, prompts help learners accomplish increasingly difficult tasks without becoming overwhelmed or disengaged. Prompts possess the capability to adapt to the specific requirements and progress of learners, making them essential in learner-centered and adaptable digital pedagogy (Graesser, Conley, & Olney, 2012).

Fading and its implications

Fading, as a pedagogical approach, is an essential component of effective prompting in both traditional and digital learning environments. It refers to the process of gradually decreasing the amount of external direction given to learners as they become more skilled in an activity, which ultimately promotes increased self-reliance and expertise (Puntambekar & Hübscher, 2005). The primary objective of fading is to discourage learners from excessively depending on external aids while encouraging the internal assimilation of skills, techniques, and information. Fading is a technique that transfers the responsibility for learning from the teacher or system to the student as they get more skilled. This promotes self-regulated learning and a more profound engagement with the content (Collins, Brown, & Holum, 1991).

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Schmidt-Weigand, Hänze, and Wodzinski (2009) emphasize the significance of fading in relation to worked instances and complex problem-solving. Their research highlights that the steady reduction of solution stages in worked examples enables learners to progressively take on more responsibility for their learning, moving from supervised practice to independent problem-solving. The shift mentioned is of utmost importance in digital learning environments, as learners frequently encounter complex tasks that necessitate the cultivation of both cognitive and metacognitive abilities (Renkl & Atkinson, 2016).

Fading can be included into digital learning environments using different approaches. An effective approach involves gradually decreasing the frequency or specificity of suggestions as time progresses. For instance, in an intelligent tutoring system, the system may initially offer comprehensive hints and feedback but gradually decrease the level of support when the student exhibits proficiency in the subject matter (Roll, Baker, Aleven, & Koedinger, 2014). In addition, learners can be granted increased liberty in selecting the timing of prompts, enabling them to exert greater authority over their learning process. Another approach entails augmenting the assignments as learners advance, guaranteeing that learners remain stimulated while still receiving the requisite assistance to prevent discouragement (VanLehn, 2006).

The efficacy of fading is complexly connected to the initial magnitude of prompting, as well as the learner's cognitive and metacognitive capacities. For instance, learners who possess advanced metacognitive abilities may need fewer reminders and a quicker reduction of support compared to learners who are still in the process of gaining these skills (Greene & Azevedo, 2007). In addition, the process of fading can assist learners in effectively managing their cognitive load by gradually decreasing the amount of external guidance provided as they gain proficiency in the subject matter. This enables them to concentrate on internalizing techniques and knowledge without being overwhelmed (Sweller, 1988; Kirschner, Sweller, & Clark, 2006).

Steps and challenges of fading

Implementing fading in digital pedagogy necessitates rigorous deliberation of various elements, such as the learner's advancement, the work, and the particular learning setting. One of the main difficulties in implementing fading is establishing the optimal timing for reducing prompts. Removing suggestions too rapidly might result in learner frustration or confusion, which can lead to disengagement and potentially diminish their willingness to continue (VanLehn et al., 2007). On the other hand, if prompts are kept for an extended period of time, learners could rely on them excessively, which can impede the growth of independent learning abilities and impair the internalization of knowledge (D'Mello, Olney & Person, 2010).

Effective fading tactics frequently need ongoing assessment of learner performance and subsequent modification of support levels. Adaptive learning systems provide the ability to modify prompts in real-time based on data about the learner's performance (Koedinger & Aleven, 2007). For instance, a learner who consistently excels in a specific subject may be given fewer reminders, whereas a learner who faces difficulties with the same job may receive more frequent assistance until they show progress. This methodology guarantees that learners are provided with the suitable amount of assistance according to their specific requirements and advancement (VanLehn, 2011).

Implementing fading in digital environments is a problem due to the requirement for advanced algorithms that can precisely evaluate a learner's preparedness for greater independence. Adaptive learning systems and intelligent tutoring systems need to have the capability to monitor learners' progress in real-time and adapt the level of assistance accordingly

(Shute & Zapata-Rivera, 2012). These systems need to strike a balance between offering enough help to prevent learners from getting irritated and motivating learners to take more control over their learning process (Clark, Feldon, van Merriënboer, Yates, & Early, 2008).

Additionally, instructional designers must take into account the cognitive burden linked to complex tasks and guarantee that the process of fading does not overpower learners at critical times. According to cognitive load theory, learners have a finite amount of cognitive resources, and excessive supervision in the beginning stages may hinder their ability to establish the cognitive structures required for independent problem-solving (Sweller, 2011). Fading is a technique that helps learners manage cognitive load and promotes the development of expertise through purposeful practice. It involves gradually diminishing prompts. This concept was introduced by Ericsson, Krampe, and Tesch-Römer in 1993.

The process of fading can also be affected by the social and motivational factors present in the learning environment. In collaborative learning environments, fading refers to the gradual reduction of scaffolding supplied to a group of learners, enabling them to assume more responsibility for their collective learning process (Dillenbourg & Jermann, 2010). This strategy has the potential to enhance the formation of strong bonds within a group and foster a sense of collective accountability, all while ensuring that each individual learner receives the necessary assistance to achieve their goals (O'Donnell & Hmelo-Silver, 2013).

Fading plays a crucial role in digital pedagogy by gradually shifting the responsibility from external guidance to the learner, thereby enhancing the effectiveness of prompting. Fading, through the deliberate adjustment of assistance levels according to learner progress, cognitive load, and task complexity, facilitates the development of independence and problem-solving skills essential for long-term success. Nevertheless, achieving fading in digital environments necessitates the utilization of advanced algorithms and instructional practices that effectively manage the provision of support while also fostering learner autonomy. As the field of digital pedagogy progresses, the concepts of fading will continue to be crucial in creating impactful educational experiences that prioritize the student.

Shadowing as a supplementary technique

Shadowing is an important teaching method in digital pedagogy, in addition to the process of fading. Shadowing is presenting learners with exemplars of proficient conduct or cognitive processes, enabling them to witness and imitate these behaviors. Shadowing, which has traditionally been employed in apprenticeship models and expert-novice interactions, is becoming an increasingly effective technique in digital learning environments (Collins, Brown, & Newman, 1989). Shadowing can be implemented through digital platforms using various methods such as written examples, video demonstrations, or interactive simulations. These methods exhibit expert performance in action.

Shadowing in digital learning environments is commonly provided through multimedia presentations or interactive simulations, enabling learners to watch expert behaviors and methods in a controlled setting. For instance, digital platforms like Khan Academy or Coursera frequently offer video demonstrations in which specialists demonstrate the accurate procedures or problem-solving approaches in several subjects, including mathematics and coding (Clark & Mayer, 2023). These examples enable learners to acquire understanding of the decision-making processes of experts and to internalize optimal methods for handling complex jobs (Renkl, 2014). Shadowing involves more than just observing passively; instead, learners are required to actively participate by either trying to imitate the actions they observe or by adjusting the tactics to fit their specific situations (Van Gog, Paas, & Van Merriënboer, 2004).

Combining shadowing with prompting can greatly enhance its effectiveness, as it enables learners to get strategic instruction and observe a visual or conceptual model of excellent performance at the same time. The integration of shadowing with supervision, as advocated by cognitive apprenticeship models, has long been recognized as a way to support learners in developing complex cognitive skills (Brown, Collins, & Duguid, 2000). These approaches involve learners watching an expert execute a job, receiving reminders to think about the observed behavior, and then trying the activity themselves with less assistance as time goes on (Collins et al., 1989). As learners advance and acquire proficiency, the requirement for direct shadowing decreases, mirroring the process of fading.

The interactivity of digital platforms improves the effectiveness of shadowing by providing learners with real-time opportunity to experiment with expert tactics. Simulations offer learners a risk-free environment to practice actions before implementing them in real-world circumstances (Clark, 2011). Medical education platforms such as Touch Surgery enable learners to observe a digital expert executing a surgical operation, and then they are urged to practice the process themselves within the virtual environment (Seymour et al., 2002). These immersive learning environments facilitate the internalization of complex processes by involving both observation and active experimentation.

Over time, the phenomenon of shadowing can diminish in a manner akin to fading, as learners acquire their own proficiency and no longer necessitate the same degree of assistance (Van Merriënboer & Sweller, 2005). By gradually eliminating the presence of shadowing, learners are able to shift from relying on external models to independently addressing problems, which promotes the growth of self-regulation and independent learning (Zimmerman, 2002). The success of this shift relies on the learner's capacity to incorporate the demonstrated behaviors into their cognitive repertoire, a process often aided by reflective prompts that promote self-evaluation and adjustment of tactics (Chi & Wylie, 2014).

Moreover, studies on observational learning have demonstrated that shadowing can greatly enhance learners' capacity to apply abstract concepts in unfamiliar scenarios, hence improving their transfer of learning (Bandura, 1977). Through the observation of experts, learners are introduced to adaptive skills that can be utilized in many situations, fostering cognitive flexibility (Renkl & Atkinson, 2010). The ability to adapt is especially advantageous in digital settings, where learners frequently encounter complex, open-ended problems that lack a definitive answer (Hmelo-Silver, Duncan, & Chinn, 2007).

Shadowing is a crucial component in collaborative digital learning settings. During group assignments, learners have the opportunity to observe and learn from more experienced peers or virtual agents, allowing them to gain a deeper comprehension of the task before actively participating in the group's work (Dillenbourg, 2002). Collaborative shadowing is highly effective in project-based learning environments, where learners are assigned difficult, real-world issues that demand group problem-solving (Scardamalia & Bereiter, 2006). Through the process of observing and engaging with more skilled peers or digital agents, learners have the opportunity to develop their own expertise while also making valuable contributions to the group's achievements (Roschelle & Teasley, 1995).

Conclusion

In the era of digital pedagogy, prompting is still an essential component of teaching strategies since it helps students traverse more customized and complex learning environments. Prompting gains even more effectiveness when paired with techniques like fading and shadowing, which ensures that students receive support without becoming unduly dependent on outside aid. By giving students a clear example of professional behavior to observe, model, and eventually apply to their own activities, shadowing improves the learning process.

As digital technologies advance, we must deepen our understanding of prompting, fading, and shadowing to support effective, self-directed learning. Future research endeavors should concentrate on the development of increasingly elaborate adaptive systems that may successfully integrate these techniques to furnish learners with personalized support. The long-term impacts of these tactics on learners' performance, independence, and ability to apply what they have learned in many circumstances need to be further investigated. By consistently advancing and refining our digital teaching methodologies, we can guarantee that students acquire the competencies and approaches required to thrive in an ever-growing technology environment.

References

1. VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. Educational psychologist, 46(4), 197-221.
2. Aleven, V., Stahl, E., Schworm, S., Fischer, F., & Wallace, R. (2003). Help seeking and help design in interactive learning environments. Review of educational research, 73(3), 277-320.
3. Long, Y., & Aleven, V. (2017). Educational game and intelligent tutoring system: A classroom study and comparative design analysis. ACM Transactions on Computer-Human Interaction (TOCHI), 24(3), 1-27.
4. Azevedo, R., & Cromley, J. G. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? Journal of Educational Psychology, 96(3), 523-535.
5. Baker, R. S., D'Mello, S. K., Rodrigo, M. M. T., & Graesser, A. C. (2010). Better to be frustrated than bored: The incidence, persistence, and impact of learners' cognitive–affective states during interactions with three different computer-based learning environments. International Journal of Human-Computer Studies, 68(4), 223-241.
6. Bandura, A. (1977). Social Learning Theory. Prentice Hall.
7. Brown, J., Collins, A., & Duguid, P. (2000). Situated Cognition and the Culture of Learning. Psychology of Education: Major Themes: Pupils and Learning, 2, 207-230.
8. Chi, M. T., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. Educational psychologist, 49(4), 219-243.
9. D'Mello, S., Olney, A., & Person, N. (2010). Mining collaborative patterns in tutorial dialogues. Journal of Educational Data Mining, 2(1), 1-37.
10. Clark, R. C. (2011). Developing technical training: A structured approach for developing classroom and computer-based instructional materials. John Wiley & Sons.
11. Clark, R. C., & Mayer, R. E. (2023). E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. John Wiley & Sons.
12. Clark, R. E., Feldon, D. F., Van Merrienboer, J. J., Yates, K. A., & Early, S. (2008). Cognitive task analysis. In Handbook of research on educational communications and technology (pp. 577-593). Routledge.
13. Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. American Educator, 15(3), 6-11.
14. Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the craft of reading, writing, and mathematics. Knowing, learning, and instruction: Essays in honor of Robert Glaser, 453-494.

15. D'Mello, S., & Graesser, A. (2012). Dynamics of affective states during complex learning. Learning and Instruction, 22(2), 145-157.
16. Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), Three worlds of CSCL: Can we support CSCL? (pp. 61-91). Heerlen, Netherlands: Open Universiteit Nederland.
17. Dillenbourg, P., & Jermann, P. (2010). Technology for classroom orchestration. In M. S. Khine & I. M. Saleh (Eds.), New Science of Learning: Cognition, Computers and Collaboration in Education (pp. 525-552). Springer.
18. Dweck, C. S. (2006). Mindset: The new psychology of success. Random House.
19. Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. Psychological Review, 100(3), 363-406.
20. Graesser, A. C., Conley, M. W., & Olney, A. M. (2012). Intelligent tutoring systems. In K. R. Harris, S. Graham, & T. Urdan (Eds.), APA educational psychology handbook (Vol. 3, pp. 451-473). American Psychological Association.
21. Graesser, A. C., McNamara, D. S., & VanLehn, K. (2005). Scaffolding deep comprehension strategies through Point&Query, AutoTutor, and iSTART. Educational psychologist, 40(4), 225-234.
22. Greene, J. A., & Azevedo, R. (2007). A theoretical review of Winne and Hadwin's model of self-regulated learning: New perspectives and directions. Review of educational research, 77(3), 334-372.
23. O'Donnell, A. M., & Hmelo-Silver, C. E. (2013). The international handbook of collaborative learning. Introduction: What Is Collaborative Learning? an Overview, 19-40.
24. Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). Educational Psychologist, 42(2), 99-107.
25. Kirschner, P., Sweller, J., & Clark, R. E. (2006). Why unguided learning does not work: An analysis of the failure of discovery learning, problem-based learning, experiential learning and inquiry-based learning. Educational Psychologist, 41(2), 75-86.
26. Koedinger, K. R., & Aleven, V. (2007). Exploring the assistance dilemma in experiments with cognitive tutors. Educational Psychology Review, 19, 239-264.
27. Liu, R., & Koedinger, K. R. (2017). Closing the Loop: Automated Data-Driven Cognitive Model Discoveries Lead to Improved Instruction and Learning Gains. Journal of Educational Data Mining, 9(1), 25-41.
28. Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. Review of educational research, 86(1), 42-78.
29. Puntambekar, S., & Hübscher, R. (2005). Tools for scaffolding students in a complex learning environment: What have we gained and what have we missed? Educational Psychologist, 40(1), 1-12.
30. Renkl, A. (2014). Toward an instructionally oriented theory of example-based learning. Cognitive Science, 38(1), 1-37.
31. Renkl, A., & Atkinson, R. K. (2016). Structuring the transition from example study to problem solving in cognitive skill acquisition: A cognitive load perspective. In Cognitive Load Theory (pp. 15-22). Routledge.

32. Renkl, A., & Atkinson, R. K. (2010). Learning from worked examples: How to prepare students for meaningful problem-solving. In J. Plass, R. Moreno, & R. Brünken (Eds.), Cognitive Load Theory (pp. 91-108). Cambridge University Press.
33. Roll, I., Baker, R. S. D., Aleven, V., & Koedinger, K. R. (2014). On the benefits of seeking (and avoiding) help in online problem-solving environments. Journal of the Learning Sciences, 23(4), 537-560.
34. Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving. In Computer supported collaborative learning (pp. 69-97). Springer Berlin Heidelberg.
35. Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 97-115). Cambridge University Press.
36. Schmidt-Weigand, F., Hänze, M., & Wodzinski, R. (2009). Complex problem solving and worked examples: The role of prompting strategic behavior and fading-in solution steps. *Zeitschrift für Pädagogische Psychologie*, 23(2), 129-138.
37. Seymour, N. E., Gallagher, A. G., Roman, S. A., O'brien, M. K., Bansal, V. K., Andersen, D. K., & Satava, R. M. (2002). Virtual reality training improves operating room performance: results of a randomized, double-blinded study. Annals of surgery, 236(4), 458-464.
38. Shute, V. J., & Ventura, M. (2013). Stealth assessment: Measuring and supporting learning in video games. MIT Press.
39. Sweller, J., Ayres, P., Kalyuga, S., Sweller, J., Ayres, P., & Kalyuga, S. (2011). Intrinsic and extraneous cognitive load. Cognitive load theory, 57-69.
40. Van Gog, T., Paas, F., & Van Merriënboer, J. J. G. (2004). Process-oriented worked examples: Improving transfer performance through enhanced understanding. Instructional Science, 32(1-2), 83-98.
41. Van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. Educational Psychology Review, 17(2), 147-177.
42. VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. Educational Psychologist, 46(4), 197-221.
43. VanLehn, K., Graesser, A. C., Jackson, G. T., Jordan, P., Olney, A., & Rose, C. P. (2007). When are tutorial dialogues more effective than reading? Cognitive Science, 31(1), 3-62.
44. Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. Computers & Education, 46(1), 71-95.
45. Bakhtiar, A., & Hadwin, A. F. (2022). Motivation from a self-regulated learning perspective: Application to school psychology. Canadian Journal of School Psychology, 37(1), 93-116.
46. Woolf, B. P. (2010). Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning. Morgan Kaufmann.
47. Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. Theory into practice, 41(2), 64-70.