Scaffolding Cognitive Friction for Learning with Generative AI

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Abstract

In this conceptual contribution, I argue that the use of generative AI (GenAI) applications by students reduces cognitive friction - the effort and productive struggle needed to develop conceptual understanding - resulting in a lack of learning. Current GenAI applications commonly used by students are designed primarily to provide information with ease and to make users habitual of using the technology. To use GenAI productively, educators need to come up with design principles from research on scaffolding to design productive interruptions and introduce reflection in the learning process. The argument presnted here recognizes a broader dilemma: regardless of the intended purpose, increased dependence on GenAI can reinforce device-centered overuse and digital addiction.

Keywords

Generative AI, scaffolding, cognitive friction, learning design

1. Introduction

Learning environments are designed artifacts and humans are the only species to have formalized the creation of learning environments through the practice of schooling [1]. It can even be argued that although human capability to augment cognition through external representations and artifacts, including languages and tools, has been an essential component of human development, the true differentiator when it comes to the advancement of the species are our cultural practices of formal teaching and schooling, and cultural transmission of knowledge as a result of that practice.

This cultural practice of teaching and schooling is constantly evolving and in recent times shifts have been triggered by ever more frequent and complex developments in information technology (IT). The separation of place and learning, and the ability to learn across the entire day, are both newer practices that have come about as a consequence of digital technology.

The scale and depth of changes brought about by GenAI have had a faster and higher impact than most previous technologies in the past few decades. The ability to "converse", use language naturally, to "know" things, the ability to process information, significant amounts of it, and to respond to or solve questions, are affordances that have not been available in a technology before.

Consequently, the growth and use of GenAI in society are leading to a moment where formal schooling, and even informal learning opportunities, need to be revisited and many aspects of them redesigned to ensure that we are able to innovate beyond the basic amplification advantages of the technology and reorganize our cultural work of schooling [2].

2. Generative AI - beyond cognitive offloading

Recent academic and popular discourse on the role of GenAI and education has fixated on the central idea that the use of AI in learning is akin to cognitive offloading – a common activity, whereby, humans

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use external representations and artifacts to reassign some of their mental effort to accomplish more, and in theory, higher cognitively taxing tasks [3].

This perspective is limiting and does not fully appreciate the shift in learning due to the use of GenAI and why we need to think more deeply about its use. I can think of two analogies that I believe serve us better when it comes to understanding how GenAI is shaping student learning with implications for teaching and design of learning environments.

The first analogy is to think of using GenAI for learning as akin to learning to type or more specifically touch-typing. It is a skill that takes a long time to master; you have to pay attention, start out slowly, practice and then you become proficient. Yet proficiency in typing in and of itself is of little value unless you want to make a career in a now defunct profession of being a typist. But, once you master it you can use it to make a lot of other tasks more efficient whether it is a writing career or programming or using a machine in any way. conversational interface and by learning basic prompting techniques, is akin to typing in that sense.

Yet, this skill set alone does not allow you to use its affordances fully. To be a power user you need to know what to do with it and for that you need domain expertise. Therefore, learning GenAI use at the expense of building cognitive and domain depth, is not likely to lead to intended outcomes for students.

The second analogy, and the more worrisome one, is that using GenAI is akin to eating ultra processed food or becoming a fast-food junkie. It is cheap and easy to procure, it makes you feel energetic at the moment, but it is disastrous for your body in the long run. Furthermore, it is designed to be addictive, to train your brain to crave it even more, and it is a hard habit to break out of. Using GenAI is very much like that at this moment. It is fueled by addiction to devices. In turn its use further fuels that addiction, resulting in a consumption cycle that users find difficult to get out of. The conversational aspect of chatting with a system to get responses is akin to a dopamine kick and its use begets even higher use. This is the real danger lurking in GenAI tools. The fact that users find ChatGPT entertaining actually hinders to appropriating it for learning design easily.

3. The need to design for cognitive friction

Learning is a deliberate act that occurs as learners work through and solve problems and it requires cognitive friction. Failing and trying again, the process of struggling, that is at the heart of how people learn. This is not because learning has to be hard but because that is how we develop strong neural structures and neuroplasticity. And beyond the neuroscience aspects, guided trial-and-errors are essential for building proficiency in cultural practices which are often an outcome of long-term apprenticeship-based participation in situated contexts. Teaching and schooling have been about creating contexts for managing learner' cognitive friction thereby achieving cognitive development. Facilitating learning through different kinds of cognitive lubrication processes such as scaffolding, guided participation, worked examples, among others, are essential teaching practices educators have developed and used over time. Engagement eases cognitive friction, helps move students from cognitive fixation, and enables cognitive development.

Currently, the use of GenAI is designed not just to reduce cognitive friction but to eliminate it completely and make the interaction flawless and gratifying, in other words, to make the use of the application addictive. This end goal does not take into account the effect of the process that is used to achieve that goal, in other words, the resultant lack of learning in the interest of instant acquisition of information, as this is not a concern for GenAI application developers. For learners within formal schooling system where the goal is often to excel on assessments, this ease of use is not a bother. However, as educators, we have the difficult task of trying to break bad habits and then instilling some good ones. We need to rethink and redesign learning environments so that we can start with what is easily done and take that and ask learners to break it down. For design of learning environments with GenAI, friction needs to be integrated in a meaningful way and this is difficult because GenAI applications are by default designed to make things easy.

4. Scaffolding cognitive friction

Traditionally, scaffolding has been defined as the process by which a parent, teacher or a more knowledgeable other provides assistance to enable learners to solve problems that would be too difficult to solve alone [4]. Once a learner develops requisite expertise, the scaffolds can be removed. The idea has been to "lubricate" the learning process just enough for the learners to advance to the next level or stage. Yet, with GenAI, it is easy for learners who are working on any problem or activity to move to the advanced level in terms of output without necessarily working through a problem. In effect, they can ask an expert for the solution, so long as they know how to ask, and respond. Therefore, in the context of GenAI use of education, it is important to think of scaffolding as a way to create necessary and productive obstacles or interruptions to the use of prompting.

This use requires adhering to many of the essential elements of scaffolding at the initial stage of the learning process, in particular, developing intersubjectivity or shared understanding. This applies both to the problem at hand and at a meta level to the overall goal of using the application, i.e., there has to be a mechanism to assess and ensure that the learner understands that the purpose of using GenAI in this case is to learn. If this initial goal is achieved, and the learner wants to learn, the system has to reliably assess learner's level of understanding, and then through ongoing diagnosis of learner's state of knowledge move them along the path of learning. The system has to achieve this while keeping learner frustration under control. Furthermore, it is important that other theoretical features of scaffolding such as calibrated support and fading are applied appropriately as well [5].

Given that the use of technology including digital technology for learning through scaffolding is not new any more, the generative element needs more attention [5]. In particular, given the tendency of GenAI systems to not be stable and shift responses with each new model, a system or application designed specifically for teaching or learning has to be relatively closed or limited in scope [6].

5. Design patterns for scaffolding cognitive friction with GenAI

Educators need to shift to a new paradigm in instructional design that takes GenAI use into account and then incorporates design features to add friction using emerging interaction design techniques such as the use of microboundaries [7] and nudging [8] that have found use in other domains such as serious games [9]. A microboundary is an intervention that introduces a small obstacle prior to an interaction and prevents a user from rushing from one context to another. The system achieves this by creating a brief moment in which users deliberately reflect on their actions. This interaction can be implemented via a short time cost and prompts a switch from the often disruptive and "mindless" automatic interaction prompting reflection and more "mindful" interaction. This act of slowing down can act as cognitive friction allowing for learning to take place.

Nudging is a design approach where the designer guides the users' decisions towards an intended direction and nudges provide results that are in users' best interest and least likely to harm (Cox et al., 2016). When it comes to teaching and learning, sometimes the nudges will not be in the best interest of the learner in the sense that they just quickly want to get some information and move on; but they are indirectly in learners' best interest as they act as scaffolding and use cognitive friction gainfully.

Beyond the design of single applications there is also the need, as Natali et al. [10] propose, of 'frictional protocols' or consensus deliberate design choices that slow down interactions to achieve greater cognitive engagement and thoughtful decision-making. This can foster user empowerment, skill development, and appropriate reliance on AI tools so that they use them responsibly.

Overall, educators to engage with the idea of designing for cognitive friction and making learners' interactions with technology slower and more deliberate. This approach is essential if we want students to learn how to do things in a better way and in different ways so that they are able to use what they learn in other contexts, i.e. transfer their learning.

6. Conclusion

The use of GenAI by learners has reached a critical mass, and as a recent study from Pew reports, over half of teenagers use chatbots for schoolwork. In this context, convincing learners to slow down, or designing systems to slow learners down, might not be easy to implement. Therefore, the success of the approach presented here resides within a wider context. In this larger educational ecosystem, the goal, purpose, and motivation for learning are critical concerns to manage if learners are to be engaged longer-term. If the current assessment and reward system continues as it is, it is difficult to get students to do something else beyond "doing school" or game the system to achieve the overall objective or outcome, whether a good grade or something larger.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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