Meta-Learning for the 21st Century: What Should Students Learn?

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ABOUT THE CENTER FOR CURRICULUM REDESIGN

In the 21st century, humanity is facing severe difficulties at the societal, economic, and personal levels. Societally, we are struggling with greed manifested in financial instability, climate change, and personal privacy invasions, and with intolerance manifested in religious fundamentalism, racial crises, and political absolutism. Economically, globalization and innovation are rapidly changing our paradigms of business. On a personal level we are struggling with finding fulfilling employment opportunities and achieving happiness. Technology’s exponential growth is rapidly compounding the problems via automation and offshoring, which are producing social disruptions. Educational progress is falling behind the curve of technological progress, as it did during the Industrial Revolution, resulting in social pain.

The Center for Curriculum Redesign addresses the fundamental question of "WHAT should students learn for the 21st century?" and openly propagates its recommendations and frameworks on a worldwide basis. The CCR brings together non-governmental organizations, jurisdictions, academic institutions, corporations, and non-profit organizations including foundations.

Knowledge, Skills, Character, and Meta-Learning

CCR seeks a holistic approach to deeply redesigning the curriculum, by offering a complete framework across the four dimensions of an education: knowledge, skills, character, and meta-learning. Knowledge must strike a better balance between traditional and modern subjects, as well as interdisciplinarity. Skills relate to the use of knowledge, and engage in a feedback loop with knowledge. Character qualities describe how one engages with, and behaves in, the world. Meta-Learning fosters the process of self-reflection and learning how to learn, as well as the building of the other three dimensions.

To learn more about the work and focus of the Center for Curriculum Redesign, please visit our website at www.curriculumredesign.org/about/background
WHY META-LEARNING

“The illiterate of the twenty-first century will not be those who cannot read and write, but those who cannot learn, unlearn and relearn.”

—Psychologist Herbert Gerjuoy as quoted by Alvin Toffler, Futurist, in Future Shock (1970)

We are seeing the growing need, from the education community at large and from a rapidly growing research base in the learning sciences, to expand the meaning, purpose, and goals of education, and to holistically transform students’ learning experiences, motivations and outcomes. The world is changing ever more rapidly, and it is becoming clear that preparing children for today’s world, much less the world of adults’ past, is a losing strategy. They will be graduating over a decade later into a very different world with very different challenges and opportunities.

In addition to redesigning relevant knowledge, skills, and character qualities necessary for the twenty-first century, we believe that there needs to be a meta layer of education, in which students practice reflection, learn about their learning, internalize a growth mindset that encourages them to strive, and learn how to adapt their learning and behavior based on their goals. The OECD has described this dimension as reflectiveness. The EU Reference Framework of Key Competencies, the Hewlett Foundation Deeper Learning Competencies, and the Assessment and Teaching of Twenty-First Century Skills all refer to it as “learning how to learn.” (see table in the Beyond Knowledge section).

The surest way to prepare students for a changing world is to give them the tools to be versatile, reflective, self-directed and self-reliant.

METACOGNITION—
REFLECTING ON LEARNING GOALS, STRATEGIES, AND RESULTS

Metacognition, simply put, is the process of thinking about thinking. It is important in every aspect of school and life, since it involves self-reflection on one’s current position, future goals, potential actions and strategies, and results. At its core, it is a basic survival strategy, and has been shown to be present even in rats.

Perhaps the most important reason for developing metacognition is that it can improve the application of knowledge, skills, and character qualities in realms beyond the immediate context in which they were learned. This can result in the transfer of competencies across disciplines—important for students preparing for real-life situations where clear-cut divisions of disciplines fall away and one must select competencies from the entire gamut of their experience to effectively apply them to the challenges at hand.

1 Flexnib, “That Alvin Toffler Quotation,” www.flexnib.com/2013/07/03/that-alvin-toffler-quotation
2 Rats were presented with a task that they could choose to decline; they received a higher reward if they declined than if they failed the task. As expected, the frequency of declining increased with the difficulty of the task, and accuracy was higher on trials where the rats chose to complete the task compared with trials when they were forced to. See A. L. Foote & J. D. Crystal, “Metacognition in the Rat,” Current Biology 17, no. 6 (2007): 551–555.
Even within academic settings, it is valuable—and often necessary—to apply principles and methods across disciplinary lines. Transfer can also be necessary within a discipline, such as when a particular idea or skill was learned with one example, but students must know how to apply it to another task to complete their homework or exams, and yet another context. Transfer is the ultimate goal of all education, as students are expected to internalize what they learn in school and apply it to life.

To illustrate the value of metacognition and how it actually plays a role in learning, we can consider an example from mathematics, where it has been shown that metacognition plays a central role in learning and achievement. Specifically, when novice students were compared to seasoned mathematicians, the students selected a seemingly useful strategy and continued to apply it without checking to see if the strategy of choice was actually working well. Thus, a significant amount of time was wasted in fruitless pursuits. The more experienced mathematicians on the other hand, exercised metacognition, monitoring their approach all along the way to see if it was actually leading to a solution or merely to a dead end. Being aware of how one is engaging with the process of learning influences how the student interprets the task at hand, and what strategies are selected and employed in service of achieving learning goals. It can help optimize the problem-solving experience at a very high level, and is thus applicable across a large range of contexts. These metacognitive strategies are powerful tools for any discipline, inter-discipline or for learning in general.

Of course, with such an abstract learning goal, it is important for educators to be precise with how they teach it. Traditional methods for improving students’ learning strategies often focus on prescribed procedures (note-taking, self-testing, scheduling, etc.) and typically result in initial motivation and some short-term improvement, but ultimately a reversion to old habits happens. While these tactics may work in the short term (e.g., to cram for an exam), once the context changes, successful transfer of these methods is less likely to occur. More strategic methods that focus on metacognition for deeper learning—such as developing a

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growth mindset (discussed later), setting and monitoring one’s learning goals, and growing one’s capacity to persist despite difficulties—have been shown to result in more permanent learning gains.\(^7\)

It is important to note that since metacognition involves higher-level thinking overseeing lower-level thoughts, there is actually a range of mental processes that fall under its definition. Effects of metacognitive training vary based on what kind of lower-level thoughts are being overseen, and how they are being overseen. Research has identified three levels of reporting on metacognitive processes:

1. Verbalization of knowledge that is already in a verbal state (such as recalling what happened in a story).
2. Verbalization of nonverbal knowledge (such as recalling how one solved a Rubik’s Cube).
3. Verbalization of explanations of verbal or nonverbal knowledge (such as explaining how one makes use of the rhetorical structures of a story as one reads).

Only this third level of metacognitive process has been linked to improved results in problem solving.\(^8\)

Metacognition can be developed in students in the context of their current goals and can enhance their learning of competencies\(^9\) as well as transfer of learning,\(^10\) no matter their starting achievement level. In fact, it may be most useful for lower-achieving students, as the higher-achieving students are already employing strategies that have proven successful for them.\(^11\) For learning disabled and low-achieving students, metacognitive training has been shown to improve behavior more effectively than traditional attention-control training.\(^12\)

Students who have higher levels of self-efficacy (more confidence in their ability to achieve their goals) are more likely to engage in metacognition and, in turn, are more likely to perform at higher levels.\(^13\) This strongly indicates a positive feedback loop for high-achieving students—they are more successful by using metacognitive strategies, which increases their confidence and in turn leads them to continue to increase their performance. Metacognition is an integral part of this virtuous learning cycle, and one that is amenable to further improvement through instruction.

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INTERNALIZING A GROWTH MINDSET

Without having to think about it, students have all absorbed from society some mix of messages about themselves, their talents, and the importance of hard work. We see this underlying model expressed in many different ways. Students often brag about how little they studied for a particular exam that they did well on, or claim to be “just not good at” one subject or another. These and a plethora of other student behaviors are clues into their subconscious models for how much talent and hard work contribute to success.

According to Carol Dweck’s research14, there are two broad categories of these mental models for success. In a fixed mindset, people believe their basic qualities, like their intelligence or talent, are simply fixed traits. They spend their time documenting their intelligence or talent instead of developing them. They also believe that talent alone creates success—without effort. This leads to self-defeating patterns of behavior that the students aren’t even aware they are engaging in. In a growth mindset, on the other hand, people recognize that talent is just the starting point, and believe that abilities can be developed through hard work. This view creates a love of learning for the sake of learning, and a resilience that is essential for success in large endeavors (see figure for more information15).

15 Image source: Nigel Holmes
Of course, both natural talent and hard work contribute to success. Alfred Binet, the inventor of the IQ test, believed that education was crucial to increasing our intelligence:

Some recent philosophers seem to have given their moral approval to these deplorable verdicts that affirm that the intelligence of an individual is a fixed quantity, a quantity that cannot be augmented. We must potest and react against this brutal pessimism; we will try to demonstrate that it is founded on nothing... With practice, training, and above all, method, we manage to increase our attention, our memory, our judgment and literally to become more intelligent than we were before.16

We are now learning more about how people are able to increase, through practice, capacities that seemed fixed. Herbert Nitsch, a world champion free diver,17 can hold his breath for over nine minutes. We used to think the brain did not change; we then recognized the existence of certain periods of development in which the brain changed. We now know that the brain quite literally changes based on experience in every single moment, and it is the collective effects of these experiences that result in our personalities, and our conscious experiences.

So how does mindset affect students’ interactions with their goals in school?

Students who have a learning goal (associated with a growth mindset) are concerned with internalizing the skills, understandings, and mindsets of the lesson. Students with a performance goal (associated with a fixed mindset) are mostly concerned with being perceived as having mastered what is being taught. Learning-oriented students tend to see mistakes as opportunities for growth and improvement, while performance-oriented students see them as failures. As a result, learning-oriented students expend more effort when confronted with challenges, whereas performance-oriented students expend less.18

Students with a learning orientation tend to employ more metacognitive strategies and attain higher levels of academic achievement.19 These internal views of personal learning capacity implicitly and explicitly influence students’ metacognitive processes as early as third grade20 and learning strategies are employed, (or not!), accordingly.

THE IMPORTANCE OF META-LEARNING

As adults, we no longer get all of our goals and deadlines decided and enforced for us. The majority of most people’s lives will be spent out of school, and will require motivation from the individual to continue to grow and develop in order to live fulfilling lives and meet the challenges society faces. The more we learn, the more our previous conceptions of the world get outdated. In clinical research for example, the half-life of truth is 45 years.21 This means that half of what doctors learned in school, if they don’t update their knowledge

17 Free diving is the practice of diving without the use of any external breathing apparatus.
themselves, is wrong by the time they retire. There is reason to believe that even people who decide they want to keep learning struggle to do so. On average, only 7 percent of people who sign up for an online class follow it through to completion.\textsuperscript{22} We need meta-learning to be able to effectively recognize our weaknesses and push ourselves to improve.

Education without meta-learning is only so effective, as there is evidence that people do not apply their understanding—even if they have deep understanding!—to their decisions in the world. In one study, researchers examined whether ethicists were more ethical in their lives:

\begin{quote}
The evidence suggests that they are no likelier to donate to charity, to choose a vegetarian diet, to reply to student emails, to pay conference registration fees they owe, to return their library books, to vote in public elections, to stay in regular contact with their mothers, to be blood or organ donors, or to behave politely at conferences.\textsuperscript{23}
\end{quote}

So metacognition is key to recognizing opportunities for improvement and a growth mindset is necessary to believe that one can successfully improve. After that, metacognition is needed to effectively plan, monitor, and evaluate strategies.

Meta-learning is the fourth dimension of education that can help all students with the varied tasks of learning in the present and the future, as well as all of the jobs and personal choices individuals must make during their lifetimes. It is the internalized voice that says, “Okay, how do I know that this is the right thing to do?” and the voice that says “I can do this, if I keep trying.” It supports and rounds out every other dimension of education (knowledge, skills, and character), by creating goals and feedback loops in which students continue to improve and thrive, without teachers or parents prodding them at every step. It sets students up to succeed in lifelong, self-directed learning, in the productive careers they may choose, and in continuing to grow throughout their lives, as the world continues to shift what is needed to be an effective, well-rounded twenty-first century person.

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