

Leveraging Epistemic Emotions to Cultivate Intrinsic Motivation

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In 2010, when news of the Chilean mining accident had captured our collective attention, a group of third graders sat on the floor around a piece of paper in the shape of a giant pizza slice. The students were engaged in a unit on geology, and the paper was serving as a scale model of a wedge of the earth, with marks delineating the crust, mantle, and inner and outer core. Sensing an opportunity to connect back to a topic of interest, the teacher asked each student to place a dot on the model indicating how deep below the earth's surface they thought the miners had been trapped. Most students' guesses placed the miners somewhere near the earth's outer core...an impossible, and certainly unsurvivable, place for humans to be! When the teacher displayed the miners' actual location – a “mere” 800 meters deep – the students were stunned. “There is so much more earth beneath our feet than I'd realized,” one student remarked. Another asked if anyone had ever been deeper below the surface than the miners, leading to a class-wide Internet search for “world's deepest mines,” “how deep is the Mariana Trench?” and so on. Weeks later, a student declared that his new career goal was to develop technology that could help humans travel deeper toward the center of the earth.

More recently, in a summer program for rising high school juniors, students were perched around lab tables in small groups, murmuring to each other as they worked on a class activity about DNA replication. In several of the groups, a puzzle had surfaced: what happens to DNA over time? Does it get old, or worn down after multiple rounds of replication? A college student serving as a mentor for the class overheard one group raising this question and told the students about telomeres, the structures at the end of chromosomes which become shorter with each cell division and are associated with aging. Alisha widened her eyes at this news. “So if we stopped that from happening,” she questioned, “we could live forever?!” The mentors weren't certain whether or not to endorse this conclusion, but it didn't matter – the students were fully committed to the idea. As if they'd just been led to the fountain of youth, they buzzed with excitement. A mentor called out from the other classroom that it was time for the groups to rotate. “Guys,” Alisha said emphatically to her classmates as they travelled across the hallway, “together we all have to go into science so we can figure this out!”

Far too often, learners of all ages are given the message that they need to suppress their emotions in order to focus and persevere, especially when they find themselves in challenging learning environments. In fact, research has long supported the opposite approach: being aware of one's emotional state is a crucial component of self-regulated learning, and emotions play an important role in many complex learning processes. For instance, emotions support transfer, or applying our understanding to new contexts, by directing our attention to the domain of knowledge that is relevant to the task at hand.¹ Emotional engagement is also crucial to the process of conceptual change, in which learners come to recognize the limitations of their present understanding and “trade up” for more powerful explanations.²

A wide range of emotions are involved in the process of learning, but of particular importance are the *epistemic* emotions – these are the “finding out” emotions like surprise, curiosity, wonder, and awe that drive the pursuit of new knowledge. In our [last piece](#) for this series on Next Level Learning, we discussed how epistemic emotions can be leveraged to develop agentive learners.³ Here, we will further explore the relationship between epistemic emotions and intrinsic motivation.

Commonly, epistemic emotions are triggered by experiences of cognitive disequilibrium – that is, scenarios where a person encounters information that does not fit with their existing understanding of how the world works.⁴ Epistemic emotions are fruitful because they draw the learner’s attention to the gap between what they know and what is possible to know, and motivate them to seek further information in order to close this gap.⁵ Some epistemic emotions, such as curiosity and wonder, generally feel positive. These are the emotions that make us say, “Wow! I can’t believe that’s how that works. I can’t wait to find out more about it!”. Research indicates that awe, which is typically (though not always) experienced as a positive emotion, is especially well-suited to facilitating conceptual change, because a key component of the emotional experience is a desire to accommodate new information that does not fit in with our existing understanding of the world.⁶ Other epistemic emotions, like surprise and confusion, may initially be accompanied by a sense of frustration. However, these emotions can still be productive if the learner senses that there will be an opportunity to resolve uncertainty and move forward with their understanding.⁷ A learner experiencing these emotions might say, “Hmm...that result was not what I expected. Let me try again and see if I can figure out what happened!”

In contrast, cognitive disequilibrium can also elicit negative emotions like anxiety and shame; these emotions have the opposite effect and can shut down learning by making the individual feel discouraged, helpless, or fearful of making mistakes. Still other emotions, like pride, may seem positive but do not motivate future learning because they are evoked by a sense of achievement or accomplishment rather than the process of finding things out – indeed, as the research on growth mindset tells us, overvaluing achievement can discourage students from taking risks and pushing themselves to grow as learners.^{8,9} Unlike awe, wonder, or even confusion, emotions like pride and shame are typically associated with performance outcomes rather than the process of learning. Thus, it is important to help learners recognize and draw upon emotions that are elicited by an innate desire to satisfy their own curiosity.

On some occasions, students may organically develop an interest in a topic that they choose to learn more about for a class project or on their own time. But even when students are initially presented with a new concept by an instructor – such as the third graders’ understanding of the earth’s depth or the high schoolers’ understanding of telomeres – leveraging epistemic emotions can help students connect with the ideas and point them toward directions for further exploration. This knowledge seeking behavior is intrinsically motivated – that is, it is the act of seeking knowledge for the “inherent satisfaction” of narrowing the gap in one’s understanding, rather than for some external reward such as grades or gold stars.¹⁰ As we have discussed previously, this is why tapping into epistemic emotions is a powerful tool for developing agentic learners who are able to take charge of their own learning.

Notably, experiencing epistemic emotions seems to provide a source of intrinsic motivation in the face of challenging or discouraging external circumstances. For instance, in my recent research on the awe experiences of expert scientists, nearly two-thirds of participants reported that having experiences of awe that were elicited by moments of discovery, and hoping for similar experiences in the future, served as a type of “fuel” that encouraged them to persist despite institutional challenges like low pay, long hours, and repeated failure. As Luke, a molecular biophysicist, explained, “there’s so much drudgery, that if you don’t hang on to those [awe] moments, I don’t know what else you hang on to.”¹¹ Helping K-12 students (who also encounter their fair share of drudgery) tap into their epistemic emotions can be a powerful way to encourage perseverance that is motivated by a sense of curiosity rather than obligation.

What does this mean for practice? First, epistemic emotions are more likely to be triggered when students believe that they are engaging in authentic inquiry. In the scientist study described above, many participants shared that they were often bored by “cookbook” K-12 science activities where the teacher was clearly expecting a specific answer, and that it was not until they reached higher education – sometimes even graduate school – that they were given the chance to pursue novel questions and make their own discoveries, however small. To the extent that it is possible, providing students with opportunities to be genuinely surprised by what they have learned, and to chart a path forward based on the questions that spark their interest, is crucial for eliciting epistemic emotions. Exposing students to the materials and processes that are used by practitioners in a given discipline, such as primary source documents for historical research or actual environmental data collected for a citizen science project, communicates to learners that they are not just following a formulaic classroom protocol and that they can ask questions to which there is no singular “right” answer.

Educators can leverage students’ epistemic emotions by:

- ✓ Presenting students with open-ended exploratory activities, rather than formulaic activities that have one clear right answer
- ✓ Creating a classroom culture that invites students to recognize and “lean in” to their affective state, rather than attempting to ignore or suppress their emotions
- ✓ Encouraging students to connect their emotions to specific puzzles or wonderings (e.g., “I’m feeling confused because the first strategy I tried didn’t work”)
- ✓ Offering concrete strategies to act on epistemic emotions (e.g., “If I am feeling curious about something we’ve learned, I can make a list of questions and choose one to explore for my next class project”)

Critically, it is important to allow enough time for these emotionally evocative experiences to “linger” so that the feeling does not dissipate before students can recognize and draw on their feelings to support their learning. At the same time, when students experience the sort of cognitive disequilibrium that can elicit epistemic emotions, they need support to develop a plan for moving forward with their desire for further understanding, such that they do not become overly confused or frustrated before experiencing the sense of “closure” that comes with knowledge acquisition. For these reasons, it is important to incorporate metacognitive practices that encourage students to reflect on their emotions and what has caused them, identify what specifically they are curious about and why, and lay out a plan for the pursuit of further knowledge. For instance, the most recent season of Sesame Street introduced the mantra “I wonder...what if...let’s try!” to encourage their preschool audience to recognize feelings of confusion or puzzlement and to develop a plan for creative, playful problem-solving.¹² For older learners, asking questions like, “It seems like you got a lab result that you didn’t expect – was that frustrating, exciting, or both?” or “This book presents a counternarrative to our typical understanding of this time in history – how did reading this perspective make you feel?” sends the message that attending to emotions is an important component of learning and that feelings of confusion or surprise can motivate further inquiry.

Students should not have to wait until they are in graduate school to experience the motivational “fuel” that accompanies feelings like curiosity, wonder, and awe. Being attuned to epistemic emotions can help Next Level Learners of all ages hook into complex ideas, illuminate gaps in understanding, and propel future learning.

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