AFFECT TRAJECTORIES DURING COMPLEX LEARNING

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Synonyms
Affect dynamics, affect transitions, affect sequencing

Definition
An affective state is a feeling, mood, or emotion. Students’ experience affective states during learning activities such as problem solving, studying for an exam, taking a test, or learning from a human or computer tutor. An affective trajectory is a sequential pattern of affective states that change over time. For example, confusion followed by frustration followed by anger is an affective trajectory. Complex learning pertains to learning at deeper levels of comprehension. Complex learning requires learners to generate inferences, answer causal questions, diagnose and solve problems, make conceptual comparisons, generate coherent explanations, and demonstrate application and transfer of acquired knowledge. This form of deep learning can be contrasted with shallow learning activities such as memorizing key phrases, definitions, and facts, and classical associative learning. This entry is concerned with tracking sequences of student affect during complex learning activities.

Theoretical Background
Efforts to learn difficult subject matter at deeper levels of comprehension (i.e., complex learning) involve a complex coordination of cognitive and affective processes. Cognitive processes such as diagnosing problems, making salient comparisons, and generating explanations are inevitably accompanied by negative emotions such as confusion, frustration, anger, and sometimes rage when the learner makes mistakes, struggles with troublesome problems, gets stuck, and experiences failure. On the other hand, positive emotions such as flow, delight, excitement, and eureka are experienced when tasks are completed, challenges are conquered, insights are unveiled, and major discoveries are made.

Theoretical frameworks that predict systematic relationships between affective and cognitive processes during learning are beginning to emerge in the fields of psychology (Dweck, 2002), education (Schultz & Pekrun, 2007), neuroscience (Immordino-Yang & Damasio, 2007), and artificial intelligence (Conati & Maclaren, 2009). Some of the emerging theories that link affect and learning have highlighted the importance of confusion, frustration, boredom, flow/engagement, anxiety, curiosity, delight, and surprise to learning activities. Although identifying the emotions that are relevant to learning is an important step, knowing what states occur and how they impact learning does not tell the entire story. What is missing is a specification of how these states evolve, morph, interact, and influence learning and engagement.

An analysis of the affective trajectories is particularly relevant because emotions are seldom static and persistent; instead, they are dynamic and highly transient. For example, consider the affective trajectory of an actual learner from a learning session with a computer tutor (see Figure 1). The learner settles into the flow or engaged state after initially oscillating between engagement and delight. An impasse potentially causes the
A model of cognitive disequilibrium is one framework to understand the affective transitions that emerge during learning. The model postulates an important role for cognitive disequilibrium in comprehension and learning processes. Cognitive disequilibrium is a state that occurs when learners face obstacles to goals, contradictions, incongruities, anomalies, uncertainty, and salient contrasts (Piaget, 1952). Cognitive equilibrium is restored with thought, reflection, problem solving, and other effortful deliberations. The model states that the complex interplay between external events that trigger impasses, and the resultant cognitive disequilibrium, are the key to understanding the dynamics of the affective processes that underlie learning.

The model suggests that learners who are in a flow/engaged state will experience confusion when an impasse is detected. They engage in effortful problem solving activities in order to resolve the impasse and restore equilibrium. Equilibrium is restored when the impasse is resolved and learners revert back into the flow/engaged state. However, confusion transitions into frustration when the impasse cannot be resolved, the student gets stuck, and important goals are blocked. Furthermore, persistent frustration may transition into boredom, a crucial point at which the student disengages from the learning process. Boredom may revert back into frustration when a student is forced to endure the session despite his or her ennui.
Emerging evidence has confirmed the presence of confusion--flow and boredom--frustration oscillations as well as confusion to frustration transitions (see Figure 2) (D'Mello & Graesser, in press). Hence, students in the state of engagement/flow are continuously being challenged and are experiencing two-step episodes alternating between confusion and insight. In contrast to these beneficial flow-confusion-flow cycles, there are the harmful oscillations between boredom and frustration. As the cognitive disequilibrium model asserts, confusion plays a central role in the learning process because it the gateway to positive (flow) and negative (frustration) emotions.

**Figure 2. Transitions between affective states**

**Important Scientific Research and Open Questions**

At this point in science, we have only begun to understand the dynamics of student emotions during learning. The present entry has described an emotional trajectory that was observed (and replicated) in one learning context. There is the important question of whether this trajectory replicates across different learning environments (human tutors, computer tutors, classrooms), topics (science vs. math), and learner populations (ages, cultures, etc). If the major patterns in Figure 2 generalize to different contexts, then we will have some confidence that the cognitive disequilibrium model is a viable framework to study affect dynamics. However, failure to replicate the patterns will be equally informative, because it would highlight the need for either a more comprehensive model that generalizes across contexts, or individual models that are sensitive to subtle nuances in contexts.

There are also opportunities for the model to be refined and expanded. Currently, transitions from one state to another are governed by single links (e.g., impasse detected). This leaves room for additional possibilities. For example, identifying multiple conditions that trigger transitions between the same pairs of states would represent one important advance. The model can also be expanded in scope as it currently only addresses four affective states. Expanding the model to include additional learning-relevant affective states such as anxiety and curiosity would be another item for future research. It is also unlikely that all learners transition through emotions in similar ways. Hence, refining the model to incorporate individual differences in prior knowledge, ability, motivation, and learning styles is yet another crucial and open problem. Finally, in addition to these research questions that attempt to provide a process level account of the affective trajectories during learning, there is also a need to understand how affective dynamics influence the products of learning (i.e., distinguishing transitions that facilitate learning from transitions that hinder learning).
Cross-References

→ Affective and cognitive learning in the online classroom
→ Affective dimensions of learning
→ Cognitive and affective learning strategies
→ Emotion-based learning
→ Emotions: Functions and effects on learning
→ Confusion and effects on learning
→ Boredom of learning
→ Flow experience and learning

References


