

# Understanding Students' Emotions during Interactions with Agent-Based Learning Environments: A Selective Review

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**Abstract.** This selective review discusses the emotions that learners report experiencing while interacting with agent-based learning environments.

**Keywords:** Emotions, affect, pedagogical agents, intelligent tutoring systems.

## 1 Toward a Deeper Understanding of Emotions and ABLEs

How do students feel about interacting with specific types of computer-based learning environments (CBLEs)? Does the incidence of discrete emotions vary between similar types of these environments? What features support or hinder learners' experience of different emotions? This selective review addresses these questions as they relate to a type of CBLE: agent-based learning environments (ABLEs). ABLEs are unique from other CBLEs because of their use of pedagogical agents (PAs). PAs are animated characters designed to provide several functions such as immediate and tailored prompts and feedback to support student learning [1-7]. The primary objective of this review is to compare the emotions elicited by six different ABLEs. This selective review differs from other reviews, in several ways: (1) by focusing only on CBLEs with PAs; (2) examining any study that measured emotions using one or more methods so long as they met the criteria; (3) comparing and contrasting learners' incidence of each of the discrete emotions reported for all six of the ABLEs. Seven studies were selected on the basis of the following inclusion and exclusion criteria: (1) studies had to measure more than one discrete emotional state using a forced-choice measure<sup>1</sup>; (2) they had to report the incidence of emotions as either proportions or frequencies; and (3) in the case of multiple published articles based on the same or part of a common data set, the study with the larger sample size was taken.

Table 1 was created to eliminate the redundancy of the large number of emotional labels used by the seven studies by organizing them into sets that could: (1) be operationalized as different emotional states and (2) that reduced the number of emotional labels, but maintained as much meaningful variation in learners' emotions as possible. This synthesis was guided by research and operationalization of emotions by Pekrun

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<sup>1</sup> Emotions in Table 1 could add up to more than 100% if they possessed different object-foci (e.g., PA [admiration/reproach] vs. event outcome [joy/distress]) [1].

[8] and D'Mello, Graesser, and colleagues [2]. Emotions were therefore associated within the dimensions of valence and activation. Positively-valenced, activating emotions that were specifically related to learning and characterized as cognitive-affective states (e.g., curiosity, engagement) were grouped together because they represent ideal emotional states where the learner is not just feeling 'good and energized' (e.g., happy), but in an emotional state where they are prepared to learn effectively.

## 2 Results

**Table 1.** Proportions of grouped discrete emotions experienced with ABLEs

			ABLE						
			AutoTutor [2]	Operation ARIES! [3]	Crystal Island [6] [7]		MetaTutor [5]	Prime Climb [1]	Wayang Outpost [4]
Val.	Act.	Emotion %							
+	Act.	Happy/Joy/ Delight /Excitement	.06	.02	.25	.14	.09	.92**	.34
+	Act.	Eng./Flow / Focus/ Cur iosity	.24	.24	.42	.41			
+	Act. <sup>2</sup>	Admiration						.82*	
+	De-Act.	Concentrated/ Satisfied							.58
-	Act.	Anger/ Frustration	.13	.06	.07	.16	.03		.06
-	Act.	Fear/ Anxiety/ Distress		.01	.09	.05	.00	.08**	
-	Act.	Disgust/ Contempt/ Reproach					.00	.18*	
-	De-Act.	Boredom/ Tired	.18	.33	.03	.09			.02
-	De-Act.	Sadness			.02		.03		
+/-	Act. <sup>2</sup>	Confusion	.17	.09	.13	.16			
+/-	Act.	Surprise	.03	.01			.03		
NA	Baseline	Neutral	.19	.26			.77		
+	Act.	-	.30	.26	.67	.55	.09	.92/.82	.34
+	De-Act.	-							.58
-	Act.	-	.13	.07	.16	.21	.03	.08/.18	.06
-	De-Act.	-	.18	.33	.05	.09	.03	-	.02
+/-	Act.?	-	.20	.10	.13	.16	-	-	
NA	Baseline	-	.19	.26	-	-	.77	-	

## 3 Discussion

A number of preliminary conclusions can be drawn from this review: First, game-like elements, when implemented in a sufficient quantity (e.g., more than a narrative context) and with sufficient quality to make the environment truly game-like are related to learners' experience of positive, activating emotions [1, 6, 7]. Similarly, the relevance of content to students' academics and the affordance of choice in an ABLE is also related to learners' experience of positive emotions [1, 4, 6, 7]. This review

illustrates that there is a range in the incidence of desired (positively-valenced, activating) emotions that learners experience while interacting with ABLEs. Few negatively-valenced, activating emotions are elicited, however, which is good news. Instead, the greatest challenge for researchers to target in emotional interventions is boredom. Neutral was found to be one of the most commonly appearing states in those environments that measured it [2, 3, 5]. Future research should include neutral because it is important to capture the range of students' emotional states, including those that may be considered to be a non or baseline emotional state. More studies with forced-choice emotional labels and their incidence are needed to validate and expand upon the number of ABLEs presently reviewed and the samples they drew upon.

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