Field Observations of Engagement in Reasoning Mind

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ABSTRACT. This study presents Quantitative Field Observations (QFOs) of educationally relevant affect and behavior among students at three schools using Reasoning Mind, a game-based software system designed to teach elementary-level mathematics. High levels of engagement are observed. Possible causes for these high levels of engagement are considered, including the interactive pedagogical agent and other design elements.

Keywords: Affect Modeling, Intelligent Tutoring System, Boredom, Frustration, Engaged Concentration.

1 Introduction

Reasoning Mind (RM) is a hybrid mathematics program that combines extensive teacher training with a game-based AIED system. It is used by around 100,000 students a year in the Southern United States. Developed for elementary and middle school students, the RM system graphically represents student learning activity modules in a virtual "RM City," where activities take place in different virtual buildings. An interactive pedagogical agent named "Genie" guides students through both the city and the activities. On successful completion of the activities, students are rewarded with points that they may use to furnish their own space within the environment. Student and teacher reports indicate that students find both the pedagogical and artistic designs of this system highly engaging, but to date, no quantitative study of student engagement has been conducted. In this paper, we use Quantitative Field Observations (QFOs) to evaluate student engagement with the RM software. We demonstrate that key measures of behavior and affect reflect anecdotal reports from students and teachers who have used the system—that students engage in a high degree of on-task behavior and engaged concentration, as intended by the software designers.

2 Methods and Results

Quantitative Field Observations (QFOs) were collected using the BROMP method [1]. In this method, which has previously been used in multiple studies of student engagement [cf. cf. 2-5] trained coders record synchronized observations of educationally relevant behavior (on task, on task conversation, off task, gaming the system, and other) and affect (boredom, confusion, delight, engaged concentration/flow, frustration, and other) using an Android application designed for these purposes.

Coders using the BROMP method follow a strict protocol. In order to avoid bias towards dramatic events in the classroom, QFOs occur in a pre-determined order. Each student is observed individually, and observers avoid looking directly at that student in order to disguise who is being currently observed. Because behavior and affect are considered orthogonal in this coding scheme, they are coded separately. The observer has up to 20 seconds to complete an observation. If a student presents more than one behavior or affect during that window, only the first is recorded. In ambiguous cases, or when a student leaves the room, "other" is selected. During the QFOs for this study, BROMP training was conducted, and an acceptable inter-rater reliability was obtained (Kappa=.58-.72 for affect, Kappa=.63-.79 for behavior). As the secondary coders were being trained during data collection, only data from the trainer is included in our results.

Students from three different schools in the Texas Gulf Coast region were observed. Two schools were in urban areas with large class sizes (around 25 students each). Both served predominantly ethnic minority populations: one with a large Hispanic population and another with a large African American population. Both served communities with a median income below the state average, reflected by substantial populations (57% and 96%) of economically disadvantaged students, defined as those who received free or reduced price lunch. A third, suburban charter school had smaller class sizes (approximately 15 students each), a majority White population, a median income slightly above the state average, and fewer economically disadvantaged students (16%). For each of the three schools, two classes were observed.

Table 1: Summary of Classroom Observation Data

BROMP Category		**N**	**%**
behavior	on task	243	82%
	on task conversation	20	7%
	off task	31	10%
	gaming	2	1%
affect	boredom	27	10%
	confusion	24	9%
	delight	9	3%
	engaged concentration	194	71%
	frustration	19	7%

Results are given in Table 1. The overall incidence of behavior and affect indicates high engagement. Students were on-task 82% of the time, in on-task conversation 7% of the time, off-task 10% of the time, and gaming the system 1% of the time. The total of 89% on-task (in either fashion) is higher than values observed in Cognitive Tutor classrooms in US suburban middle schools [cf. 4] and in traditional US classrooms [cf. 6-7]. Affect patterns also indicate high engagement. There was a high proportion of engaged concentration (71% of the time), while boredom was fairly uncommon, occurring in only 10% of observations.

3 Discussion and Conclusion

Within this paper, we use quantitative field observations to examine the frequency of engaged and disengaged student behaviors and affective states in students using Reasoning Mind, a popular AIED system. These numbers reflect patterns that suggest high student engagement with this learning system, despite the largely economically disadvantaged urban populations investigated, findings that should be explored further in future research.

It is worth asking which design factors have influenced these outcomes. Some potential hypotheses include the scaffolding curricular techniques in RM and Genie (the embodied pedagogical learning agent in RM City). The designers of RM have spent considerable effort to replicate curricular techniques used by Russian teachers, both in the software design and in the extensive teacher training they require. Thus, students alternate between units of theory and units of practice. It is possible that this activity switching may reduce disengagement.

Anecdotal evidence suggests that students are quite attached to Genie, who regularly receives (and answers) email on topics beyond the scope of the learning software, including jokes, requests for friendship, and confessions about students' home life. On the basis of these reports, it seems that the effect of Genie deserves more careful consideration, as the success of her design may contribute significantly to the high levels of engagement observed.

Finally, we should consider the many game-like elements in its design, including a point system that rewards students for speed drills and puzzles. Once sufficient points have been accumulated, students may furnish their own virtual space within RM City or buy virtual books. Particularly at a young age, this kind of autonomy is likely very appealing.

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