When Off-Task is On-Task: The Affective Role of Off-Task Behavior in Narrative-Centered Learning Environments

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Abstract. Off-task behavior is the subject of increasing interest in the AI in Education community. This paper reports on an investigation of the role of off-task behavior in narrative-centered learning environments by examining its interactions with student learning gains and affect. Results from an empirical study of students interacting with the CRYSTAL ISLAND environment indicate that off-task behavior generally has negative impacts on learning. However, further analyses of students' affective transitions suggest that some students may be using off-task behavior as a strategy to regulate negative emotions.

Keywords: Narrative-centered learning environments, off-task behavior, affect.

1 Introduction

Narrative-centered learning environments contextualize problem solving in interactive story scenarios. While narrative-centered learning environments present significant opportunities for enhancing engagement, they may also invite behaviors that are not learning oriented. Concerns about off-task behavior are reinforced by recent findings, which indicate that going off-task is detrimental to learning [1]. There is also evidence that off-task behavior may be associated with students' emotional states, such as *boredom* and *frustration* [2]. However, off-task behavior may play an important productive role in educational settings. Rather than serving as an unproductive diversion, off-task behavior could offer a means for students to take a needed "break" from complex or challenging learning activities. In this manner, off-task behavior may function as an emotion regulation mechanism that students use to renew their motivation to participate in productive learning activities.

The work presented in this paper investigates the impact and affective role of off-task behavior in narrative-centered learning environments. It extends previous work that characterized the relationship between off-task behavior and learning in the CRYSTAL ISLAND learning environment [3]. Data from emotion self-reports collected during a study with CRYSTAL ISLAND is used to investigate relationships between students' moods, affect transitions, and off-task behaviors.

2 Investigating Off-Task Behavior in CRYSTAL ISLAND

Our work on off-task behavior is situated in CRYSTAL ISLAND, a narrative-centered learning environment [3]. Several in-game actions are identified as off-task, including: (1) interactions with in-game objects that re not relevant to the illness scenario, (2) moving a task-related object to an unrelated location, (3) spending too much time in a location irrelevant to the task, or (4) exceeding a height achievable by normal navigation (e.g., climbing on top of trees or boxes). Intervals of time in which several off-task behaviors occur in succession are aggregated and considered as a single duration of off-task behavior. No actions from the first five minutes of game play are designated as off-task, in order to provide ample exploration time.

In order to investigate the role of off-task behavior in narrative-centered learning environments, data from 260 eighth grade students from a rural North Carolina middle school was used. During the week prior to the study, students completed a curriculum test involving 19 microbiology questions. Students interacted with CRYSTAL ISLAND until they solved the mystery or 55 minutes of interaction elapsed. Afterward, students completed the same curriculum test used in the pre-survey.

Students' affect data was collected during the learning interactions through regular self-report prompts. Students were prompted every seven minutes to self-report their current mood and "status" through an in-game smartphone device. Students selected one emotion from a set of seven options, which included: *anxious*, *bored*, *confused*, *curious*, *excited*, *focused*, and *frustrated*.

An investigation of student learning indicated that on average students answered 2.11 (SD = 3.25) more questions correctly on the post-test than they did on the pre-test, which was statistically significant, $t(259) = 10.46$, $p < 0.0001$. Students spent approximately 4.58% (SD = 6.82) of their time off task, with a range of 0% to 63.2%.

A previous investigation using an earlier version of CRYSTAL ISLAND found that students' overall learning gains were not affected by the frequency of off-task behaviors [3]. However, the current data reveals a negative correlation between off-task behavior and normalized learning gains, $r(258) = -0.18$, $p = 0.004$. These findings indicate that off-task behavior may be more harmful to learning in CRYSTAL ISLAND than previously believed.

An analysis of transition likelihoods, L, between emotional states and off-task behaviors was conducted [4]. The analysis indicated that no emotional states were more likely than chance to lead to off-task behavior, with $\alpha = 0.05$. Next, similar analyses were conducted that compared intervals where off-task behaviors occurred between emotion self-reports and intervals where students remained on task. In particular, the transitions originating from *confusion* and *frustration* revealed differences in how students transition to new emotions depending on their off-task behavior (Figure 1). Students who remained on-task after reporting *confusion* were likely to next report feeling *focused*. Alternatively, students who went off-task after reporting *confusion* were likely to report *boredom* or *frustration* next.

While off-task behavior indicated negative emotional transitions for students who were *confused*, the opposite was true for students experiencing *frustration. Frustrated* students who went off-task were more likely to report being *focused* at the next report, which suggests that these students may have used off-task behavior to temporarily distance themselves from problem solving. Alternatively, *frustrated* students who

a. b.

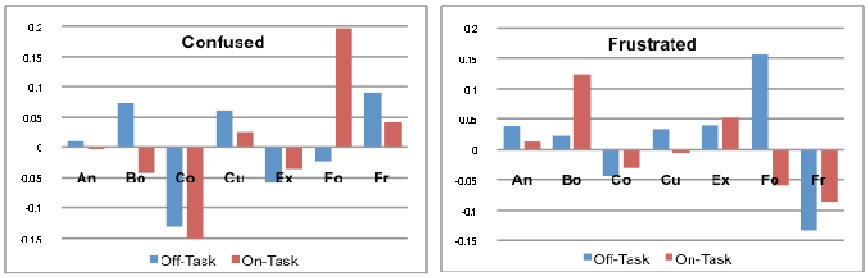

Figure 1. Average likelihoods for transitioning from a) *confused* and off/on-task to a particular emotion, and b) *frustrated* and off/on-task to a particular emotion.

remained on-task were likely to report *boredom* at the next report. These students may have remained on-task even when it would have been beneficial to take a break.

These findings provide insight into how narrative-centered learning environments might best respond to off-task behavior. It appears that while in a state of *confusion*, students should be encouraged to continue working on the task and not be distracted by extraneous elements of the environment. Alternatively, once this *confusion* has reached the point of *frustration*, students should not only be permitted, but perhaps encouraged to explore non-learning aspects of the environment as a short reprieve.

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