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Measuring Learner Engagement in Computer-Equipped College Classrooms

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Although engagement and learning appear linked, quantitatively measuring this relationship is challenging. New technologies offer a window into studying the interactions among classroom activity, student engagement, and positive learning outcomes in computer-equipped classrooms. A Classroom Behavioral Analysis System (CBAS) was developed to measure student engagement in a college writing class, and to test the hypothesis that an interactive lesson would increase student engagement levels in a computer-equipped classroom. Student computer-based behaviors (off-task and on-task internet visits) were compared during a traditional, lecture-based lesson (no-simulation condition) and an interactive simulation-based lesson (simulation condition). The dependent variable was student engagement as measured by the number of off-task and on-task internet activities during the lesson. Off-task internet activities were operationalized as website visits that were not part of the classroom activity; on-task internet activities included websites that related to the assigned class activity. CBAS recorded all student computer actions during the observed instructional periods. Students attending a simulation-based lesson performed more on-task internet actions, and significantly fewer off-task internet actions than did students attending a lecture-based lesson. These findings support the hypothesis that interactive lessons increase student engagement levels in computer-equipped classrooms, and demonstrate that CBAS is a promising tool for studying student engagement.

In a typical classroom situation, at any given time, some students are paying attention to varying degrees and others are not. It is difficult for instructors and researchers to determine the extent to which students are actually engaged with the classroom activities. Behavioral cues, such as students looking at the teacher, may provide some indication of engagement levels; however, students who appear to not be paying attention may be completely engaged and vice-versa. While engagement and learning appear tightly linked, there is little research to quantify relations among classroom activity, student engagement, and positive learning outcomes (Fredricks, Blumenfeld, & Paris, 2004). Part of the difficulty in determining this relation lies in the challenge of measuring student engagement.

A potential solution to this problem rests in new technologies, which offer a window into student engagement that has previously not been available. Previously problematic areas of learning and cognition, such as student engagement levels within a classroom, can now be measured using emerging technologies to record and analyze student computer actions (Dickey, 2005; Zhang, Almeroth, & Bulger, 2005).

In this study, we developed a Classroom Behavioral Analysis System (CBAS) to measure student engagement levels as reflected by their on-task and off-task internet actions during an instructional episode. CBAS consists of monitoring software that records all student computer actions performed during a class session, including keystroke activities, active applications, and website visits. At the end of each class session, CBAS reports this information as a log file that can then be studied to determine whether patterns exist in student engagement levels. This record of internet activity can then be evaluated in light of the classroom instructional environment.

To validate CBAS as a tool for measuring engagement, we compared student computer behaviors in a writing class taught by lecture (no-simulation condition) and a writing class taught by using an interactive simulation exercise (simulation condition). We used CBAS to record student internet activities during a class session and then counted student off-task and on-task behaviors. We then compared these behaviors to determine whether student engagement levels, as measured by off-task and on-task internet actions, were affected by the teacher's instructional style. If CBAS is a valid tool for measuring engagement, the level of on-task behaviors should be higher and that of off-task behaviors lower in the simulation class than in the lecture class.

What Mediates the Notion that Engagement Improves Learning?

Engagement is a central component in many theories of academic learning. In fact, a general assumption of learning studies is that students learn more if they pay attention (Fredricks, Blumenfeld, & Paris, 2004; McMahon & Portelli, 2004). Early studies defined engagement in terms of interest (Dewey, 1913), effort (Meece & Blumenfeld, 1988), motivation (Pintrich & DeGroot, 1990; Skinner & Belmont, 1993), and time on task (Berliner, 1979, 1990; Lentz, 1998). In these studies, a conceptual correlation between engagement and positive learning outcomes was established by linking interest, for example, to active learning (Dewey, 1913; Schraw & Lehman, 2001), or effort to goal achievement (Brophy, Rashid, Rohrkemper, & Goldberger, 1983; Meece & Blumenfeld, 1988). Research on active engagement consistently shows that when students are focused on a task, they are more likely to apply effort during their learning experience (Ames, 1992; Brophy, Rashid, Rohrkemper, & Goldberger, 1983).

A trend in recent research is to study the cognitive strategies that result from varying levels of motivation (Pintrich, 2002; Pressley, 1986; Winne, 1992). Metacognitive control, which is evident in students' ability to not only know what to do in a learning situation (cognitive strategies), but when to do it, is measured by self-efficacy cues, self-regulation, and goal setting. Pressley and Winne (1992) argue that metacognitive control is teachable. Current studies of classroom engagement consistently find that classroom environment, including the teacher's lesson plan and lecture delivery style, can affect students' practice of metacognitive control (Dickey, 2005; Winne, 2006). Importantly, students demonstrating cognitive strategies such as task-mastery goals report higher levels of engagement and perform better on assigned tasks (Ames & Archer, 1988; Meece, 1988). Students who believe they are capable of performing assigned tasks (i.e., students high in self-efficacy beliefs) also demonstrate high levels of academic performance (Ames & Archer, 1988; Schunk & Hanson, 1985; Schunk, 1991; Zimmerman & Martinez-Pons, 1990).

Research on self-efficacy shows a correlation between self-efficacy beliefs and active learning strategies, as well as between self-efficacy beliefs and improved performance on achievement tests (Ames, 1992; Pintrich & DeGroot, 1990; Schunk, 1985, 1989; Zimmerman & Martinez-Pons, 1990).

Students' self-efficacy beliefs reflect how well they believe they will perform on a task. Although factors such as experience and aptitude play a role in the self-efficacy beliefs students bring to the classroom, Ames has shown that self-efficacy beliefs are also formed during the instructional episode. Since students revise their self-efficacy beliefs based on interpretations of peer and teacher interactions, the presentation of information during the lesson is essential to encouraging high self-efficacy and therefore active engagement in the learning process (Zimmerman & Martinez-Pons, 1990).

A basic tenet of these cognitive theories of learning and instruction is that students learn more deeply when they are engaged in active learning than when they are passive recipients of information (Grabinger, 1996; Mayer, 2003; Pearce, Ainley, & Howard, 2005). Active learning occurs when a learner engages in active cognitive processing during learning, such as attending to relevant information, organizing the selected information into a coherent cognitive structure, and integrating the information with existing knowledge (Mayer, 2001, 2003). Active learning takes place in an environment where a student is not a passive listener but is instead an active participant in his/her learning experience (Gee, 2003; Jonassen, 1996; Jonassen, Peck, & Wilson, 1999).

How Can New Technologies be Used to Study Student Engagement?

Computer lab settings provide fresh opportunities for measuring classroom behaviors because students use the computer for both course-relevant and recreational activities. In this setting, it is possible to collect student behavior data such as applications used, time spent using each application, internet activities, frequency of attention shifts within program use, and keystrokes. These computer actions offer a window into the cognitive interplay between student and computer. Computer actions show where students focus their attention during instruction, the duration of this focus, and when their attention focus shifts.

In light of the new measurement opportunities made possible by emerging technologies, it makes sense to return to Berliner's research (1987, 1990) on student engagement as measured by time on task. In Berliner's (1979) study of engagement, he assumes a causal relationship between *engaged time,* that is, the period of time in which students are completely focused on and participating in the learning task, and academic achievement. In our study, we applied Berliner's concept of time on task to measure student engagement levels. We used CBAS to record student computer actions during a class session and then coded the actions as on-task or off-task. We focused on internet actions because they provide a clear record of on-task use, which included using the course website, reference pages, or online writing labs versus off-task use, as demonstrated by visits to sports, gambling, or banking websites. We hypothesize that student computer actions, specifically, their internet use, reflects their engagement levels.

Predictions

To test the validity of our measurement tool, we assessed student levels under two conditions. In one set of classes, we measured student engagement during a standard instructional episode that was not specifically designed to be engaging. We refer to this as the no-simulation condition because a traditional lecture format was used instead of an interactive simulation exercise. We predict that in this no-simulation condition, student engagement levels will be low, reflected in frequent off-task internet actions and minimal on-task internet actions.

In another set of classes, we assessed student engagement levels as measured by off-task and on-task internet actions during an instructional episode that we specifically designed to be engaging. Since we used an interactive simulation exercise in these classes, we refer to it as the simulation condition. Applying engagement research findings to lesson plan development should result in instructional activities that enhance student engagement levels.

While in the first set of classes, the lesson was lecture-driven and instructor-centered with minimal structure for using the computer as a resource; in the second set of classes, we designed a student-centered interactive activity to promote active participation in the lesson. Unlike the no-simulation condition, in the simulation condition the activity centered on using the computer as a resource to complete the assignment. We predict that in the simulation condition, on-task internet actions will be high and off-task internet actions will be minimal. We predict that this type of lesson design will result in the participants using the classroom computers as learning resources, rather than recreational tools. Testing these predictions provides a means for testing the validity of the Classroom Behavioral Analysis System (CBAS) as a tool for capturing learner engagement.

METHOD

Participants and Design

One hundred thirty-nine students enrolled in freshman composition courses at the University of California, Santa Barbara participated in the study. Participants were enrolled in seven sections of a freshman composition course taught during the 2004 – 2005 academic year.

All students enrolled in the seven freshman composition courses were given the option to participate. Out of 144 students, 139 volunteered for the study and five chose not to participate. All consented to the recording of their in-class computer activities. Thirty-two participants in two intact classes were given the no-simulation treatment and 107 participants in five intact classes were given the simulation treatment. The design is quasi-experimental because intact classes (rather than individual learners) were assigned to the treatments.

The dependent variable was student engagement as measured by the number of off-task and on-task internet activities during a class lesson. Off-task internet activities were operationalized as website visits that were not part of the assigned class activity. For example if a participant visited a banking or sports news website (e.g., Wells Fargo or ESPN), we considered this activity off-task. On-task internet activities included website visits that related to the assigned class activity, such as a word definition search or the use of an online writing lab (e.g., Purdue's OWL).

Materials and Apparatus

The classroom used in the study held 25 computers arranged in five vertical rows. The classroom was equipped with Dell Pentium III computers, which were identically configured to include internet access, Microsoft Office, and graphic development software. CBAS was installed on each computer and recorded keystroke activities, active applications, and URL visits. A video camera positioned in the back of the classroom recorded observable classroom activity, including the instructor's actions and participant behavior.

Procedure

Participants were observed during a single 110-minute instructional episode. As participants entered the classroom, they logged into a computer of their choice. CBAS recorded every computer action during the class period, beginning with login and ending with logout. Once participants logged out at the end of class, CBAS generated a log file containing all keystrokes, application use, and URL information for each participant as well as a comprehensive file for the entire cohort.

No-simulation condition. In the two non-simulation classes, the instructor used a traditional, lecture-style format for the first fifteen minutes of class and then directed the students to use the additional class time to revise their paper drafts. The focus of the lesson was on revision, so the instructor began her lecture by describing a personal experience in which she needed to learn a new skill and then introduced techniques for revision. Next, she reviewed the requirements of the assignment and directed participants to use the computers to revise their drafts. For the remaining hour of the class period, participants worked individually on their papers.

Simulation condition. For the five simulation classes, we developed a simulation exercise consisting of a website that detailed a mining accident and prompted participants to write a rescue plan. A simulation exercise is a learning activity that immerses students in a real-world environment. In these classes, the activity took place in real time and required participants to submit a report to the instructor at the end of the exercise. Participants worked collaboratively in groups while the instructor participated directly in the learning activity by role-playing and responding to student requests for information and support.

Figure 1 shows the online entry and resource pages used in the simulation exercise. All of the events described on the website were designed to occur within the timeframe of the class.

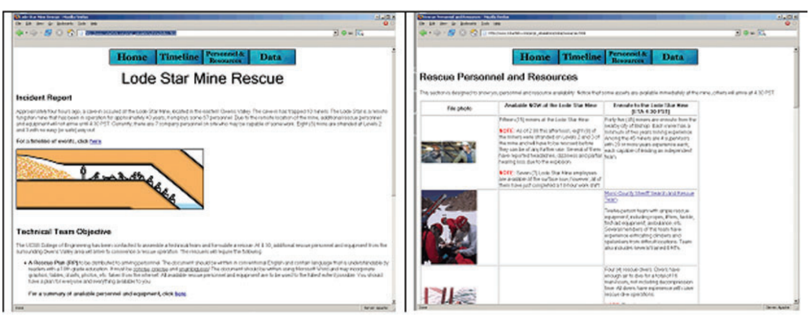


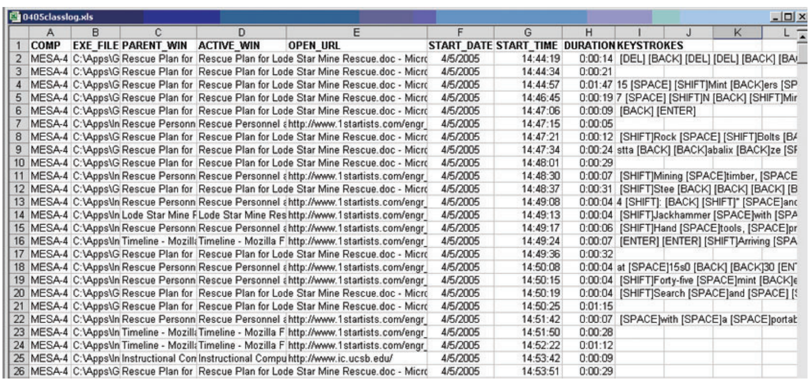
Figure 1. Entry page for simulation exercise and sample resource page

Instructors directed participants to the mining simulation website, described the rescue plan assignment, and divided the class into groups of four or five. Participants were required to identify critical tasks and assign duties within their groups. At the end of class, participants uploaded their group rescue plans to a folder that all class members were able to access. The instructors ended their classes with a group discussion about the feasibility, clarity, and depth of each rescue plan and asked the participants to evaluate their experience of working as a team to write a collaborative document.

RESULTS

Scoring

The action logs generated by CBAS reported all keystroke actions, URL visits, and active window entries for each participant (as shown in the sample log file in Figure 2). Each instance of Microsoft Internet Explorer or Mozilla Firefox that appeared as an active window entry was counted and labeled as either an off-task or on-task internet action.


0405classlog.xls

	A	B	C	D	E	F	G	H	I
1	COMP	EXE_FILE	PARENT_WIN	ACTIVE_WIN	OPEN_URL	START_DATE	START_TIME	DURATION	KEYSTROKES
2	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:44:19	0:00:14	[DEL] [BACK] [DEL] [DEL] [BACK] [BA
3	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:44:34	0:00:21	
4	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:44:57	0:01:47	15 [SPACE] [SHIFT]Mint [BACK]ers [SP
5	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:46:45	0:00:19	7 [SPACE] [SHIFT]N [BACK] [SHIFT]Mir
6	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:47:06	0:00:09	[BACK] [ENTER]
7	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:47:15	0:00:05	
8	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:47:21	0:00:12	[SHIFT]Rock [SPACE] [SHIFT]Bolts [BA
9	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:47:34	0:00:24	stta [BACK] [BACK]abalix [BACK]ze [SI
10	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:48:01	0:00:29	
11	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:48:30	0:00:07	[SHIFT]Mining [SPACE]timber, [SPACE
12	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:48:37	0:00:31	[SHIFT]Stee [BACK] [BACK] [BACK] [B
13	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:49:08	0:00:04	4 [SHIFT]: [BACK] [SHIFT]" [SPACE]anc
14	MESA-4	C:\Apps\In	Lode Star Mine F	Lode Star Mine Res	http://www.1startists.com/engr_	4/5/2005	14:49:13	0:00:04	[SHIFT]Jackhammer [SPACE]with [SPA
15	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:49:17	0:00:06	[SHIFT]Hand [SPACE]tools, [SPACE]pr
16	MESA-4	C:\Apps\In	Timeline - Mozilla	Timeline - Mozilla F	http://www.1startists.com/engr_	4/5/2005	14:49:24	0:00:07	[ENTER] [ENTER] [SHIFT]Arriving [SPA
17	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:49:36	0:00:32	
18	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:50:08	0:00:04	at [SPACE]15s0 [BACK] [BACK]30 [EN
19	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:50:15	0:00:04	[SHIFT]Forty-five [SPACE]mint [BACK]e
20	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:50:19	0:00:04	[SHIFT]Search [SPACE]and [SPACE] [S
21	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:50:25	0:01:15	
22	MESA-4	C:\Apps\In	Rescue Personn	Rescue Personnel a	http://www.1startists.com/engr_	4/5/2005	14:51:42	0:00:07	[SPACE]with [SPACE]a [SPACE]portab
23	MESA-4	C:\Apps\In	Timeline - Mozilla	Timeline - Mozilla F	http://www.1startists.com/engr_	4/5/2005	14:51:50	0:00:28	
24	MESA-4	C:\Apps\In	Timeline - Mozilla	Timeline - Mozilla F	http://www.1startists.com/engr_	4/5/2005	14:52:22	0:01:12	
25	MESA-4	C:\Apps\In	Instructional Con	Instructional Compu	http://www.ic.ucsb.edu/	4/5/2005	14:53:42	0:00:09	
26	MESA-4	C:\Apps\G	Rescue Plan for	Rescue Plan for Lode Star Mine Rescue.doc - Micrc		4/5/2005	14:53:51	0:00:29	

Figure 2. Sample log file generated by monitoring software

Website addresses (URLs) that were not part of the assigned class activity were labeled as off-task. For example, URLs containing terms such as “poker” and “NBA” were considered off-task. We used these off-task entries to compile a list of 93 unique search terms and then calculated the total number of off-task internet actions recorded in the log files.

URLs were labeled as on-task if they were assigned as part of the class activity. We used these on-task entries to compile a list of 47 unique search terms. We then used these unique search terms to calculate the total number of on-task internet actions. Examples include: dictionary, library, OWL, research, thesaurus, and .edu.

How Engaged Are Students During a Lecture Taught Using Traditional Methods?

The focus of our study of the two non-simulation classes was to determine whether CBAS would reflect low student engagement levels in a lesson not specifically designed to be engaging. In these classes, the lesson was taught using a traditional lecture-style format and did not use a simulation exercise. We predicted that student engagement levels would be low, resulting in frequent off-task behaviors and minimal on-task behaviors. We further predicted that CBAS, which recorded keystroke actions, active window records, and URL visit data, would reflect these low levels of student engagement by recording high levels of off-task behaviors.

In the no-simulation condition, participants performed significantly more off-task internet actions (M =34.31, SD = 28.03) than on-task internet actions (M = 11.72, SD = 11.33), $t(31) = 4.35$, $p < .001$. Off-task internet actions accounted for 79% of the cohort's total internet use. This result shows that a lesson taught using a traditional lecture-style format that did not apply engagement research findings resulted in low student engagement levels, as reflected by high off-task internet actions.

How Engaged are Students During a Lecture Taught Using a Simulation Exercise?

In the five simulation classes, we tested whether CBAS would accurately reflect student engagement levels during an instructional episode designed to be engaging. In this study, we predicted that student engagement levels, as measured by on-task internet actions, would be high given the interactive nature of our simulation exercise.

An analysis of variance (ANOVA) revealed that the mean number of internet actions for each condition did not differ significantly from any of the other groups $F(4, 102) = 107$, $MSE = 624.14$, $p = .65$, $r^2 = .023$. The group in which students were assigned to participate explained only 2.3% of the variance in internet action counts. Therefore, we combined the five classes into one large group labeled the simulation condition.

In the simulation condition, participants performed significantly more on-task internet actions (M = 27.71, SD = 19.11) than off-task internet actions (M = 3.79, SD = 5.89), $t(106) = 12.55$, $p < .001$. Off-task internet actions accounted for 9% of this cohort's total internet use. This result shows that using an interactive simulation exercise resulted in increased student engagement levels, as reflected by high on-task internet actions.

Are Student Engagement Levels Affected by Instructional Style?

In these studies, we tested the hypothesis that student engagement levels can be increased by applying findings from engagement research to lesson plan design. We also tested CBAS to determine whether it would reflect student engagement levels during instructional episodes designed to be high or low in engagement. Table 1 shows total internet actions, on-task internet actions, and off-task internet actions for each condition.

Table 1

Mean Number and Standard Deviations of Total Internet Actions, On-task Internet Actions, and Off-task Internet Actions by Students in the No-simulation and Simulation Conditions

	Total internet actions		On-task internet actions		Off-task internet actions	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*
No-simulation	43.38	36.46	11.72	11.33	34.31	28.02
Simulation	40.34	24.80	27.71	19.11	3.79	5.89

Total internet actions per user did not differ significantly between the simulation condition (M = 40.34, SD = 24.8) and the no-simulation condition (M = 43.38, SD = 36.46), indicating that students in both conditions were equally active in their internet use, $t(137) = -.541$, $p = .589$. This finding is important when considering the significant difference in the proportion of off-task and on-task internet actions recorded for the two conditions.

We predicted that off-task internet actions would be high in the no-simulation condition and low when a simulation was used. As predicted, the simulation condition performed significantly fewer off-task internet actions (M = 3.79, SD = 5.89) than the no-simulation condition (M = 34.31, SD = 28.03), $t(137) = 10.59$, $p < .001$. Since off-task internet actions reflect low levels of engagement, students in the no-simulation condition appear to have lower engagement levels than students in the simulation condition. These results support our hypothesis that it is possible to specifically design an instructional episode that heightens student engagement levels. Additionally, this data validates that CBAS effectively reflected student engagement levels since it recorded high levels of off-task internet actions in the no-simulation condition and low levels of off-task internet actions in the simulation condition.

Also, as predicted, the simulation condition produced significantly more on-task internet actions (M = 27.71, SD 19.11) than the no-simulation condition (M = 11.72, SD 11.33), $t(137) = 4.50$, $p < .001$. This significant difference in on-task internet actions further supports our hypothesis that an interactive simulation exercise will result in increased engagement levels, as reflected by a higher number of on-task actions. These findings also validate CBAS as an effective tool for measuring engagement during learning.

The proportion of off-task internet actions in the simulation condition accounted for 9% of the students' total internet use, compared with 79% of the students' internet use in the no-simulation condition. A t-test showed that these numbers were significantly different, $t(137)$ = -.5.19, $p < .001$. This high difference between the two conditions further supports our hypothesis that a lesson specifically designed to be engaging will result in a lower number of off-task internet actions and higher number of on-task actions.

To compare overall internet use for both conditions, we subtracted on-task internet actions from off-task internet actions for each participant. Overall internet activity types differed significantly, with the simulation condition performing more on-task actions and the no-simulation condition performing more off-task actions, $t(137) = 10.37$, $p < .001$. Using Cohen's d, we found an effect size of 1.57, which is considered a large effect size. This finding indicates that CBAS detected a difference in engagement levels that has practical significance.

DISCUSSION

Technical Implications

In this study, we developed CBAS to measure student engagement levels in computer-equipped classrooms. Our findings provide support for the validity of this tool. First, CBAS recorded high levels of student engagement in the simulation condition demonstrated by low levels of off-task internet actions and high levels of on-task actions. Second, CBAS measured low levels of engagement with the class activity in the no-simulation condition as reflected by high levels of off-task internet actions and low levels of on-task actions. CBAS is thus a promising tool for measuring student engagement and can be used in future studies to assess whether classroom technologies affect student engagement levels.

Theoretical Implications

On the theoretical side, this study shows that student engagement is related to instructional method, namely, that the no-simulation condition primed lower engagement in learners than did the simulation condition. An important next step is to investigate whether student engagement is related to academic achievement.

One of the most challenging aspects of teaching is maintaining student engagement levels. In this study, we found that it is possible to encourage high levels of student engagement by using an interactive simulation exercise. The high levels of student on-task actions in the simulation classes indicate that directed interactive activities can promote high levels of student engagement.

What, then, causes students to pay attention? In our study, participants appeared more attentive during the simulation exercise than in the traditionally taught lecture. We incorporated several strategies to promote active learning in the simulation condition. Strategies included assigning collaborative work with an in-class deliverable, requiring students to seek information beyond the confines of the classroom, and supporting the formation of learning connections by providing resources and encouraging students to develop their own understandings of the material presented. Further studies must be conducted to determine exactly which combination of strategies result in increased engagement levels.

Practical Implications

This study addresses the potentially distracting nature of internet-connected computers in the classroom. Although the participants in the no-simulation condition clearly demonstrated low levels of engagement reflected in low on-task internet use, the participants in the simulation condition used the computer as a resource, rather than a recreational tool and demonstrated correspondingly high levels of on-task internet actions. These findings support our hypothesis that, while a computer can be potentially distracting, immersive activities can maximize its effectiveness as a learning tool and classroom resource.

Limitations and Future Directions

This study provides an example of effectively applying emerging technologies to previously problematic areas of study (Fredricks, Blumenfeld, & Paris, 2004; McMahon & Portelli, 2004). To further test the potential of CBAS, future studies should explore the relationship between measured engagement levels and academic performance. In our study, different instructors taught in the two conditions; future studies should use the same instructor for both conditions to reduce the possibility of an instructor effect. In the simulation condition, participants worked in groups, whereas in the no-simulation condition, participants worked alone. Better experimental control could be achieved by consistently requiring group work in both conditions. In this study, the sample size for the no-simulation condition was considerably smaller than the simulation condition. While this study did not address differences in age and gender among participants, these differences might also be explored in future research examining conditions that yield different levels of engagement for students in computer-equipped classrooms.

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