

The changing nature of student engagement during a digital learning task

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The construct of student engagement has been useful in understanding students' motivation in digital learning environments where they are required to show increased autonomy and independence in learning. Increasing clarity around this construct has allowed researchers to more accurately describe the nature of student engagement and the context in which it is being investigated. At a task-level, psychological states of engagement have been shown to be beneficial for students' positive learning experience, and performance. Despite this, we still lack knowledge of how these engaged states unfold or sustain during a learning task. In this paper we report on a qualitative study that investigated undergraduate students' experiences of psychological states of engagement in a digital learning task. Findings revealed that the three dimensions of engagement - cognition, affect, and behaviour - changed in intensity, with students experiencing both times of engagement and of not being engaged through the course of a digital learning task.

Introduction

With increased use of digital and online learning in higher education, researchers have sought ways to improve students' experience and outcomes in digital and online learning. Student motivation has become increasingly important as students' work becomes more independent and self-directed in nature. Student engagement is a well-researched construct relating to student motivation in higher education, yet much of its nature and the psychological processes involved remain clouded. Research that further teases out the processes and factors that underpin the engagement process remain important for understanding students' experience of learning, students' learning outcomes, and how these can be enhanced through evidence-based learning design.

Student engagement in digital learning

Despite the broad body of literature surrounding student engagement in higher education, the waters remain muddy in terms of how the construct is operationalised at different levels and in different contexts (Kahu, 2011; Balwant, 2017). Kahu (2011) began to separate out the construct of engagement from its antecedents and

outcomes. Drawing from the organisational psychology literature (Kahn, 1990; Shuck, 2011), Wiseman, Kennedy, and Lodge (2016) proposed that education research could benefit from more specific delineations between the 'levels' at which the student engagement construct is operationalised. For example, a macro investigation of student engagement may involve students' behaviours and attitudes in relation to their university or their degree course. At a meso-level, students' attitudes and behaviours toward their studies may be related to persistence and commitment. At a micro level, students' involvement in learning may be considered at a within-task level. As a first step, higher education researchers might begin to specify the level at which they are investigating student engagement as this provides the necessary context for understanding how various important constructs (belonging, persistence, meaningfulness) are related to students' engagement with their institutions, degree courses, and learning activities.

Another step in clarifying the meaning of student engagement is then providing clarity of the type of engagement being discussed. At a macro-level,



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investigation may focus primarily on students' behavioural engagement when investigating attendance and retention of large cohorts in an institution-wide context. Students' attitudinal stances towards their university, and learning in general, may be the focal point of a meso-level investigation into students' learning behaviours and habits. These behaviours may be underpinned by psychological and emotional factors, yet would be unlikely to involve a student being in an absorbed psychological state. At a micro-level, a psychological state of engagement may be considered as consisting of cognitive, emotional, and behavioural dimensions of engagement (Fredricks, Blumenfeld, & Paris, 2004), that when combined allow a student to enter into a state of absorption for a discrete period of time within a particular learning task or activity.

Research around the student engagement construct is more broadly located within education literature relating to student motivation, and broader still, human motivation in general. Student engagement and other closely related constructs such as intrinsic motivation (Lepper & Cordova, 1992), situational interest (de Barba, Ainley, & Kennedy, 2015), flow (Chan & Ahern, 1999), and interactivity (Simms, 2000), have been well researched within the context of technology-mediated learning. We follow the Fredricks, Blumenfeld, and Paris (2004) conceptualisation of engagement as consisting of three dimensions (cognition, affect, behaviour). We (Wiseman, Kennedy, & Lodge, 2016) proposed a unifying model of task-level engagement in digital learning environments, that draws upon intrinsic motivation (Ryan, 2012), situational interest (Hidi & Renninger, 2006), flow (Csikszentmihalyi, 1990), and episodic engagement (Kahn, 1990). *Digital task engagement* (Wiseman, Kennedy, & Lodge, 2016) refers to an active psychological state when a student is fully invested - cognitively, emotionally, and behaviourally - in a digital learning task. We theorised that this state may result in enhanced learning outcomes and improved learning experience.

Engagement, as a psychological state, has been investigated by organisational psychologists for over 25 years. Kahn (1990) observed the tendency of subjects to move into and out of engaged psychological states during the performing of their work activities. He clearly differentiated between this notion of cognitive, affective, and behavioural engagement in a task or role, and the 'higher' levels of employee engagement that consider employee commitment and other enduring attitudes towards work and organisations. He observed that employees moved in and out of discrete periods of engagement in their work and described this ebb and flow as episodic engagement. Kennedy and Lodge (2016) demonstrated how students transition through affective states such as confusion, frustration, and boredom at a task-level. Yet, there is little research that has investigated this same ebb and flow of cognitive,

affective, and behavioural engagement at a learning task level in digital and online learning. Research that provides evidence of how and why digital task engagement changes during a learning task would be informative for digital and online learning design, and help to dispel some of the myths around good teaching practice (e.g. 'videos must be shorted than X minutes').

In this study we aimed to explore the nature of students' cognitive, affective, and behavioural engagement, as they undertook a digital learning task chosen on the basis of being likely to promote a state of engagement. As a complex psychological process, digital task engagement is heavily influenced by individual and socio-cultural factors that may promote or inhibit a student's ability to become engaged. Such individual differences are difficult to capture using quantitative methods. In this study, we used a qualitative approach in relation to students' individual experiences of being engaged – or not – during the learning task. This paper presents results from a qualitative analysis of undergraduate students' experiences of digital task engagement in a digital learning module.

Methods

Participants

Participant recruitment occurred via an online advertisement through the university careers website and via posters placed on campus noticeboards. In accordance with the university ethics approval, participants were compensated with a sum of \$15 for one hour of their time to participate in the study. A total of 23 participants were recruited. All participants were undergraduate students from a range of disciplines.

Nine participants reported having completed an online course previously, and one participant reported having previously studied biomedical science. Thus 22 participants did not have any significant prior knowledge of the topic in the learning task. Four of the participants were male and 19 were female. The mean age of all participants was 21.3 years. Ethics approval for this study was granted by the appropriate university Human Research Ethics Committee.

Materials

This study used a mixed methods approach to explore undergraduate students' experience of digital task engagement in a digital learning task. The instruments used to capture self-reported digital task engagement are consistent with prior research of school engagement (Fredricks Blumenfeld, Friedel, & Paris, 2005), work engagement (May, Gilson, & Harter, 2004), flow (Martin & Jackson and 2008), and self-regulated learning (Pintrich, Smith, Garcia, & McKeachie, 1991). Quantitative data were collected through surveys completed prior to, during, and after the learning task. Qualitative data were

collected using semi-structured interviews with a sub-set (eight) of the participants. A framework of analysis based on prior research of engagement was used to uncover a variety of ways in which participants may report the cognitive, affective, and behavioural facets of digital task engagement during the learning task. Qualitative data were further analysed for emergent themes based on students' descriptions of their experiences during the learning task. Due to the small sample size, quantitative data did not reveal any significant findings. However, analysis of the qualitative data revealed some important insights into the changing nature of digital task engagement during the learning process. These qualitative data are the focus of this paper.

The study was conducted in a computer laboratory at a major Australian university. The digital learning task was presented on a 13-inch computer monitor. Participants used a mouse to control all on-screen activities. All survey instruments were delivered in printed format.

Blood alcohol concentration learning task

The Blood Alcohol Concentration (BAC) digital learning task presented material about blood alcohol concentration (Dalgarno, Kennedy, & Bennett, 2014). The concepts within the task are considered to be challenging for users without a background in biomedical science. This task was chosen as it would present a challenge to participants requiring them to invest cognitive effort to understand and complete the task. In line with known flow antecedents (Csikszentmihalyi, 1990), an undergraduate student should have sufficient ability to have a balance of challenge and skills.

The BAC task was developed by Dalgarno, Kennedy, and Bennett (2014), and written in Adobe Director. The digital module presents users with task instructions (5 screens) and some basic information about some of the variables that affect blood alcohol concentration over time (4 screens). Following these informational screens, the user is presented with a 'simulator' screen shown in figure 1. Users can adjust the values of each variable ('Your Values') up or down relative to a baseline in the form of 'Bill's Values'. Participants are asked to mentally predict what effect a theorised change will have, before making that change in value and running the simulation. Once a simulation has been run the output is displayed in a graph where users can compare the effect change against the baseline.

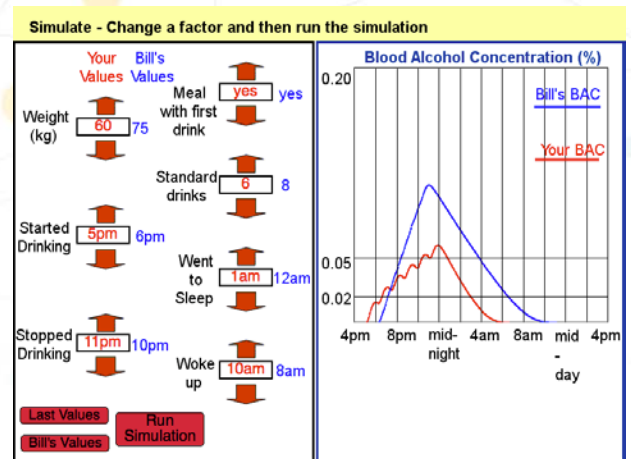


Figure 1: Sample screen from blood alcohol concentration learning task

Procedure

Participants began the BAC learning task and proceeded to work through the informational screens at their own pace. Once they finished this section of the module they were free to run one or two simulations to familiarise themselves with the tool. At this point a timer was started and participants were free to run as many simulations as they desired for a period of five minutes. At the end of the five-minute period, participants were presented with a short five-item in-task probe (questionnaire). Once completed, participants resumed the BAC learning task. This process was repeated three times resulting in four blocks of five minutes on task, each followed by an in-task probe.

Semi-structured interviews

Interviews were conducted with eight of the participants immediately following the completion of the study. Interviews ranged in time from 10 – 30 minutes depending on the willingness of the participant to engage in meaningful discussion about their experiences during the learning task. The researcher used a set of prepared questions to guide the conversation while allowing the participant to describe their experiences in their own words and to identify the most important or meaningful aspects of their experiences.

Interview recordings were transcribed and read multiple times. A framework for analysis was developed using known elements of the psychological constructs of engagement and flow, and their antecedents (Flanagan, 1954). Other key themes were recorded as they emerged from the data. Quotes were extracted from the interview transcripts and coded according to the analytic framework or emergent themes (Merriam, 2009). The unit of analysis was a thought by a participant that reflected on or articulated an element of the learning task or study process. An initial list of 21 themes was developed containing 185 quotes. Themes with only a few

quotes were re-examined to see if they had shared meaning with other themes. The list of themes was reduced to 15 distinct categories containing 183 quotes. A second rater examined a selection of quotes and matched them against the 15 themes. The second rater was in agreement and confirmed the fit of quotes with the developed categories, ensuring reliability of the coding process.

Results and discussion

Digital task engagement

Participants in the study reported phenomena that would lead us to believe they experienced episodes of digital task engagement. They described thoughts and feelings that are consistent with cognitive and affective states of engagement. Log file data from the BAC learning task showed behavioural patterns of a strategic approach to the learning task. Participants' descriptions of being engaged during the BAC task reveal differences in both the frequency and duration of engaged episodes throughout the duration of the learning task.

Cognitive engagement

As expected the BAC task provided sufficient stimuli to promote some degree of cognitive engagement. Seven of the eight participants reported being attentive and focused on the problem of trying to understand the task content. One participant described their thought process in the task as follows;

"Yeah, I wonder whether like the body weight is getting higher or getting lower to see very a better graph or the values and so I just keep trying then to see the relationship."

Some participants further demonstrated cognitive processes that connected the information they were learning in the task with their own prior knowledge and experience.

"Like I watch the TV shows, the ones about the mobile speed thing and then drink-driving so some of that made sense when say I changed only the weight or I changed how many drinks I had and sleep doesn't affect it at all which is interesting."

Cognitive engagement seems to have been fairly consistent for all participants as they each undertook and completed the task in some fashion. Several participants seem to have experienced more pronounced cognitive engagement with the task as they related the content to contexts outside the simple objectives of the task as evidenced by the quote above. However, some participants clearly articulated a sense of being cognitively engaged despite not being emotionally involved or particularly invested in the exercise. One participant described their experience thus;

"I wouldn't say I was 'in the zone' – I was just maybe focused. Like, I really wanted to know certain things. Maybe it's just me having like a little short attention span or, you know, like I'll find it hard to focus... especially in the same thing for like a long time."

The data clearly show differences between participants' cognitive engagement in the task. While not unexpected, these differences are a reminder that other motivational factors may play a critical role in supporting cognitive engagement in a digital learning task. Further, we are reminded that while digital task engagement might be an ideal 'flow-like' state, cognitive engagement and subsequent on-task behaviour may be entirely sufficient for learning to occur.

Metacognitive awareness

Several participants were further able to articulate moments during the task where they demonstrated some metacognitive awareness of their cognitive processes during the learning task.

"It was kind of sometimes good to see what I was feeling at the time as well, so I'd be like 'Oh, okay, so the things I was doing it wasn't working or it wasn't what I predicted,' and then I felt a bit like 'Oh, okay, maybe I wasn't completely in control' for example. So that kind of gave me some sort of alertness as to what I was feeling and thinking at the time."

Most of these comments seem to indicate times when the participant stepped back from the task to evaluate what they were learning and how they were approaching the task. However, one participant described how she felt that this metacognitive process of 'self-checking' required such a level of cognitive focus or concentration that it pulled her out of the engaged 'flow-like' state.

Affective engagement

Six of the eight participants described some form of emotional response during the task. A mix of both positive and negative emotions were reported, including confusion (both procedural and conceptual), interest ("it was very gripping..."), happiness, perceived control, absorption ("I got really engrossed"), annoyance, and boredom. Of these, the most commonly reported were absorption, and boredom.

Absorption

Not all participants reported a sense of absorption, but the descriptions provided by five participants demonstrated periods within the task when they entered into an absorbed state. One participant spoke of being so absorbed in the task that she was initially unaware of some noise and commotion that was happening outside

the computer laboratory. As the task progressed, her level of absorption decreased and she became more acutely aware of that noise. Several participants indicated that these periods of absorption did not last for the full duration of the exercise, but that they changed during the task:

"When I came to the second part of it, when it was all the simulations, in the beginning I just got really absorbed."

In line with flow theory (Csikszentmihalyi, 1990) this sense of absorption in a task or activity is an indicator of an engaged psychological state, and is considered a positive affective state promoting intrinsic motivation in the task. Of particular note in this study is the apparent fluctuation in participants' sense of absorption throughout the duration of the task.

Boredom

The largest affective category overall in the data set was experiencing a sense of boredom. Six participants spoke frequently about being bored at some point during the task. This is particularly interesting as all but one of these participants also spoke explicitly about the BAC task as being interesting with much of this interest in the topic being related to the relevance of alcohol consumption in the participant's life. As with absorption, these feelings of boredom changed throughout the task, although the general pattern was that it was more interesting at the beginning and more boring toward the end.

"I don't know, it gets a bit dull towards the end, like maybe the third or fourth attempt [block of 5 minutes] because I was kind of losing focus."

Most frequently, the descriptions of being bored were related to the task processes rather than to the topic of interest. Participants spoke of the task as being repetitive and becoming increasingly more boring as time progressed.

"It got a little bit boring after a while because you were doing the same thing again, again, and again."

This may be attributable to the time given to participants to complete the task. It seems that once they had exhausted all their ideas of how to change the variables, they began to lose interest. The time taken to reach this point differed between participants. One participant became bored by the end of the first block of five minutes on task. Others reported reaching this point of boredom in the second or third time block, or only when they reached the fourth block.

What is consistent about the reporting of affective states during the task is the changing nature of those states.

The task may start as interesting and then become boring. Yet, concentration on the task, or metacognitive awareness of the learning process may enable a participant's interest to be rekindled and allow the participant to re-enter a state of absorption. While the links between constructs such as metacognition (Pintrich et al., 1991), motivation and interest (Hidi & Renninger, 2006) are well documented, their interactions within a learning task are less well understood, particularly in terms of the ebb and flow of affective states throughout the duration of that task.

Changing engagement

One emergent theme was participants' descriptions of how their task engagement changed during the BAC learning module. Participants' change in engagement differed in time and duration. Some were engaged during the first five-minute block of time on the task and became less engaged in the later half or toward the end of the whole study session. One participant described their overall experience in the following way;

"Well I was pretty engaged. It was just that I think I exhausted all my options and then like I basically finished it and then I had nothing to do. It was just that I felt like I'd learned everything I needed to."

Others described a change in their engagement within a five-minute block of on-task activity.

"As I started the fourth [five-minute block], it was still all right and then it got – again, got boring like towards the end. It was just kind of like an up and down kind of thing."

Several participants spoke about reaching a point where they had discovered everything that they could and felt they had successfully completed the task even though there was still some time left. They then chose to find ways to interest or entertain themselves within the task by 'playing' with the simulator. Some simply entered random numbers to fill in time while others entered extreme values to experiment and see what effect these would have on the graph output in the simulator. One participant described becoming increasingly annoyed that she had to use the mouse to click on the up and down arrows to change values rather than being able to type the values directly into the text box. While she began the task with a significant level of enjoyment, her affective state changed considerably as time passed, due in part to this annoying procedural function of the task.

The differences between interest in the topic and frustration or boredom with the mechanics of the task was also demonstrated in participants' reflections on their changing engagement. The following quote is from a participant who had articulated being absorbed in the task;

"I think as I was doing all of these new ones, the sort of novelty of it just gripped me quite a bit but when, as I said before, going back to... like re-running the old simulations again – again, it's the whole novelty of it, it kind of just doesn't make your brain as engaged so it doesn't flow as well because it's not something that's interesting anymore in the same sense as if you go to a new movie."

Novelty was clearly linked to interest and engagement for this participant, and when that novelty wore off, engagement appears to have waned.

Other affective states also seem to have had some impact on participants' engagement. In one case confusion seems to have disrupted or diminished engagement. A participant was describing the process of predicting an outcome prior to running the simulation;

"I think at times when my predictions might not have been what I thought it would be – that took me off the... slightly with the engagement."

These descriptions of change in the intensity, frequency, and duration of engagement support the idea that engagement within a task is not static and can fluctuate dynamically as a result of conceptual or procedural processes within the task, or may be influenced by within-person factors such as interest, or other affective states such as confusion.

Discussion

Cognition seems to have been the most stable of the three dimensions of engagement during the task. Even when participants became bored with the task they were still thinking about it and what else they could do. They may not have been strategic about this or even trying to learn, but they mostly remained focused on completing the task. Participants described change in their cognitive engagement as the novelty of the task wore off. Both the conceptual nature of the content and the visual graph output of the simulator seem to have promoted interest in the initial stages of the task, but then became less interesting as the novelty wore off. Metacognitive awareness was sometimes an extension of cognitive engagement, helping to support interest in the task and resulting in greater cognitive and affective engagement. At other times, metacognition seems to have required such an increase in cognitive effort that feelings of absorption were disrupted.

Similarly, behavioural engagement was relatively consistent throughout the task. Participants' on-task behaviour seems to have remained consistent. There was one exception to this where one participant described 'filling in time' by entering random values into the variables and running simulations without being

interested in the output. In this case, there seems to have been no cognitive effort, and the behaviour was not related to the task.

The affective dimension of engagement appears to be where the most change occurred. Feelings of absorption were disrupted by a number of other affective states. Decreasing interest, annoyance with procedural aspects of the task, and loss of perceived control all contributed to negative affect during the task. In most cases confusion was also described as disrupting affective engagement. This included both procedural confusion with the task and conceptual confusion with the task content. However, in one case conceptual confusion seems to have been a prelude to increased engagement as a participant grappled with trying to understand why her prediction was wrong. This is consistent with patterns of confusion and resolution leading to engagement in an online task demonstrated by Kennedy and Lodge (2016). In this case, the conceptual confusion led to a re-evaluation of how the participant approached the task (metacognition) which seems to have promoted increasing interest in the task.

These data show that digital task engagement is not a static state and that all three engagement dimensions go through changes during a learning task, although affective engagement seems to be the most pronounced. The interplay between numerous affective states and their influence on cognitive and affective engagement seems to be of particular interest for learning design. As we would expect, interest is critical to promoting and sustaining digital task engagement. In the BAC learning task where the same process is repeated multiple times, interest seems to have diminished for several reasons. The repetitive nature of the task itself seems to have resulted in decreasing interest and increasing boredom. Conceptual understanding - or even perceived understanding - also seems to have resulted in this decline in interest. Learning tasks with multiple stages based on students' conceptual understanding may resolve both these issues as a student could demonstrate their conceptual understanding within the task and immediately progress to another stage or component of the task (Kennedy & Lodge, 2016). This may alleviate the sense that the student is just doing the same thing over and over with increasing levels of annoyance or frustration. Dividing a learning task into multiple stages with progressive learning goals could be a way to sustain and support interest over the task duration.

Following on from this, conceptual confusion may also have a role to play in stimulating digital task engagement. Recent research on misconception in learning (Arguel, Lodge, Pachman, & de Barba, 2016) suggests that confusion may have utility in promoting learning. Learning tasks that present users with a misconception and the resources to resolve their confusion may provide

sufficient challenge and interest to facilitate cognitive and affective engagement.

Kahn (1990) clearly articulated the idea that episodes of engagement were temporary and transient psychological states in which people had the capacity to be fully invested - cognitively, emotionally, and behaviourally - in their work roles and tasks. We recognise that there may be differences in the nature of engagement in a work role versus that of a work task, and further note that even in this study the outworking of formal and informal roles (e.g. researcher and participant), may also have had an effect on participants' task-level engagement during this study. Despite this, participants clearly articulated their experiences of being engaged and not-engaged within the learning task. Clearly, other individual and socio-cultural factors would have also influenced each individual's ability to engage in the learning task used in this study. We do not claim that these are not highly significant factors that contribute to an individual's engagement. Our purpose here was to further explore experiential phenomena related to the learning task, conceptual material, and task processes. Thus, our focus has been on how participants' experience of digital task engagement went through changes throughout the duration of the learning task.

This study has shown that digital task engagement and its three dimensions - cognition, affect, and behaviour - vary in intensity throughout a learning task. This is consistent with observations of employee engagement (Kahn, 1990). This change in digital task engagement is important for researchers to consider in terms of observing or measuring cognitive, affective, and behavioural engagement at multiple points during a learning task rather than relying solely on self-report data captured after the conclusion of a learning task. Using multiple observations or measures may allow researchers to track an individual's engagement, or the mean engagement for a group, over the duration of a particular learning task. Such an analysis may provide insight about what aspects of the task best facilitate digital task engagement, or other task-based factors that promote, inhibit, or disrupt that engagement. In turn, such knowledge might assist learning task designers in constructing tasks that account for some of the procedural disrupters of digital task engagement that we have discussed.

Further research

We recognise that this study used a single digital learning task and that comparisons of fluctuating digital task engagement between multiple digital tasks may be informative for digital learning researchers and learning designers. Future research could focus on identifying common attributes of digital learning tasks that either promote or disrupt students' digital task engagement. We call for further research to explore well-defined

conceptualisations of student engagement within specific contexts, to develop our understanding of how engagement fluctuates within digital learning tasks and the implications this has for learners, educators and learning designers.

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