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A Learning Experience Design Approach: Investigating the Mediating Roles of Situational Interest and Mind-Wandering in Children's Online Engagement

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Abstract: Historically, learning for young students has occurred in formal, in-person classroom environments, but the distance learning context has opened a myriad of learning modalities. To this end, we aim to better understand how deploying learning experience design (LXD) approach supports or hinders children's engagement while participating in an online, video-based math course. This study operationalized LXD through the integration of evidence-based pedagogical instructional design and human-centered user experience (UX) design. Findings suggest that students' situational interest and mind-wandering significantly mediate the relationship between user experiences and online engagement. These results provide practical implications for how researchers, designers, and instructors can intentionally iterate the learning experience to reduce mind-wandering and sustain children's online engagement with learning theories as we consider the future of online teaching and learning modalities.

Introduction

The field of teaching and learning has rapidly undergone a major shift over the last two years of distance learning through the COVID-19 pandemic. The pandemic abruptly caused shifts in workflows across many sectors, and education specifically was required to fundamentally modify course delivery infrastructures. COVID-19 necessitated a systematic change in course delivery due to the nationwide orders of social distancing to mitigate spread, resulting in the suspension of in-person instruction (Ferrel & Ryan, 2020). For many educational institutions, transplanting the same in-person teaching through synchronous Zoom meetings may have been sufficient. However, it was always intended to be a short-term emergency solution that while facilitated the continuance of teaching and learning, is still distinctly different to online learning experiences grounded with evidenced-based pedagogical learning design.

Zoom certainly facilitated teaching and learning, but it also brought concerns of student disengagement, lack of interest, and validity from both the instructors and the student perspectives (Son et al., 2020; Unger & Meiran, 2020). At the same time, students described issues related to technical difficulties, increased distractions, and decreased motivation, with emergency remote distance learning through Zoom—all of which are critical contributors affecting the student learning experience (Agarwal & Kaushik, 2020; Fawaz & Samaha, 2021). As a result, this study documents the efforts to shift from synchronous Zoom courses to design, deploy, and document the impacts of an online math course grounded in the learning experience design (LXD) framework to examine children's frequency to mind-wandering and online engagement.

Learning experience design (LXD) refers to the creation of learning situations that extend beyond the formal classroom learning environment and which often utilize online and virtual technological formats (Ahn, 2019). LXD is the process of developing effective learning experiences that enable learners to reach a specified learning outcome in a human-centered goal-oriented method (Floor, 2018). Weigel (2015) further defines LXD as an interdisciplinary synthesis of instructional design, teaching pedagogy, cognitive science, learning sciences, and user experience design. As such, LXD broadens our definitions of what is to be considered a learning experience, affording instructors, designers, and researchers the opportunity to empathize with learners and develop experiences that expand our learning design toolbox (Ahn et al., 2019; Weigel, 2015).

In the context of our study, we operationalized LXD by grounding our online course in learning design frameworks and ensuring quality user experience design. We also explored the connection between students' situational interest and students' mind-wandering as a result of our LX designs within a learning environment, supporting or hindering students' online engagement. Courses designed with the LXD paradigm are relatively new, and this study provides insight into evidenced-based asynchronous online learning environments grounded in LXD as a feasible learning modality for children learning math. To this end, we aim to better understand how our design efforts foster children's' engagement while participating in an online grounded in the LXD paradigm.

Theoretical approach towards learning experience design

The following sections provide an overview of the literature on engagement, mind-wandering, situational interest, and user experience examined, which ultimately serves to theoretically ground our analytic model. Situational interest was identified as a potential source of mind-wandering that may positively or negatively mediate the relationship of students' online engagement. Further, a critical factor influencing students' levels of situational interest is the medium of learning and the quality user experience that medium evokes. Limited studies have examined the interrelation of such specific constructs, even less so during a crisis learning context, warranting analysis. Reviewing these key bodies of literature thereby informs the basis of our hypothesized model to characterize the student learning experience by examining the effects of students' situational interest and mind-wandering mediating the relationship between students' user experience influencing their online engagement.

In education, student engagement is defined as the amount of student effort or active participation needed to complete a learning task (Richardson & Newby, 2006). In an online course, engagement can be further described as the attention, curiosity, interactivity, and interests students exhibit during an instructional unit, which further extends to the level of motivational traits students may have during the learning process (Pellas, 2014). Research in online learning attributes increased student engagement to quality instructional design (Pappas, 2015), student user experience with the interface (Hu, 2008), and student motivational factors (e.g., interest, self-efficacy) that can emerge as a result of the learning environment (Sun et al., 2012). When learning interfaces are difficult to navigate, uninteresting, or unengaging, studies have shown that this will likely lead to negative learning experiences such as increased mind-wandering, or the direction of attention away from a primary task (Desideri et al., 2019). Thus, we focus our design efforts onto ensuring quality instructional design to foster students' interests and strong user experience in order to maximize students' participation and degree of interactivity.

Mind-wandering or the colloquial term "zoning out," is defined as the shift of an individual's attention away from a primary task at hand and towards other internalized information (Smallwood & Schooler, 2006). Another way to describe mind-wandering is the human experience of drifting into thoughts away from the "here and now" (Smallwood & Schooler, 2006). Unlike being in a state of focus, mind-wandering is considered an off-task processing state such that the individual experiences an attentional lapse (Danckert, 2018). Mind-wandering is more likely to occur during monotonous environments (Eastwood et al., 2012) or long cognitively undemanding tasks (Smallwood & Schooler, 2015). Conrad and Newman (2020) conducted a mind-wandering study on students during the COVID-19 pandemic and found that students with greater instances of mind-wandering during long continuous Zoom class sessions had lower achievement scores. Considering that "Zoom" classes typically represent a low cognitively demanding task, often plagued by boredom, frustration, and lack of engagement (Katz & Kedem-Yemini, 2021) identifying potential detrimental factors that contribute to mind-wandering may be essential to better support students' learning (Randall, 2015; Smallwood & Schooler, 2006).

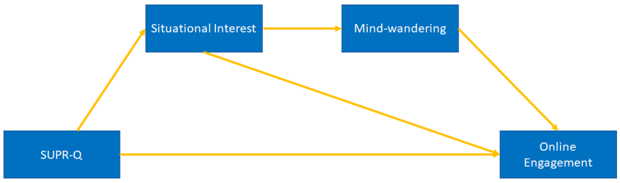
Since mind-wandering indicates a fault in information processing, where external task-related information shifts towards processing internal task-unrelated information (Smallwood & Schooler, 2009), this attentional shift is theorized to be a decoupling process between the task (external information) and the existing mental model (self-generated thoughts) of the individual (Mills et al., 2013; Smallwood et al., 2007). The Current Concerns Hypothesis suggests that mind-wandering occurs when intrinsic or extrinsic reinforcement where thinking about other personal goals outweighs the reinforcement for processing primary task goals (Klinger, 2009). Taking this into account, students' personal values in a teaching and learning context might be assessed by considering students' situational interests while engaged in a learning experience.

Situational interest (SI) refers "to the interest activated by the immediate learning environment" or the interest given the novelty aspect of a learning task (Schraw & Lehman, 2001). Past research indicates that situational interest is a powerful motivator in areas of math, reading, and history, when learner participation and interaction throughout the entire learning process is sustained (Chen et al, 2001). While situational interest and student engagement have been widely evaluated in the context of traditional in-person learning activities (Sun et al, 2012), less is understood about how to facilitate situational interest for young students in online learning environments while also reducing the onset of students' mind-wandering. We hypothesized that operationalizing the LXD learning design paradigm may aid in our juncture of supporting elementary students adopting an asynchronous online learning modality.

As SI refers to the interest activated by the learning environment, user experience can be seen as a measure linking the learner's experience of a specific learning interface and their interest in learning as a result of this utilizing this medium. Broadly defined, user experience (UX) is "the extent to which a product can be utilized by specified users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specified context of use" (ISO 9241-11, 1998). In an online course, UX refers to the effectiveness of the learning interface and whether or not a student can successfully interact with the course platform to accomplish an intended task. Learning environments with strong UX redirect students' efforts towards the learning task, rather than learning how to access the content. This shifts the researcher and instructor's perspective from only focusing on instruction, to also considering the deep understandings of learners, what they need, what they value, their abilities, and the limitations of the learning interface. As such, UX aims to create a positive student learning experience through content accessibility, interest, and design—all of which are significant predictors of student engagement in online learning environments (Thomson & Lynch, 2003).

The Situated Cognition Theory (SCT) instructional design framework was chosen to facilitate students' interests (Ghefaili, 2003) and inform the design of effective e-learning experiences while young students acclimate to distance learning. Centered around the notion that "learning" is inseparable from "doing," we adopted this framework so that learners could grasp the concepts and skills that are taught in the context in which they will be utilized (Brown et al., 1989). In practice, SCT emphasizes immersive learning environments, where new information is taught to learners in a way that simulates real-life settings. We operationalized this by using pre-recorded videos of a real-world math lesson taught by a teacher to students in a real classroom, and embedding interactive opportunities for modeling, coaching, scaffolding, articulation, reflection, and exploration (Pappas, 2015). Through this learning framework, students watched bite-sized video segments of real classroom interactions between a teacher and students, immediately practiced what they have learned through scaffolded problem scenarios, and provided written reflections on how they solved each math problem. As such, we implemented the SCT e-learning design framework to foster a deeply situated learning environment for students to actively develop interests, reduce instances of mind-wandering, and engage contextually within the online learning environment.

Figure 1. Hypothesized model for SUPR-Q (user experience), situational interest, mind-wandering, and online engagement.



Current study

Young students over the past two years have adapted to using a myriad of "edtech tools" to facilitate teaching and learning, in some cases adopting completely new modes of learning, facing new unforeseen learning challenges with the change in learning modalities (Agarwal & Kaushik, 2020). Building off the beta iteration of this online course deployed previously at the height of the pandemic (Wong et al., 2021), we gleaned the affordances and constraints identified by student commentaries to inform the design improvements of this current study to support children's online learning experience. One salient theme identified from our previous study was the notion of sustained engagement and mind-wandering while learning online (Wong et al., 2021). In this study, we employ evidence-based pedagogical LXD as a lever to support students' situational interest (SI) and ensure human-centered user experience (UX) design to alleviate technical worries related to distance learning. We then further explored the combination of situational interest and user experience predicting students' engagement, while considering the impacts of our design as a potential mechanism to reduce students' frequency to mind-wander in an online course grounded with learning experience design. This study is guided by the following research questions: (RQ 1) *To what extent do students' user experience, situational interest, and mind-wandering directly affect students' online math engagement?* (RQ 2) *To what extent do students' mind-wandering and situational interest mediate the relationship between students' user experience and students' perceived online math engagement?* (RQ 3) *To what extent does situational interest and mind-wandering sequentially mediate the path from students' user experience to online math engagement?*

Methodology

Course design context

We first worked with teachers to align with their existing Common Core State Standards (CCSS) math lesson plans. After understanding how we could best support teachers in the classroom, we then proceeded to co-develop the video lesson. Teachers, researchers, and course designers worked collaboratively to develop a script introducing ratio and proportions. Then, the instructional videos were recorded as a live, semi-scripted lesson on proportional reasoning taught by a teacher in a diverse class of fifth- and sixth-grade students. Utilizing multi-camera video production, one camera focused on the teacher, the second camera captured the teacher and the whiteboards, and the third camera captured only the students. These camera angles allowed for post-production manipulations, directing students' attention to specific camera angles for increased engagement. During the editing process, we employed a reform-based instructional model in which the teacher first asks the students to solve a challenging proportional reasoning problem on their own, prior to receiving explicit instruction (Schwartz et al., 2011). Next, the teacher strategically chose students using the target solution strategies to describe their strategy to the class. Following each student, the teacher-led a discussion on the procedures and higher-level conceptual overview of each respective target strategy: the equivalent fraction strategy and the unit ratio strategy.

Cognizant of the research behind effective user experience (UX) and instructional design (ID) in self-paced courses, these online modules were designed to be flexible and learner-paced, enabling students to start on their own time and work through the course at their own speed (Richardson et al., 2016). In addition, intentional design choices were made to maximize digital interactivity, reduce mind-wandering, and learner engagement. More specifically, an hour-long video lesson was segmented into ten parts instead of one long continuous stream to reduce fatigue, cognitive load, and opportunities for students to mind-wander (Mayer, 2019). Scaffolded problem sets (worked examples) were specifically placed in between video segments for students to practice problems immediately after learning. These types of problems scaffold novice learners by drawing attention to the structural similarities in the lesson to ensure students attend to the key ideas, concepts, and relationships in practice (Begolli & Richland, 2016). For example, students were first asked to recall strategies they observed from watching the videos. Next, students plugged in the procedural steps to solve the math question. Then, students were asked to compare their procedural steps with model example strategy solutions. Video animations that displayed the sequential ordering of mathematical procedures called "worked examples" were added to enhance the visual representations and conceptual comparisons across solution types. This allowed students the option to review and crystallize the different solution strategies prior to moving on to the next problem. After making comparisons across problem types and strategies, students would solve the math problem by assessing their conceptual understanding. Lastly, solution reflections were embedded within each problem scaffold for students to explain, in their own words, how they solved each math problem with their chosen solution strategies. This design choice enabled students to actively engage in their own productive metacognitive judgments and reflect on "how and why" they arrived at their solutions, which has been found to foster learner responsibility, increased test preparation, and review and practice (Tullis & Benjamin, 2011).

Careful considerations were made to ensure that the course interface facilitated quality user experience design. For example, course roadmaps, course goals, and navigational instructions were clearly "highlighted" and "boxed in" to promote learner ease of use and findability within the online learning environment. Additionally, standardized vector icons were utilized before every instructional type, allowing students to differentiate between interface instructions as opposed to lesson specific instructions. A table of contents and progression bar was added to let learners know their progression within the course. Each video also had instructions clearly stating how to pause, play, and re-watch. These UX design choices were made to mitigate visual complexities, technical difficulties, and allow users to focus on the content most relevant for the task at hand. The ability to click backwards in the course was activated for students to freely navigate the course space with more autonomy. This design change was incorporated to account for students potentially making mistakes or clicking through the online course too quickly. Another recommended addition to the course was to include explicit breaks from the math problem sets by asking fun and engaging pop-up questions with GIFs that students could freely respond to. Since our math lesson was immersed within the theme of cooking recipes, these GIFs and accompanying questions asked students about what they might be baking or cooking at home and how these proportional reasoning concepts might be applied in their everyday lives. While maintaining the theme of our lesson, this presented break opportunities for students to share what they were doing during shelter in place and express how these math concepts might be applied in a non-academic context. Through these iterations, an array of design decisions grounded in LXD principles were implemented to co-develop this online-video math course, with the goal of integrating elements of a real classroom and interactive features of an online learning environment in order to maximize students' online engagement while reducing the frequency of students' mind-wandering through the rapid co-design of an online math course.

Data collection and analysis

We recruited 5th and 6th grade teachers from two school districts in the Orange County area. A total of three 5th grade teachers, six 6th grade teachers, and one 5th/6th grade combination class teacher agreed to be a part of the study. There was a total of 12 classes and each classroom had between 26-33 students. Of the (N = 303) students who participated, 56.1% of the participants identified as female and 42.6% identified as male. Student ages ranged from 10 to 12 years old, with a large majority of students being age 10 (42.6%) and 11 (55.7%). This sample consisted of children from a variety of racial/ethnic backgrounds (22.6% White, 3.8% Black, 1.1% Native American, 17.7.1% Asian, 1.1% Native Hawaiian, 21.0% Latinx/ Latino, 27.19% other, 4.8% Mixed).

We administered five questionnaires during Part 2 of the study. This included the Situational Interest Scale (Chen et al., 2001), which measured students' levels of interest in the specific online mathematics lesson we distributed, the Standardized User Experience Percentile Rank Questionnaire (SUPR-Q) (Sauro, 2015), which examined students' experiences with the online platform, and the perceived online engagement scale which measured students' engagement within the online learning experience (Rossing et al., 2012). These three measures were 5-point Likert Scales ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Lastly, students' mind-wandering was measured using the Mind-wandering Questionnaire (Mrazek et al., 2013) designated on a 6-point Likert scale, 1 (almost never) to 6 (almost always).

Data were analyzed using SPSS to conduct scale reliabilities, descriptive statistics, missing data analysis, correlations, and AMOS 26 for structural equation modeling. Scale reliability checks were conducted to verify the Cronbach's alpha coefficients for all of the validated instruments used in this study. Cronbach's alpha coefficients greater than $\alpha = 0.70$ were considered acceptable levels of reliability (Nunnally, 1994). Measured variables were analyzed by first recoding the Likert questions followed by computing descriptive statistics of the items associated with each instrument. Full information maximum likelihood (FIML) was utilized as the missing data estimation approach to account for data missing at random, maximizing the case-wise likelihood of the observed data (Carter, 2006). Preliminary analysis tested assumptions of sample size, multivariate normality, linearity, and multicollinearity of the variables of interest. Bivariate correlation analysis evaluated the linear relationships between the different study variables. Lastly, AMOS was used to conduct a path analysis using the maximum likelihood estimation (MLE) in order to analyze the hypothesized research model (See Figure 1). More specifically, we conducted a covariance-based path analysis, a subset of structural equation modeling (SEM), to examine a simple mediation and sequential mediation within the same model to investigate our research questions with measured variables (Lleras, 2005). Fit indices such as the goodness of fit test conformity (Chi-square statistic), the goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), and the root mean square error of approximation (RMSEA) were calculated (Kline, 2012). Lastly, unique direct and indirect effects were analyzed to examine the factors influencing students' mind-wandering and online engagement.

Findings

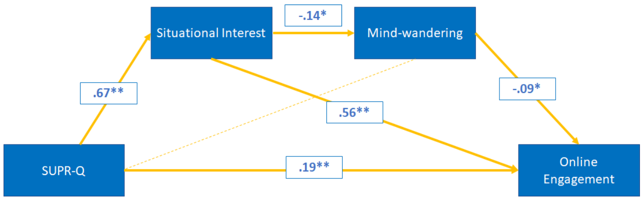
Descriptive statistics and correlations for the measured data (Perceived Learning Engagement, Situational Interest, Mind-wandering, and SUPR-Q scores) are provided in Table 1. In addition, the reliability estimates (Cronbach's alpha) of all the adapted scales are shown in Table 1. All of the measures were reliable based on the widely accepted recommendation of a Cronbach's alpha of .70 (Nunnally, 1978).

Table 1: Descriptive Statistics and Correlations for Study Variables (N = 303) **. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

Scale	1	2	3	4
SUPR-Q	—			
Situational Interest	.67**	—		
Mind-wandering	-.18**	-.14*	—	
Perceived Engagement	-.58**	-.70**	-.20**	—
Cronbach Alpha (α)	.87	.92	.83	.72
Mean	3.91	3.47	1.65	3.23
SD	.68	.74	.82	.89
Skewness	-.93	-0.69	1.66	-.02
Kurtosis	-2.45	.76	5.94	.14
Tolerance	.54	.55	.97	—
VIF	1.86	1.83	1.03	—

In the initial examination of the path analysis, we tested a fully saturated hypothesized model, analyzing the conformity indices and direct effects of user experience, situational interest, and mind-wandering influencing students' online engagement. The $\chi 2$ conformity index of the model was significant $\chi 2$ (1, N = 303) = 4.419, p = 0.036. A non-significant p-value is typically required to prove a high level of conformance; however, this is highly sensitive to large sample sizes (Hoyle, 1995). As such, the Root Mean Square of Approximation (RMSEA) was calculated to accommodate for the slightly significant chi-square statistic due to the large sample size. In this initial model, the RMSEA was 0.061 where values of < 0.08 indicate a good fit, with values closer to 0 representing a perfect fit (Kline, 2015). To determine the square root of the difference between the residuals of the sample covariance matrix and the hypothesized model (Kline, 2005), the SRMR was calculated to be 0.028, with the recommended cut-off value of less than 0.08. Lastly, the GFI, CFI, TLI, and NFI was calculated to be 0.992, 0.992, 0.950, and 0.989, respectively. Index values of 0.95 or greater represent acceptable conformity (Schumacker & Lomax, 2004). Estimating the structural β coefficients of the model provided the statistically significant pathways on all variables measured. As such, a model re-specification was not necessary, and the hypothesized model was selected as the final model.

Figure 2. Standardized structural regression model for SUPR-Q (quality of user experience on website), situational interest, mind-wandering, and online engagement for sample (n=303). *Note.* **.Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). Dotted lines represent non-significant path.



After determining the model conformity indices, the standardized beta coefficients of the direct effects were further examined. A summary of the effects can be found in Figure 2. The standardized coefficients can be interpreted as a change in units of standard deviations. For example, a 1 unit change in SUPR-Q is related to 0.193 increase in standard deviations for online engagement. Consistent with our predictions, we found that both students' SUPR-Q (user experience) (β = 0.193, $p < 0.01$) and students' situational interest (β = 0.558, $p < 0.01$) had significant positive direct effect on students' online engagement. Furthermore, students' mind-wandering (β = -0.088, $p < 0.05$) had a significant negative direct effect on students' online engagement. Altogether, students' user experience, situational interest, and mind-wandering together accounted for 51.7% of the explained variance in students' online engagement ($R^2 = 0.517$). We also found that students' situational interest (β =- 0.136, $p < 0.01$) had a significant negative direct effect on students' mind-wandering, accounting for 1.9% of the explained variance in students' mind-wandering ($R^2 = 0.019$). Lastly, we found that students' SUPR-Q (β = 0.674, $p < 0.01$) had a significant positive direct effect on students' situational interest with it accounting for 45.5% of the explained variance ($R^2 = 0.455$)

As the aforementioned direct effects were significant, the simple and sequential mediating effects of students' situational interest and mind-wandering were examined. To evaluate these mediation effects, we first examined the significance of the simple (mediated) indirect effects of students' situational interest on (1) students' SUPR-Q and students' mind-wandering and (2) students' SUPR-Q and students' online engagement. Next, we examined the significance of the indirect effects of students' mind-wandering on students' situational interest and students' online engagement. The standardized indirect (mediated) effect of students' SUPR-Q on students' mind-wandering was (β = -0.092, $p < 0.05$). In addition, the standardized indirect effect of SUPRQ mediated by situational interest on students' online engagement was (β = 0.384, $p < 0.01$). Next, we evaluated the significance of the simple mediation effect of mind-wandering on situational interest and students' online engagement. The standardized indirect (mediated) effect of situational interest on online engagement was (β = 0.012, $p < 0.05$). Lastly, we examined the cascading relationship of students' user experience indirectly related to students' online engagement through the sequential mediating effects of situational interest and mind-wandering. The standardized direct effect of students' SUPR-Q on SI (β = 0.674, $p < 0.05$), SI on MW (β = -0.136, $p < 0.05$), and MW on Engagement (β = -0.088, $p < 0.05$) were all significant. As a result, the standardized indirect (mediated) effect of students' SUPR-Q on students' online engagement was (β = 0.008, $p < 0.05$). The standardized total effect of SUPR-Q on SI was (β = 0.674). The standardized total effect of SI on MW was (β = -0.136). The standardized total (direct and indirect) effect of MW on PLE was (β = -0.088). The standardized total effect of SI on PLE was (β = 0.570). The standardized total (direct and indirect) effect of SUPR-Q on MW was (β = -0.092). The standardized total effect of SUPR-Q on PLE was (β = 0.577). These results suggest the partial mediation of the association between students' user experience and online engagement through situational interest and students' frequency to mind-wander.

Conclusion, implications, and limitations

During this unprecedented time, LX designers have the challenge to not only develop learning environments that increase conceptual understanding by drawing on theories of learning sciences, but also create experiences that are interesting, engaging, and human-centered to support a broad range of learners given the disruptions to teaching and learning. This affords a unique opportunity to deploy online courses that are grounded in evidence-based pedagogies to further validate the utility and efficacy of online learning as an effective mode of learning in its own right that may have been plagued by Zoom teaching methods. As LX designers, educators, and researchers, we must be conscientious of students' dynamic learning contexts and the impacts of their surrounding environment to empathize with young students' needs while developing educational interventions (Seymour, 2020). Thus, by collaborating with teachers directly, codesigning the online video lessons to fit the classroom curricula and assessing the needs of teachers and their students while distance learning, we co-developed a video-based online math course to explore how best to support students' engagement through LXD.

More specifically, this study operationalized LXD through the combination of instructional design as a lever for promoting students' situational interest (SI), emphasis on human-centered design to support students' user experience (UX), and the combination of situational interest and user experience to reduce students' mind-wandering and foster student engagement in an online learning environment. Interestingly, our analyses suggest that students' situational interest and user experience while interacting with the online learning interface were significant predictors of students' online engagement. The results also reveal that situational interest and mind-wandering were significantly corelated to students' online engagement. Thus, when analyzing the indirect pathways, we confirmed our hypotheses that students' mind-wandering and situational interest as significant mediators explaining the relationship between students' user experience in the course and their online engagement. Furthermore, we identified sequential mediating effects of students' user experience to engagement through situational interest and mind-wandering.

These findings illuminate our understandings of the application of LXD, suggesting a potential underlying mechanism explaining our LX design impacts on learners' course experience and course engagement. On average, we documented that students who experience high user experience within the learning environment, show greater situational interest within the math course, and ultimately show greater instances of course engagement. The results also suggest that students' situational interest positively effects their level of engagement, when factoring in how much students' mind-wander. By preserving the ecological validity of the classroom environment in the instructional videos, students were able to follow along with the teacher and immediately practice the math concepts. This may be one factor in the course design that increases students' situational interest and reduces students' mind-wandering, as it provides a similar in-person learning context of the classroom while also utilizing the key affordances of asynchronous online learning (Begolli & Richland, 2018). Careful attention to the course usability aimed to promote quality user experience design by facilitating ease of use, findability, and navigability (Simunich et al., 2015). Additionally, to maximize opportunities for engagement, knowledge checks, scaffolded problem sets, math animations (worked examples), and math reflections were embedded within each math problem to guide students through sustained participation and interactivity. These user experience design decisions afforded students the opportunity to recognize their initial understandings of the math concepts and allow students to review and practice by navigating backwards or replaying a video. As such, students were able to actively take control of their learning pace and adapt their learning behaviors to mind-wander less and stay engaged in the course content. Thus, quality user experience and the degree of interaction between learners and the online learning environment are consequential to supporting students' engagement in an online learning environment. These findings suggest that the LXD paradigm of combining evidenced-based pedagogical learning design and human-centered user experience design as a feasible approach to generate interest, reduce the onset of mind-wandering, and increase engagement in asynchronous teaching and learning with children.

While the results of this study are correlational which serves as a limitation, there are important theoretical underpinnings and practical implications that support children's motivational, cognitive, and behavioral factors that can be applied to online teaching and learning immediately. As referenced earlier, emergency remote online learning is fundamentally different from online courses designed with evidence-based theory and practice. However, this presents a unique opportunity to further research and identify how instructors can better support their student's learning experience, as the remote learning context has paved the way for alternative learning modalities. Based on our study findings, we have learned that students' engagement is, in part, explained by their user experience with the learning platform, and mediated by situational interests and mind-wandering. These results are important as it affords instructors to consider the LXD paradigm to better attend to factors that positively impact students' mind-wandering and online engagement. Thus, our study makes an important contribution to building and clarifying learning theories with educational technologies, as it suggests design factors contributing to students' user experience and situational interest together with mind-wandering mediates students' online engagement. Moreover, these results add to our understandings of students' learning experience during emergency remote distance learning, which will serve as a foundation for future experimental research iterations to implement online LX design principles. As the landscape of teaching and learning continues to evolve with expanded learning options, this research provides insights into LXD as a feasible pedagogical model and suggests design facets that may be implemented in-person and through hybrid modalities in the future.

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