"I felt like I was on campus" creating a situated learning environment through Instagram

Wangda Zhu, Ying Hua* and Luping Wang

*Correspondence:
Yh294@cornell.edu
Department of Human Centered
Design,
Cornell University,
300 Day Hall, Ithaca, New York,
USA
Full list of author information is
available at the end of the article

Abstract

The transition to online learning due to COVID-19 brought opportunities for applying Situated Learning Theory through mobile social media to enhance individual cognitive growth and community sense of belonging in online learning environments. In this study, we invited students from an Environmental Psychology course to participate in a semester-long project, during which they were required to post Instagram photos of their surrounding environments every week. We intend to understand the mechanism of integrating social media (Instagram) into a hybrid class amid the global pandemic, and how the project affects students' learning experience. Through in-depth interviews with 22 study participants, we found that integrating Instagram into the course helped students effectively connect with both real contexts and their peers. The project enhanced participants' situation awareness and a sense of belonging through posting, interacting with peers, and browsing profiles and posts. We then proposed a framework of creating a situated learning environment through social media using conjecture mapping to inform design implications and future studies in social and mobile learning communities.

Keywords: Online learning environment, Social media, Situated learning, Sense of belonging

Introduction

COVID-19 quarantine forced schools to transform learning from physical classrooms to online environments. Students had to sit in front of screens watching videos and with fewer opportunities to interact with peers. Communicating with others via computer-mediated technologies provides impoverished social experience compared to face-to-face communication (Symeonides & Childs, 2015). As a result, students feel a decreased level of social presence (Paton et al., 2018) and experience social isolation from peers (Sun et al., 2019). During the college years, schools serve as micro-social environments where students share beliefs, fears, values, and norms (Bandura, 1993). However, when university

education goes "virtual", the social fabric of learning gets weakened. If students do not feel they are part of a community, they would feel isolated, anxious, defensive, and unwilling to take risks in their learning (Wegerif, 1998).

Online learning enables students to learn from different locations. However, it decreases students' chances to experience and explore their physical learning environments like school campus and other surrounding areas. For example, for freshmen students, their curiosity and eagerness to get in touch with the real campus are not fulfilled. For them, physical spaces (the "campus") have unique values that are hard to be fully replaced by an online setting. These spaces, such as libraries and public spaces, in fact, embody the values of the learning institution.

To address these issues mentioned above, we introduced a social media intervention that highlights "(re)inserting" social and physical elements into online learning. We invited students to participate in a project that post photos of their surrounding environments on Instagram during a semester-long *Introduction to Environmental Psychology* course and completed interviews (n = 22) to investigate their behavior and experience of attending this project.

In the remainder of the paper, we first review related work on how social media is being used to support conventional learning, and why situation awareness and the sense of belonging are two important constructs in situated learning environments. Then in the results section, we present how students connect themselves with their distributed learning contexts and their classmates. In the discussion section, we propose the framework of creating a situated learning environment through mobile social media and discuss the design implication. After that, we list future directions and address limitations presented in this current work. We conclude the paper by summarizing the findings and contributions.

Related works

In this section, we first reviewed social media use in educational settings. Next, we briefly introduced Situated Learning Theory and how it was applied through social. Lastly, we layout our research questions based on works reviewed.

Mobile social media in educational settings

Facebook, Twitter, and Instagram are social media applications that are frequently used in clinical, management, design, language-learning, and computer science courses (Dabbagh & Kitsantas, 2005) to enhance learning experience and outcomes for students. Previous works suggest the adoption of those platforms can supplement and even transform conventional learning (Kirkwood & Price, 2013). And many application cases could be summarized in a common pattern of "post" and "interact". For example, Schroeder and Greenbowe (2009) used Facebook as an online discussion platform for students posting

and answering questions they had about the course. Aubry (2013) asked students to follow instructors' Facebook accounts to discuss learning materials they posted. We've also seen instructors redesigned learning activities or substantial parts of class modules to provide active learning opportunities for students. In an Architecture and City Planning course in Australia, instructors used Facebook and Twitter as platforms for students to upload, share, and comment on lecture-related examples uploaded by the class (Kassens-Noor, 2010; McCarthy, 2013). Similarly, in various English as a Second Language (ESL) courses, researchers introduced Facebook, Twitter, and Instagram for students to share content (e.g., a video of reading an English article) and interact with their classmates (Al-Ali, 2014; Gonulal, 2019; Khalitova & Gimaletdinova, 2016; Salomon, 2013; Shazali et al., 2019).

As discussed in many computer-supported learning literature, using mobile social media could offer a more personalized, social, and authentic learning experience for learners (Archambault et al., 2010). In this study, we focus on exploring the mechanisms of social media enhanced learning. Namely, how do students utilize mobile social media by "post" and "interact" to enhance their learning experience such as sense of belonging and contextual/situation awareness.

Situated learning environments through mobile social media

Situated Learning Theory is developed as researchers and educators noticed the separation between knowing and doing traditionally has been hallmark of school and university learning (Resnick, 1987). The abstract knowledge taught in schools is not retrievable in real-life as this approach ignores the interdependence of situation and cognition (Herrington & Oliver, 2000). Collins et al. (1988) defined situated learning as "a notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life". Lave and Wenger (1991) further propose that the "community of practice" which enables "legitimate peripheral participation" is one critical aspect in situated learning which emphasizes learning is a social process that people learn in communities where they are situated.

Previous studies (Choi & Hannafin, 1995) proposed the framework of situated learning centered on four basic elements: context, content, facilitation and assessment. In education literature, context covers different types of environments such as physical, social and psychological for the learner to build and apply their knowledge (Figueiredo, 2006); content is broadly defined as information that has been structured and encoded as text or multi-media materials. In the constructivist perspective, part of the content may be consigned to the status of context and vice versa (Figueiredo, 2006). Facilitation means instructors' role in situated learning is more like facilitators to organize the interactions between students and communities; assessment means students are not recommended to be judged by standard tests but portfolios with open discussions. William Ranking also stated

three elements: content, context and community. Community here is where students "create, interpret, reflect and form meanings" which is result of facilitation.

Situated learning systems focus on growth in students' cognition (Choi & Hannafin, 1995), as suggested by Cognition and Technology Group, to allow students to understand the environments of new knowledge by placing learners in realistic settings where socially acquired ways of knowing are often valued (Lave & Wenger, 1991). Students construct understanding rather than being taught specific knowledge through exploration in the community with diversified perspectives from others (Winn, 1993). Individual learning should be thought of involving opportunities to participate in the community and the development of an identity which provides a sense of belonging (Handley et al., 2006). In summary, the benefits of situated learning include individual growth in cognition of situation awareness and sense of belonging in the community. The concept of situation awareness is defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley & Garland, 2000). Recent works in the education field gradually adopted it and developed its own framework to understand how learners build situation awareness in classrooms and online learning environments (Norman et al., 2016). In particular, researchers are interested in examining how different elements of learning environments work with each other and facilitate the learning process (Norman et al., 2016).

Not surprisingly, technologies like mobile social media have been used to enhance learners' situation awareness (McCarthy, 2013; Uzunboylu et al., 2009; Vázquez-Cano, 2013) and sense of belonging (Dhir et al., 2013; Grosseck & Holotescu, 2008). For example, in an Urban Planning course (Kassens-Noor, 2010), students were asked to use Twitter to post unsustainable practices they observed in cities and suggest remedies. They were also asked to use hashtags and mentions in the content to raise awareness from the public. To do so, participants needed to physically go around the city to find examples and added personal reflections to the posts. Students reported that participating in this project enabled them to know the city better and extend learning environments from classroom to the city. Similarly, Hsu and Ching (2012) summarized that using social media to post course-related content enables students to learn from their surroundings and be more aware of examples in their daily lives that they would not otherwise notice. Other works further claimed that when Twitter and Facebook were used for group discussion, students gained the sense of belonging to both the small group they belong to and the course community (Dhir et al., 2013; Grosseck & Holotescu, 2008).

During COVID-19, due to the lockdown and the transformation to online learning, students' learning environments are constrained as physical learning environments like campus are not accessible to students. Since learners are away from conventional

classrooms and campus, the potential loss of environment/situation awareness and sense of belonging becomes a key concern for both students and instructors (Zhu et al., 2022).

Research questions

Summarizing previous literature, there are a host of benefits using mobile social media to enhance students' learning experience. Situated learning benefits learners in enhancing situation awareness and sense of belonging.

There are a few studies experimenting situated learning afforded by mobile social media (Huang et al., 2014; Mills, 2011; Shaltry et al., 2013) such as Facebook, however, the specific mechanisms of how these technologies enable students to enhance situation awareness and sense of belonging in the learning environment together remains to be investigated. Our study of creating situated learning environments through Instagram resonated with the practice of these studies and will go further to summarize the mechanisms.

The reason for using Instagram is compared with other platforms like Facebook and Twitter, Instagram is heavily visual-oriented, and each piece of content users post needs to have photo or video component in it. With the design of integrating Instagram to an online course to enhance remote learners' (1) situation awareness and (2) the sense of belonging during a global pandemic, we hope to examine how this intervention influences students' overall learning behavior and experience. Specifically, we asked the following research questions (RQs):

RQ1: What behaviors are students engaged in this Instagram learning environment such as posting and interacting with peers?

RQ2: How does this Instagram learning environment affect students' learning experience such as situational awareness and sense of belonging through different behaviors?

Through this study, the authors aim to (1) understand the mechanism of how this online environment affects students' experience; and (2) propose a framework of a mobile social media enhanced learning environment to inform future design and analysis.

Methods

This study employed a case study research method as it provides the researchers with the opportunity to engage in an in-depth data collection (Creswell et al., 2007) in a concrete real-life environment (Yin, 2017) and is useful for formulating concepts (Mahoney, 2010). A single case study was utilized. In this section, we first introduce the study context to give readers an overview. Next, we briefly cover the interview process including interviewees' recruitment and interview questions. Then we describe the data analysis method, namely Grounded theory. Finally, the interviewees' accounts information and their posts are summarized.
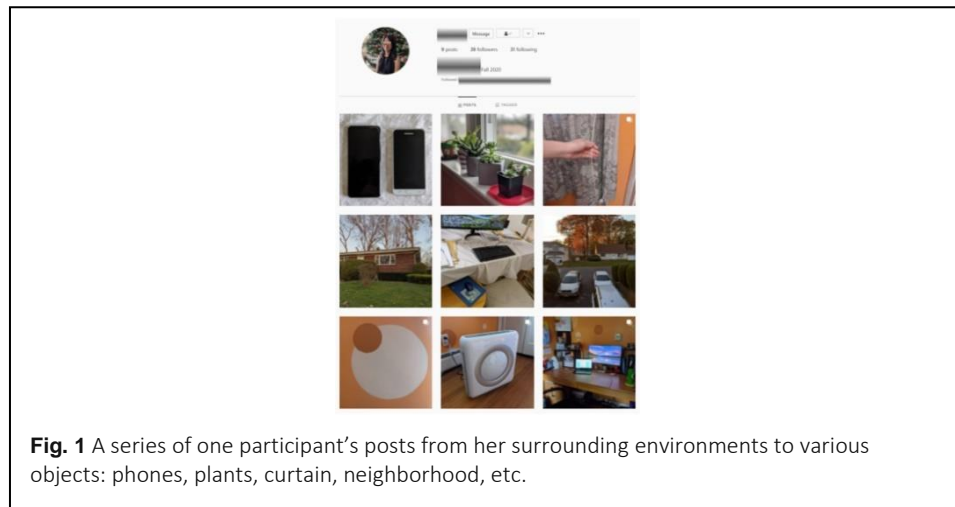
Study description and interview process

During each week of the study, each study participant needed to post an Instagram photo that related to the Human-Environment Relations (HER) processes (Chapman & Chapman, 1977) learned in the class. The overarching goal is to facilitate interaction between the students with both their physical environments and peers. Meanwhile, the task could hopefully help students understand abstract concepts from the course in daily contexts and enhance their knowledge application ability. Among 365 participants who registered for this course in the Fall semester, 115 completed the study. 22 of them participated in a post-project semi-structured interview. After analyzing Instagram posts and transcripts, we uncovered different behavioral patterns in this Instagram learning environment, and how participating in this project improved students' learning experience. Specifically, by posting, interacting with peers, and browsing peers' posts and profiles, participants were able to enhance their cognitive growth such as situation awareness and gained a sense of belonging.

The first online discussion section of *Introduction to Environmental Psychology* course was redesigned to a warm-up session for participants recruitment. Every student in the class was required to pick a photo of their learning environment and they needed to discuss the post with other classmates. This procedure helped students become familiar with the study they would be doing. After the section, a formal introduction of this research project together with an invitation to participate were sent via email. Participation was voluntary with extra credits as incentive. Every week, each participant was required to post at least one original Instagram post with the surrounding environment, as well as a short comment on the photo. The images needed to be related to the lecture contents on the week of posting. In each post, participants were instructed to add a common hashtag, so their posts were searchable by their peers.

Among 365 students who enrolled in this class, we received 201 completed consent forms in total before the official beginning of the project. At the end of the semester, 115 students (57.2%) completed the project by posting at least seven out of eight weeks during the study period. They posted 591 posts in the 8 weeks (Mean = 7.4; Median = 8) and received the extra credits for the course. Initial participants might choose to drop this study due to other opportunities with the same extra credits and similar workload offered. Figure 1 shows a screenshot of one participant's Instagram profile.

Interview process

Email invitations that asked study participants to join a post-study interview were sent at the end of the semester. In total, we conducted 22 semi-structured interviews through Zoom online meetings (Zoom, 2021). To ensure the representativeness of the participants sample, we used the stratified sampling strategy (Robinson, 2014) based on gender and year of

Fig. 1 A series of one participant's posts from her surrounding environments to various objects: phones, plants, curtain, neighborhood, etc.

study when sending out invitations. The demographic information of interviewees, participants, and the whole class is presented in Table 1. The duration of each interview ranged from 15 to 20 minutes. All interviews were audio-recorded and transcribed. Before the interviews, all participants consented for the conversation to be recorded.

During the first part of the interview, we asked participants their impressions of participating in the study, such as: "could you describe some advantages and disadvantages of Instagram in terms of online interaction with your classmates, when compared with other platforms you used?". Next, we asked them to locate the most recent post they made on Instagram and describe the topic and content: "could you walk us through how you decide to post this particular content?". We then asked about their experiences of interacting with surrounding physical environments and with peers. Specific questions we asked were "this post had some responses from your classmates. did you find their comments helpful, if so, in what ways?", "what were your feelings after going to the surrounding environment and linked it back to the class materials you learnt?", etc. We concluded the interview by asking an open-ended question about how they would like to see social media embedded in online learning environments.

Table 1 Demographic summary of all students, project participants, and interviewees

	Gender		Year of study				Region		
	M	F	1	2	3	4	on	off	other
All	143	222	73	116	94	82	164	173	28
	39.2 %	60.8%	20.0%	31.8%	25.6%	22.5%	44.9%	47.4%	7.7%
Participants	37	78	40	45	21	14	50	53	12
	32.2 %	67.8%	34.8%	39.1%	18.3%	12.2%	43.5%	46.1%	10.4%
Interview	9	13	5	9	5	3	13	7	2
	40.9%	59.1%	22.7%	40.9%	22.7%	13.6%	59.1%	31.8%	9.1%

Interviewees' accounts and posts

In total, we had 22 respondents who participated in the interview and shared their experiences participating in this study. We accessed their accounts, collected basic information of their accounts, such as number of followers and number of posts, and saved screenshots for all their posts. They created a total of 167 posts on Instagram in the 8 weeks. On average, each participant posted 7.6 images (Median = 8). All posts were presented in the format of photos (no videos). Our participant group was diverse in terms of major, ethnicity and class of standing. We had 9 male and 13 female participants from various majors (Engineering, Business, Design, Social Sciences, and Biology). While most participants were physically located in the U.S. (on-campus, off-campus or at-home), there were two international students who lived in India and China during that semester. To protect participants privacy (anonymity), participants were given the option to use their own personal accounts or create a new account (recommended) for participation. Participants were also encouraged to use nicknames and their preferred profile image in this study. Not surprisingly, only one participant used her personal account to complete the task. Since most of the accounts were newly registered and the only content posted related to this course, most students had less than twenty followers at the end of the study. Several participants gained "momentum," though: having more than 40 followers.

  While most participants expressed that they had extensive knowledge of how to use Instagram, two respondents shared with us that they had never used Instagram prior to this study. For frequent users, when reflecting on what they mainly used Instagram for, they said they mainly explored what others were doing, connected with friends, and captured life beauties. During the eight-week long study, there was an increasing number of posts in later weeks, suggesting participants engaged with the task more. Along with this trend, we further observed that the interaction among students increased, and participants described that they "enjoyed this task more" especially in later weeks. Approximately half of the posts were posted on Mondays, the day we sent out the reminder to participants that encouraged posting every week. The rest of posts were posted throughout the week: some participants mentioned that they enjoyed posting while they were "at the scene".

Data analysis

Grounded theory approach (Locke, 2002) was applied to analyze the interview scripts. All interview sessions were transcribed before the qualitative data analysis. Atlas.ti (2021), a qualitative data analysis software was used to code and synthesize data considering our research questions. A typical grounded theory approach is composed of three stages of coding, namely open coding, axial coding, and selective coding (Creswell et al., 2007). The authors mainly used the constant comparative method (Glaser & Strauss, 1967) to generate insights that are presented in this paper. By comparing each code with all others constantly,

further commonalities were found which formed even broader codes. Glaser and Strauss (1967) described this method of continually comparing codes with each other as "constant comparative method". It is a process of clustering and merging (Weinhandl et al., 2023).

In the beginning, two of the authors revisited the interview protocol and did the first round of open coding of five randomly selected transcripts, by assigning codes to important instances. During this initial coding, more than 50 codes were generated, such as "visited a remote area," "mental benefits of feeling connected," "helpful to understand class materials," etc. Then, two coders sat together and compared codes, then merged similar ones (different in wording) to a consistent name. This calibration process was important to build a codebook that would be used in the following steps. Next, two researchers combined unique codes into a codebook and re-coded the first five transcripts, as well as the remaining ones. During the second round of coding, when a new code emerged, two researchers communicated with each other to ensure the codebook was up to date.

Upon finishing the open coding process, codes were grouped and organized into more than 20 themes representing participants' experience in this study. Emerging themes included "impression of the task," highlighting participants' evaluation of the task design; "communicate with different types of environments," highlighting various approaches participants decided the content of the post; "benefits of participating the research project," highlighting students' satisfaction-level and what they got upon finishing the study; as well as "sense of belonging in the Instagram community," encompassing examples and quotes participants mentioned about how they feel connected with their classmates. In the results section, we discuss these themes in detail and provide specific quotes to support our findings.

Besides analyzing the interview scripts, we also analyzed interviewees' posts by recording their locations (nature, indoor, outdoor, product) and randomly selected a sample for open card sorting. In an open card sort, subjects sort cards into as many groups as desired and then name the groups (Lewis & Hepburn, 2010). We first randomly selected 3 posts each week and gathered them together (n = 24) as the cards for sorting. Next, two researchers clustered the cards into different categories based on the post content independently. Lastly, the two researchers discussed thoroughly their results and adjusted the clusters.

Results

The interview results uncovered three behaviors in the Instagram community, including posting, interacting with peers, and browsing posts and profiles. Participants built situation awareness and sense of belonging through these behaviors. In this section, we organize our findings into three parts: first, how did participants build situation awareness by connecting concepts they learned to the real contexts such as surroundings, outside (natural)

environment, and previous experiences through posting; second, how did participants collectively create a sense of belonging by communicating with their classmates through interacting channels such as commenting and like behaviors; third, how did participants internalize the knowledge from posts and enhance both situation awareness and sense of belonging in the community through browsing peers posts, peers profiles, and their own profiles.

Building situation awareness by posting real scenarios

During the interview, we specifically asked students how they decided what photos to take weekly. In the data analysis, we coded this question directly, namely the way they completed the task of posting. The answers were diverse – most of interviewees described the specific process from deciding to topic, to complete the task of snapping a photo, then to post it on Instagram. After clustering the codes, we observed an emerging theme that is commonly brought up by participants: (1) took pictures in where they lived and surrounding areas, (2) went outside to find fitted scenarios, or (3) re-interpreted images they already had in their albums. Furthermore, we found students expressed the benefits of this project that it increased their connections with surrounding environments (19 out 22 participants). Through the process of creating Instagram posts, participants enhanced their cognitive growth by applying knowledge to real contexts and situation awareness.

Many participants reflected that the "home environment" was where they took most pictures (n = 7) which is consistent with the themes of their posts that 59 out of 167 posts were photos taken at homes, dorms, and apartments. Engaging with the environments they were familiar with allowed participants to provide meanings to everyday things by using the knowledge learned, and many commented this experience was valuable. For example, P1 mentioned that when she thought about the concept of "ecological behavior" which was learned in the lecture of that week, she immediately looked at her surroundings (home) to find inspiration:

"I have to think about what features in my own home promote positive ecological behaviors, and I thought of the trashcan that we have in our kitchen, because it makes it easier to think about recycling when there's a specific bin for the recycling right next to the trash bin." (P1)

Similarly, P6 reflected that he tended to find what he wanted to post by looking at the environment he had the most experiences with. In his case, since he lived alone in an apartment where he spent considerable time, especially during the pandemic, he took many photos in his apartment for both this project and fun purposes. Further, he mentioned that this process of "appreciating my apartment" was helpful for him to gain a better understanding of the course materials, which then helped him perform better in course assignments and tests.

"(This project) kind of helped me to be able to observe things in my surroundings that I pay little attention to. When I go back home, I feel like I know more about what I'm looking for." (P6)

While some students chose to take photos mostly from where they live, others decided to go around the campus or go outside of their living spaces to capture the natural beauty and explore areas where they haven't been before (n = 9). 76 posts were photos on nature which is the most popular theme. They also highlighted that taking a walk allowed them to think aloud about how aspects of the architecture and the landscape were associated with concepts they learned from that week's lectures. One participant highlighted that he moved to a new region before the pandemic. The project enabled him to explore his surroundings by doing the weekly task. In other words, the task of posting a photo became a discovery process:

"I'm not super familiar with the area. So, I think I like this assignment. It gives me a reason to go outside and just explore the surrounding area." (P13)

As several respondents mentioned, during the pandemic, safely going outside made them "breathe some fresh air and get in touch with nature". One participant described the study as "something meaningful during the pandemic" (P11). It even became a weekly routine for one of the participants to go outside and take photos then post. In fact, she described herself as "self-motivated" when participating in this study.

"So, I actually found a lot of motivation to do this assignment just because it gave me the opportunity to kind of move around and get some fresh air and also explore my surroundings a little bit more." (P20)

Another participant noted that when he looked at others' posts and found a handful of posts were about immediate, proximate surroundings, he decided to be creative and drove around to take more "novel" photos. The social affordance of Instagram is the key factor that encourages him to post "remote surroundings". This echoes a consensus from participants that they cared about the quality of those Instagram posts because others were able to see the content.

"I kind of drove around everywhere to take these photos. For a lot of people, they would take photos of their immediate surroundings. Yet, I feel like people have a deeper, stronger connection to different types of surroundings. For me, to post something different, to go somewhere I haven't visited before - I feel like that is very valuable." (P21)

In general, participants were able to find content to post by drawing inspiration from their home environment or outdoor surroundings. However, for a small number of participants (4 out of 22), they mentioned that they chose to re-interpret photos that had previously taken and applied course concepts to them. Specifically, they browsed their photo archives to see if they could "recycle" some of the photos. For example, when the course discussed

the topic of "aesthetics", one participant immediately recalled her past experiences living in an Airbnb housing near Montreal:

"This was a living room of the Airbnb that I was in, and I chose it because I remembered it immediately when the professor talked about aesthetics. It is such a well-decorated room and I can tell the owner put a lot of thought into it, like the photos on the wall… So yeah, I definitely loved recalling those good memories and found there are insights behind them!" (P10)

In addition to actively looking for the content by themselves, participants also looked at what others posted to get inspiration. Six participants mentioned that kind of strategy in the interview. One participant mentioned that she searched for the hashtag of that specific week on Instagram because she was confused about the concept and wanted to see how others interpreted it. This type of behavior was not rare, especially when one got stuck finding examples.

Though strategies participants adopted for finding appropriate content to post might be different, the process of looking for a picture, adding a short paragraph of the description, finding hashtags, etc. remained largely the same. This flow of process enabled participants to critically reflect on their environment and deepened what they learned beyond examples in course materials. One participant elaborated that "I think the process of thinking about it and discovering what's around me makes me more aware of these concepts" (P22). By giving meanings to both familiar and unfamiliar surroundings, one could realize that abstract concepts were "applicable in our everyday life, and you can still see it around" (P5). We summarized that this study helped students realize that the physical environment around them is a "bigger classroom".

By building situation awareness and facilitating the connection between participants and surrounding environments, this project even led to behavioral changes for two participants. One of them shared with us that when she looked for a picture that linked with the concept of "water and energy saving," she reflected on the shower system she had in the bathroom. Further, she researched the Internet on the best practices to save water. As a result, she posted a picture and called for her classmates to consider this issue (reduce shower time to save water) as well.

"In the past, I took like 15 minutes to shower. But I think now I've decreased my shower time because I'm more aware of it, after sharing it and seeing how people respond." (P16)

Formulating a sense of belonging by direct interaction channels

There are two primary ways participants mentioned that led them to formulate a sense of belonging by direct interaction in this Instagram-based community including "likes" and "comments".

When discussing the feedback and comments they received, more than half of participants expressed that they didn't have too many expectations of receiving feedback at the beginning of the study. This is partly because they thought it was a task and were not required to provide feedback. However, with the progress of the study, they gradually observed that others started to comment and like each other's content. Most of the feedback people received was encouraging and positive.

Participants gave likes to peers' posts for many reasons: they felt they were funny, cool, beautiful, useful etc. For example, the useful posts benefited learning as they provided unique perspectives to understand the course content.

"I gave likes to posts with dogs in different environments. It brought me to think the environmental psychology is not limited in humans but could be extended to animals." (P9)

Most participants felt encouraged when their posts were liked by peers, but to our surprise, 5 participants did not feel very excited when they received a few likes as they felt it was "just kind of politeness and have no further meanings". When received many likes however, P17 mentioned his excitement:

"I was so surprised that one morning I woke up, and found my post received like 30 likes. And my post was put on top and exposed to everyone." (P17)

Normally, the sense of belonging in a class is formed through course participation, discussion sessions and group projects. During the pandemic where physical presence in the classroom was a challenge, the Instagram function of commenting (in rare cases - direct messages) became one of the pathways to maintain and enhance the community feeling. Most comments were just supportive words like "I like it", "it is so amazing" etc. But still, there were some comments discussing posts content using the course knowledge. Several interviewees (n = 3) even expressed that they viewed Instagram as a place where "an informal discussion session" happened, since they were able to start conversations like in a traditional lab where they talked about concepts learned. While this is not a perfect replacement for real-life interactions, participants expressed they were satisfied when they communicated with others on Instagram.

Sometimes, even friendship could start from comments. P9 described how she built a new friendship by participating in this study:

"I noticed photos with cats and dogs in another student's post immediately and expressed my interest on little animals in the comment area. Then we followed each other. After a while I realized how many common things we have and finally we became friends." (P9)

Bridging situation awareness and sense of belonging by browsing

Browsing behaviors were mentioned frequently by every participant in the interview. During the semester, participants expressed that they not only visited others' Instagram pages before the due date of posting content, but also browsed those pages periodically to

check their peers' profiles and look for interesting content, just like they engaged with their friends on their personal accounts. The browsing behavior plays as a way for them not only to help them build a better understanding of their surroundings (Section 4.1) and form relationships with peers in the class (Section 4.2), but also to reflect on themselves. Specifically, in the interview, participants told us what content they spend time reading, especially how they strategically utilize it for self-reflection purposes.
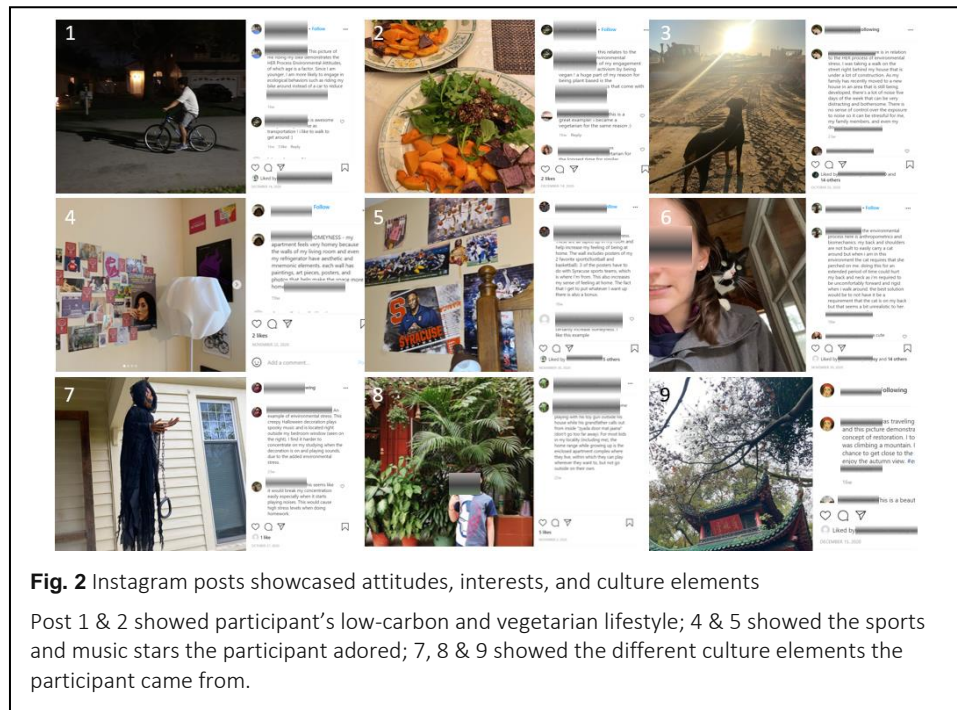
First, browsing peers' posts is a way to understand their lives, cultures, interests, and attitudes conveyed from these posts, which formulates a sense of belonging. An Instagram post can deliver more than the environment or the surroundings one lives (explicit information). P16 decided to stay in India during the fall semester and attended classes remotely, and he posted nine photos to showcase Indian culture: home decorations, furniture, natural beauty, and city skylines and connected those images with the concepts learned in class. His account had 32 followers, one of the top "influencers" among his peers. Others appreciated his efforts and felt they learned something new when looking at those photos by applauding "thanks for introducing us Indian culture!" (P4). Though physically distant, a sense of belonging (to the course) was formulated and strengthened for these two students.

In our study, participants came from different regions within the U.S. and around the globe. By posting personalized content, they delivered underlying messages about who they are, such as interests, traits, and beliefs (Figure 2). Though we didn't observe obvious patterns of posts based on participants' demographic groups (e.g., gender, age), each post they created, in fact, represented their unique identities and personalities as an individual. As a result, this project enabled participants to know each other better and formed the sense of belonging to a virtual, Instagram-based community.

"Looking at these posts like I am reading a personal story, and I really enjoyed that!" (P11) a junior stayed on campus said.

"By going through classmates' posts, I felt I was on campus." (P4) a freshman studying abroad told us.

Browsing peers' posts, on the other hand, is a process to apply the content students learned from others for deep self-reflection to formulate situation awareness. Their peers play the role of an instructor, giving them empirical examples of how to apply concepts learned from class to day-to-day environments. Then during the internalization process, people search for related experiences to post. At the same time, students were able to apply the knowledge they learned from others' posts to influence their own daily activities. P18 described this as a "deep-learning by browsing" experience. For example, he mentioned that seeing a post about "taking a walk even by oneself during quarantine was good for mental health" changed his daily routine. He took the advice and found it to be "extremely helpful to go outside of my small apartment on-campus". Several participants also

Fig. 2 Instagram posts showcased attitudes, interests, and culture elements

Post 1 & 2 showed participant's low-carbon and vegetarian lifestyle; 4 & 5 showed the sports and music stars the participant adored; 7, 8 & 9 showed the different culture elements the participant came from.

mentioned that browsing others' posts brought inherent "joyfulness" and realized there were abundant meanings they did not know of daily objects and landscapes. One participant (P1) further described Instagram as a "keep-growing archive" of documenting beauties, and added captions were deep and thoughtful.

"I feel like this is a museum. I'm like a visitor, staring at those art pieces, and immerse myself in front them is so calming. This may sound philosophical, but it's so Zen." (P1)

Second, we found that students paid attention to others' profile information. While a handful of participants' accounts had no profile content, approximately half of them did add personalized details to the profile. The information varies from short tags (including Emojis) to sentences describing their interests, as well as links to external websites. For example, one of the participants tagged herself as an "environmental enthusiast" and included a link to the World Wildlife Fund (WWF), one of the most prominent non-profit organizations in Wildlife Protection. More interestingly, this description caught the attention of her peers, and she had 52 followers. Another participant was able to capture this profile and mentioned that seeing the self-description and what the account felt enthusiastic about made one gain more knowledge of her, especially building the knowledge of "someone as a real person" (P20).

"I was able to 'humanize' my classmate because of the interesting profile provided. That also makes me, sort of want to update my profile because I also want to be recognized by others, just like the way here. Maybe a cat Emoji? I don't know – just feel like it is a personal touch." (P3)

This type of knowledge can be hard to obtain in virtual classes due to its remote nature, especially when face-to-face conversations are less often. The content in the profile also enables a self-reflection mechanism of matching. Specifically, students reflected on their own interests and saw if there was a match between their interests and the account holder. As a result, the behavior of browsing profile information facilitates potential next steps, including sending direct messages and even virtual one-on-one conversations.

Finally, 8 participants mentioned they usually reviewed their own profiles before preparing a new post. P12 shared with us that his background in animal science made him particularly interested in many Instagram posts where human-animal interaction increased during the pandemic, as well as how the wildlife situation changed because human activities were less frequent for an extended period. "Every time before I posted, I would go through to find what scenarios I had posted. I want to make a portfolio on how a little dog feels in different types of environments." For those students, they went beyond the single post every week and intended to "connect the dots" by browsing their own published posts to create a meaningful portfolio.

Discussion

Extensive work suggested that mobile social media can be integrated with the course in both classroom and online learning situations (Khalitova & Gimaletdinova, 2016; McCarthy, 2013). Our study provides a new empirical observation that Instagram is a helpful tool to enhance students' learning experiences. Specifically, in this Environmental Psychology course, students were able to interact with both their environmental surroundings and peers, and therefore enhanced their situation awareness and the sense of belonging.

In the discussion section, we used conjecture mapping (Sandoval, 2014) to summarize our study and propose a framework of situated learning environment through mobile social media. We then addressed design implications on how to create a situated learning environment through the design both on curriculum and technology beyond this course.

Creating situated learning environments through social media

Our framework (Figure 3) describes this situated learning environment through social media using conjecture mapping (Sandoval, 2014) including embodiment, mediating processes and intervention outcomes.

The embodiment articulates its reification in features of learning environment design which includes how the four key elements: content, context, identity and community systematically considered. As discussed in the related works, content and context, identity and community overlap and influence each other in the system. Fundamentally, students needed to learn from the environment ("context") to apply the knowledge they received in

Fig. 3 A framework of situated learning environment through mobile social media
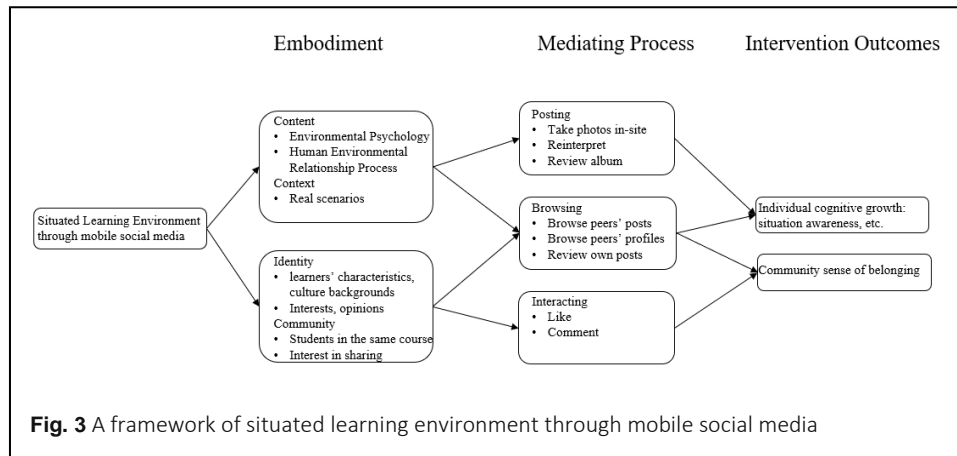
classroom ("content"). At the same time, that learning process also requires students to learn from their peers ("community"). In fact, context and community are two important aspects of situated learning (Brown et al., 1989). In our study, the basic content was the concepts (i.e., Human-Environment Relations Process) one learned in class. The student needed to find relevant "context" that matched the "content" when creating the Instagram post. Research findings show that there are three ways students connected concepts to different "contexts": they (1) took pictures of an everyday object or the environment they lived in; or (2) went outside to find fitted scenarios or (3) re-interpreted images they already had in their photo albums. All these three pathways allowed learners to connect their physical and living environments with the course material they learned (Liu & Hwang, 2010). During this "perception – comprehension – projection" process (Endsley, 1995a, 1995b) participants gained a deeper understanding of different types of environments, extended the learning environments to diversified contexts, as a result, their situation awareness of the learning environment got improved. Like content and context, identity and community are overlapped. Identity is the learner's qualities, beliefs, personality as well as expressions that make a person unique in the learning environment (Lapsley & Power, 2012). Community is where learners share opinions, express their unique identities and interact with each other (Masolo, 2002). Constructivists believe learning is assumed to be indexed by personal constructions of reality, and experience is fundamental to understanding. Diversified identities build learning communities which create authentic, problem-rich environments that encourage exploration and diversity of perspectives. Lave and Wenger's idea on situated learning stressed that learning processes entail both the development of the community and the shaping of identity (Lave & Wenger, 1991). In this study, the community was formed by students' common identity of classmates and interest in using Instagram to share posts and strengthened by diversified individual characteristics.

Mediating processes were enabled by elements in embodiment and intended to produce desired outcomes (Sandoval, 2014) including three main behaviors in this learning

environment: posting, browsing, and interacting. And each main behavior has subcategories of behaviors that were summarized in the results section.

The intervention outcomes as were also stated in the results section, include enhanced situation awareness and sense of belonging. From a more general view, situation awareness increase is a form of individual cognitive growth. There are three steps in situation awareness: perception, comprehension, projection (Endsley, 1995b). In the Instagram learning environment, they can be interpreted as observing surrounding environments, making reflections based on the course knowledge, and taking actions. It is worth noting that not all the mediating behaviors went over all these three steps, therefore, may result in different levels of situation awareness. This topic may need to be explored in future studies.

Design implications

The framework could provide general direction to design and analyze the situated learning environment via mobile social media. Noticeably, the overlapping parts between each element need careful consideration and unique design. For example, the design of interaction between content and context as well as identity and community need ecological consideration of technology, course content and pedagogy to find a natural method in real situations. Here, we will focus on addressing the features of technology to afford different behaviors in this learning environment to benefit learners' experience. In other words, what features could better afford these behaviors if we have a chance to redesign a platform compared with Instagram. There are three behaviors participants mentioned in this learning environment: post, interact, and browse, and below we address what additional affordances could invite these behaviors and improve learners' experience.

First, participants "post" on Instagram either by taking a photo or finding an existing photo from the album. By posting, participants can build the connection between the knowledge they learn in the class and real-life contexts. In the interview, we found that posting in-situ benefits them more. Thus, much like the current algorithm, we encourage future designs to promote in-situ posts and even send out nudges to those who have not done so. This would increase students' exposure to the current, at-the-moment environment – making the experience more interactive and reflective.

Second, interaction in the virtual Instagram learning environment mainly includes "like" and "comment". While those interactions conveyed encouragement and support, some more fine-grained emotions might be missing in the design to begin with. Offering more kinds of social signals such as "cool", "funny", "helpful", rather than just "like" may be a good way to encourage more meaningful interactions. We did observe cases when participants were able to make offline connections by discovering common interests – this is a direction for designers to think about – how the platform could encourage longer and impactful conversations? It might be possible to follow up on a click of "like" button, the

system can pop up a window and ask "consider share your like in a video message" to add more personal touches to the simple action.

Lastly, related to the added theme that browsing behavior as a mechanism for self-reflection, we propose future systems to enhance the current browsing reading experience to facilitate self-reflection. Currently, the Instagram homepage presents posts ranked by algorithms that users have no control. We recommend that the system allow users to customize the homepage content based on their unique needs. For example, in an education setting, different filters/ranking systems can be developed based on Teaching Assistants (TAs)/instructors' requests, shared geo-locations, relevance to one's interests and majors, the time of the posting, etc. As a result, students could easily re-organize hundreds of posts. For example, many participants expressed that TAs/instructors' involvement could help enhance the learning experience. With that, we propose instructors can play as moderators of the space and spotlight content to make it fixed for all students. Though one may also argue a diversified set of content will drive more traffic and be more inspiring. We also recommend revamping the landing page's current design by using a map to categorize all posts by locations or themes, which will reduce the time of finding relevant content for self-reflection.

Beyond environmental psychology education

COVID-19 pushed instructors to come up with approaches to engage with students using new technologies. When campuses are closed, one of the missing parts in the so-called "Zoom university" is the social learning environment such as their classmates and physical learning environment such as university campus. This current study demonstrates a possibility that students could be encouraged to reconnect with not only their peers, but also diverse learning environments including campus to some degree.

Indeed, an environmental psychology class is a representative scenario for application of social media community as described in the paper: physical environments have three-fold meanings as core knowledge in the course, available materials in life, and content of posts in social media. Therefore, we envision the results observed in terms increasing students' situation awareness and the sense of belonging are not limited to the current Environmental Psychology course, but also curriculums relevant to physical environments at different scales, such as Industrial Design, Architecture, Urban Planning, etc. For those class offerings, it will be helpful to integrate social media as part of the course instruction to encourage students to explore the surroundings and extend their learning environments from "Zoom university" to real-life physical environments.

However, we need to articulate here: to implement this learning through social media, instructors need to find a task to guide students on what to post. This task systematically considers the overlap between content and context as well as community and identity which

is part of the framework of learning environments we proposed. In our Instagram community, the task is to ask participants to post a photo related to a "Human-Environment Relations (HER) Process" they learned in each week and argue the relevance. In our example, the specific learning content in our study is HER which are key concepts students learned in the course; the learning contexts are students' surrounding physical environments which are applications of these concepts. The community is built on the common interest and benefits to explain the real environments using the course content from students; the identity is about how personal characteristics, attitudes and opinions can be integrated into photos and comments of posts. For courses like landscape architectures for example, the task might be to "ask students to post an innovative/bad case of a landscape design instance they found in the city every week". The task is not obvious and is different for each course.

When students participated in online learning, their need for social life and connection to the environment increased. These genuine needs made us design this project to examine whether this simple task could satisfy both types of needs. Summarizing our research findings, we argue a well-designed learning environment based on the framework would meet these needs. Image-based mobile social media like Instagram would be an easy and economical way to create this environment. Recent works suggested that students enjoyed using Instagram for content sharing due to its access to peers, the convenience of sharing, and powerful visual images. While prior works seldom used Instagram in assisting students to gain a sense of situation awareness and social connection, our research suggested a broader application of this service.

Limitations and future works

There are limitations of this work that need to be addressed. First, we conducted this study during a global pandemic when most of the classes were being offered remotely. Thus, there were more students geo-located in different regions within the U.S. and internationally when compared to a regular semester when they mostly reside on or around campus. On the one hand, the sparsely located nature of participants allowed us to observe diverse modes of how they interact with their surroundings; on the other hand, we expect that when students are back on campus, their posts about environments might have a different pattern. We plan to conduct replicate study after most students come back to campus, then compare what the differences are in terms of (1) how they choose the content to post; and (2) what strategies they use to gain a sense of belonging and mutual support. Though we used the stratification sampling strategy to invite study participants for the interview, there might be a self-selection bias that those who chose to talk with us could be the ones who enjoyed the project most. Thus, for future work, we suggest adding a quantitative survey study at the end of the project to collect a complete set of responses

from study participants. This survey study can also be used to examine how different factors such as gender, age, ethnicity, year of class, location status can influence students' content posted, as well as their satisfaction level of using the platform to support remote learning.

From the perspective of socioeconomic status, it should be noted that in this current study, all our participants had access to the Internet, and they had knowledge of using Instagram to post content and communicate with classmates. As a result, they reported that Instagram was helpful to enhance the sense of belonging during a global pandemic. Future ethnographic research can examine in regions and areas where such access is not feasible, how would technology enable the formation of sense of belonging among students?

Our work indicates that it is particularly helpful to motivate students to reflect on their physical environment during the pandemic in environmental education. From the perspective of generalizability, we plan to conduct a study that compares different social media platforms on their effectiveness to facilitate engagement with the environment (e.g., is a text-based platform less preferred than a visual-based platform). For broader environmental education, we wonder would our design throw light on other class offerings, such as communication and information science major courses.

Conclusions

This study examined the potential value of using Instagram to enhance learners' interaction with peers and physical environments in online learning. Participants reflected that their situation awareness and the sense of belonging enhanced at the end of the project. Throughout the eight-week long study, participants linked concepts they learned from the classroom to immediate contexts like homes, neighborhood, outdoor environments, and previous experiences. Moreover, they felt connected with classmates and the course learning community. The posts they created also reflected unique cultures, opinions and identities which are critical pathways for other participants to better understand them. We summarized how to create a situated learning environment through social network using conjecture mapping. Lastly, we discussed limitations and suggested future directions to understand students' learning experience in the situated learning environment through mobile social media more comprehensively.

The study has the following contributions to the broader technology enhanced learning communities. First, we conducted this timely work during the lockdown when students were away from the conventional classrooms and learning in distributed environments. Our work revealed that image-based social media like Instagram could act as a bridge to connect individual learning, the context, and the community that successfully transforms students' online learning experience and makes up for their experience of learning on Campus. Second, our findings suggested specific mechanisms of how students engage with real

contexts in life and communicate with their classmates (through comments, shared memories and personalized content) to enhance learning experience. Third, using our empirical study as a basis, we proposed a framework of situated learning environment through mobile social media to inform further study on learning environment design and analysis. Namely, in situated learning environment that emphasizes both the context and the community, students received benefits including cognitive growth as enhanced situation awareness and higher level of the sense of belonging.

Abbreviations
ESL: English as a Second Language; HER: Human-Environment Relations; RQ: Research Question; TA: Teaching Assistant; WWF: World Wildlife Fund.

Authors' contributions
Wangda Zhu is responsible for the whole manuscript: including research design, data collection, data analysis, and paper writing. Ying Hua is responsible for research design and manuscript revision. Luping Wang is responsible for part of the research design, data collection, data analysis, and part of paper writing.

Authors' information
Wangda Zhu received his PhD in Human Behavior and Design at Cornell University. His research interests include learning community, learning technology design, and AI in education. Ying Hua is an Associate Professor in the Department of Human Centered Design at Cornell University. Her research informs the design, delivery, operating, management, and re-engineering of working and learning environments. Luping Wang received his PhD in Information Science at Cornell University. His research interests include social media, CSCW, etc.

Availability of data and materials
Not applicable.

Declarations

Competing interests
The authors declare that they have no competing interests.

References
Al-Ali, S. (2014). Embracing the selfie craze: Exploring the possible use of Instagram as a language mLearning tool. *Issues and Trends in Educational Technology*, *2*(2).
Archambault, L., Wetzel, K., Foulger, T. S., & Kim Williams, M. (2010). Professional development 2.0: Transforming teacher education pedagogy with 21st century tools. *Journal of Digital Learning in Teacher Education*, *27*(1), 4–11.
ATLAS.ti. (2021). *ATLAS.ti: The qualitative data analysis research software*. http://atlasti.com
Aubry, J. (2013). Facebook-induced motivation shifts in a French online course. *TechTrends*, *57*, 81–87. https://doi.org/10.1007/s11528-013-0705-6
Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148. https://doi.org/10.1207/s15326985ep2802_3
Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42. https://doi.org/10.3102/0013189X018001032
Chapman, G. P., & Chapman, C. P. (1977). *Human and environmental systems: A geographer's appraisal*. Academic Press.

Choi, J. I., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research and Development*, *43*(2), 53–69. https://doi.org/10.1007/BF02300472

Collins, A., Brown, J. S., & Newman, S. E. (1988). Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics. *Thinking: The Journal of Philosophy for Children*, *8*(1), 2–10.

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The Counseling Psychologist*, *35*(2), 236–264. https://doi.org/10.1177/001100000628739

Dabbagh, N., & Kitsantas, A. (2005). Using web-based pedagogical tools as scaffolds for self-regulated learning. *Instructional Science*, *33*(5-6), 513–540. https://doi.org/10.1007/s11251-005-1278-3

Dhir, A., Buragga, K., & Boreqqah, A. A. (2013). Tweeters on campus: Twitter a learning tool in classroom?. *Journal of Universal Computer Science*, *19*(5), 672–691.

Endsley, M. R. (1995a). Measurement of situation awareness in dynamic systems. *Human Factors*, *37*(1), 65–84. https://doi.org/10.1518/001872095779049499

Endsley, M. R. (1995b). Toward a theory of situation awareness in dynamic systems. *Human Factors*, *37*(1), 32–64. https://doi.org/10.1518/001872095779049543

Endsley, M. R., & Garland, D. J. (2000). Theoretical underpinnings of situation awareness: A critical review. *Situation Awareness Analysis and Measurement*, *1*(1), 3–21.

Figueiredo, A. D. (2006). Context and learning: A philosophical framework. In A. D. de Figueiredo & A. P. Afonso (Eds.), *Managing learning in virtual settings: The role of context* (pp. 1–23). IGI Global.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education*, *19*, 18–26. https://doi.org/10.1016/j.iheduc.2013.06.002

Glaser, B. G., & Strauss, A. L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

Gonulal, T. (2019). The use of Instagram as a mobile-assisted language learning tool. *Contemporary Educational Technology*, *10*(3), 309–323. https://doi.org/10.30935/cet.590108

Grosseck, G., & Holotescu, C. (2008, April). Can we use Twitter for educational activities. In *Proceedings of 4th International Scientific Conference, eLearning and Software for Education*. Carol I National Defence University Publishing House.

Handley, K., Sturdy, A., Fincham, R., & Clark, T. (2006). Within and beyond communities of practice: Making sense of learning through participation, identity and practice. *Journal of Management Studies*, *43*(3), 641–653. https://doi.org/10.1111/j.1467-6486.2006.00605.x

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, *48*(3), 23–48. https://doi.org/10.1007/BF02319856

Hsu, Y. C., & Ching, Y. H. (2012). Mobile microblogging: Using Twitter and mobile devices in an online course to promote learning in authentic contexts. *International Review of Research in Open and Distributed Learning*, *13*(4), 211–227. https://doi.org/10.19173/irrodl.v13i4.1222

Huang, Y. M., Liao, Y. W., Huang, S. H., & Chen, H. C. (2014). Jigsaw-based cooperative learning approach to improve learning outcomes for mobile situated learning. *Educational Technology & Society*, *17*(1), 128–140.

Kassens-Noor, E. (2012). Twitter as a teaching practice to enhance active and informal learning in higher education: The case of sustainable tweets. *Active Learning in Higher Education*, *13*(1), 9–21. https://doi.org/10.1177/1469787411429190

Khalitova, L., & Gimaletdinova, G. (2016). Mobile technologies in teaching English as a foreign language in higher education: A case study of using mobile application Instagram. In *ICERI2016 Proceedings of 9th International Conference of Education, Research and Innovation* (pp. 6155–6161). IATED.

Kirkwood, A., & Price, L. (2013). Examining some assumptions and limitations of research on the effects of emerging technologies for teaching and learning in higher education. *British Journal of Educational Technology*, *44*(4), 536–543. https://doi.org/10.1111/bjet.12049

Lapsley, D. K., & Power, F. C. (Eds.). (2012). *Self, ego, and identity: Integrative approaches*. Springer Science & Business Media.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lewis, K. M., & Hepburn, P. (2010). Open card sorting and factor analysis: A usability case study. *The Electronic Library*, *28*(3), 401–416. https://doi.org/10.1108/02640471011051981

Liu, G. Z., & Hwang, G. J. (2010). A key step to understanding paradigm shifts in e-learning: Towards context-aware ubiquitous learning. *British Journal of Educational Technology*, *41*(2), E1–E9. https://doi.org/10.1111/j.1467-8535.2009.00976.x

Locke, K. (2002). The grounded theory approach to qualitative research. In F. Drasgow & N. Schmitt (Eds.), *Measuring and analyzing behavior in organizations: Advances in measurement and data analysis* (pp. 17–43). Jossey-Bass/Wiley.

Mahoney, J. (2010). After KKV: The new methodology of qualitative research. *World Politics*, *62*(1), 120–147. https://doi.org/10.1017/S0043887109990220

Masolo, D. A. (2002). Community, identity and the cultural space. *Rue Descartes*, *36*(2), 19–51. https://doi.org/10.3917/rdes.036.0019

McCarthy, J. (2013). Learning in Facebook: First year tertiary student reflections from 2008 to 2011. *Australasian Journal of Educational Technology*, *29*(3), 337–356.

Mills, N. (2011). Situated learning through social networking communities: The development of joint enterprise, mutual engagement, and a shared repertoire. *Calico Journal*, *28*(2), 345–368.

Norman, H., Nordin, N., Din, R., & Ally, M. (2016). Modeling learner situation awareness in collaborative mobile Web 2.0 learning. *Malaysian Online Journal of Educational Technology*, *4*(1), 32–56.

Paton, R. M., Fluck, A. E., & Scanlan, J. D. (2018). Engagement and retention in VET MOOCs and online courses: A systematic review of literature from 2013 to 2017. *Computers & Education*, *125*, 191–201. https://doi.org/10.1016/j.compedu.2018.06.013

Resnick, L. B. (1987). The 1987 presidential address learning in school and out. *Educational Researcher*, *16*(9), 13–54.

Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology*, *11*(1), 25–41. https://doi.org/10.1080/14780887.2013.801543

Salomon, D. (2013). Moving on from Facebook: Using Instagram to connect with undergraduates and engage in teaching and learning. *College & Research Libraries News*, *74*(8), 408–412.

Sandoval, W. (2014). Conjecture mapping: An approach to systematic educational design research. *Journal of the Learning Sciences*, *23*(1), 18–36.

Schroeder, J., & Greenbowe, T. J. (2009). The chemistry of Facebook: Using social networking to create an online community for the organic chemistry laboratory. *Innovate: Journal of Online Education*, *5*(4), 3.

Shaltry, C., Henriksen, D., Wu, M. L., & Dickson, W. P. (2013). Situated learning with online portfolios, classroom websites and Facebook. *TechTrends*, *57*(3), 20–25. https://doi.org/10.1007/s11528-013-0658-9

Shazali, S. S., Shamsudin, Z. H., & Yunus, M. M. (2019). Instagram: A platform to develop student's writing ability. *International Journal of Academic Research in Business and Social Sciences*, *9*(1), 88–98.

Sun, N., Wang, X., & Rosson, M. B. (2019, May). How do distance learners connect?. In S. Brewster & G. Fitzpatrick (Eds.), *CHI '19 Proceedings of CHI Conference on Human Factors in Computing Systems* (pp. 1–12). ACM. https://doi.org/10.1145/3290605.3300662

Symeonides, R., & Childs, C. (2015). The personal experience of online learning: An interpretative phenomenological analysis. *Computers in Human Behavior*, *51*, 539–545. https://doi.org/10.1016/j.chb.2015.05.015

Traxler, J. (2010). *Students and mobile devices*. *ALT-J*, *18*(2), 149–160. https://doi.org/10.1080/09687769.2010.492847

Uzunboylu, H., Cavus, N., & Ercag, E. (2009). Using mobile learning to increase environmental awareness. *Computers & Education*, *52*(2), 381–389. https://doi.org/10.1016/j.compedu.2008.09.008

Vázquez-Cano, E. (2013). The videoarticle: New reporting format in scientific journals and its integration in MOOCs. *Comunicar*, *21*(41), 83–91. http://dx.doi.org/10.3916/C41-2013-08

Wegerif, R. (1998). The social dimension of asynchronous learning networks. *Journal of Asynchronous Learning Networks*, *2*(1), 34–49. https://doi.org/10.24059/olj.v2i1.1928

Weinhandl, R., Mayerhofer, M., Houghton, T., Lavicza, Z., Eichmair, M., & Hohenwarter, M. (2023). Mathematics student personas for the design of technology-enhanced learning environments. *Research and Practice in Technology Enhanced Learning*, *18*, 32. https://doi.org/10.58459/rptel.2023.18032

Winn, W. (1993). *A conceptual basis for educational applications of virtual reality*. https://www.hitl.washington.edu/projects/learning_center/winn/winn-paper.html~

Yin, R. K. (2017). *Case study research: Design and methods (6th ed.)*. SAGE Publications.

Zhu, W., Hua, Y., Zhu, G., & Wang, L. (2022). Share and embrace demographic and location diversity: Creating an Instagram-based inclusive online learning community. *British Journal of Educational Technology*, *53*(6), 1530–1548.

Zoom Video Communications, Inc. (2021). https://zoom.us

Publisher's Note

Research and Practice in Technology Enhanced Learning (RPTEL) **is an open-access journal and free of publication fee.**