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Share and Embrace Demographic and Location Diversity: Creating an Instagram-based Inclusive Online Learning Community

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Abstract

It is critical to create an inclusive online learning environment for students with diverse demographic information studying in different environments, especially during the COVID-19 pandemic when they are disconnected from peers. Guided to create an inclusive online learning community by situated learning theory and community of practice, both of which advocate learning in context and community, we invited 115 undergraduate students to post photos related to environmental psychology concepts and their surrounding environments and discussed their postings on Instagram over eight weeks. To understand the inclusiveness of the community and students' perception, we collected their posts by searching designated hashtags and interviewed representatives of participants using a stratified sampling strategy. Through network analysis of 272 posts and qualitative analysis of 22 in-depth interviews, we found that when participants shared and discussed their surroundings and environmental psychology concepts on Instagram, their learning community was inclusive regarding gender, ethnicity, and program. Student participants' centrality and influence were more relevant to whether and how they expressed their identities in the community through posts. We further discuss how our findings could inform to create inclusive and active communities in the future.

Keywords

Inclusiveness, learning community, social media, network analysis, higher education, Instagram

Practitioner notes

What is already known about this topic?

- The definition of inclusive education extends to diversity and accessibility.
- Social media can support online learning communities.

What this paper adds?

- It explores the inclusiveness of an Instagram-based learning community using network analysis.
- It suggests expressing identities in a learning community helps promote inclusiveness.

Implications of this study for practice and/or policy

- It provides information to education practitioners that will help them create inclusive and active communities through social media.
- It explores the possibility of analyzing the inclusiveness of a learning community through social network analysis.

Introduction

Inclusive education is an effective approach to combatting discrimination, creating welcoming communities, and building an inclusive society (UNESCO, 1994). The current study defined it as "education for all" regardless of students' gender, ethnicity, years of study, and location of study (Messiou, 2017; UNESCO, 1994). Moving into the 21st century, ideas and policies surrounding inclusive education should incorporate matters such as community, identity, and belonging (Thomas, 2013), which are of great importance to students' success at school (CAST, 2018; Lin & Kennette, 2021; Thomas, 2013). When students feel involved, included, and on an equal par, they are more likely to learn (Thomas, 2013). Inclusive education is critical to diverse students who must learn online at different locations during the COVID-19 pandemic. Abrupt switching to online learning and the resulting disconnection from campus likely reduce students' sense of belonging and connection with peers and/or instructors (Lin & Kennette, 2021).

There is an increasing amount of research that aims to create online communities that support students' learning, interactions, and sense of belonging (e.g., Chua & Bong, 2022; Lin & Kennette, 2021). Strategies such as using inclusive languages, mentors' involvement, fluid instructional design, development process, and valuing differences in backgrounds have been proposed (Gunawardena, 2020; Ke & Chavez, 2013; Lin & Kennette, 2021) to construct inclusive online communities. In courses like environmental studies, educators embrace demographic and location diversity as it brings opportunities to apply and teach environmental knowledge in different physical contexts and enhance a sense of place (Ardoin, 2006; Basso, 1996). Social media such as Facebook, Twitter, and Instagram have been adopted to support students' and educators' learning in online learning communities (Authors, 2022; Cuesta et al., 2016; Liliia & Gulnara, 2016; Lim et al., 2017). However, there is insufficient empirical research on fostering an inclusive online learning environment by considering students' demographic and location differences through social media.

The current study aimed to address this research gap by encouraging students to express their identities and contextual diversity through sharing posts about their surrounding environments using Instagram in a meaningful context: an environmental psychology course. Instagram was selected as it is one of the top three most used social media platforms (Petrock, 2021), and is an image-based mobile app with affordances for taking, sharing, liking and commenting on photos of surrounding environments. We conjecture that doing so would allow students to construct their online learning socially and actively; as a result, it might foster an inclusive online learning environment for students with different demographic characteristics and learning locations. This study bridges inclusive education, online learning communities, and situated learning theory, and has implications for fostering inclusive education practice.

Literature Review

Inclusive Education and Inclusive Values

Over the past several decades, the development of inclusive education has been rooted in special education (Danforth & Naraian, 2015). Inclusive education advocates for the rights of disabled children to be educated with their more typically developing peers in general education classrooms (Armstrong & Barton, 2007; Danforth & Naraian, 2015). However, given that inclusive education takes many forms and general classrooms are mainly made up of students without disabilities, the development of inclusive education tends to require a more general intellectual foundation beyond special education (Danforth & Naraian, 2015). For instance, Boroson (2017) suggested that "Our public schools are expected to be inclusive of students of all fluid varieties of gender, race, and ability" and "these students and teachers are not here because of the inclusion movement; we are all here because we embrace difference and diversity." Thomas (2013) argued that inclusive education refers to the education for all learners rather than only those with disabilities. Similarly, Liasidou (2012) looked at inclusive education at the intersection of disability, gender, race, and socioeconomic class. Inclusive education values the different perspectives of students of all backgrounds and identities in classrooms or online learning communities to benefit all (UNICEF, 2021). This paper articulates inclusive values such as equity, participation, community, and diversity rather than narrowing its original scope to a specific group of people (Messiou, 2017).

During the Covid-19 pandemic, inclusive education had additional layers of meaning. In addition to what is traditionally considered as diversity (e.g., gender, race, socioeconomic background), students' learning location is another factor to consider. The reason is that students' learning location is relevant to their accessibility to the internet, electronic devices, and learning resources, which tend to influence their learning (Dube, 2020; Green et al., 2020). Therefore, the current study considered gender, race, year of college (i.e., approximation of age), program, and location of study as diversity factors in assessing the inclusiveness of a learning community.

Community of Practice and Situated Learning

Community of practice (CoP) initially describes a type of informal learning that happens among practitioners in their social environments (Wenger, 1996). With evolution, this concept emphasizes characteristics of community members' interaction with each other, knowledge sharing, and a sense of belonging to their community (Li et al., 2009). CoP's three core elements (i.e., domain, community, and practice) provide a high-level

view for its implementation (Putte & Hove, 2010; Wenger, 1998). Domain is one thing all members have in common such as identities and interests. Community is the "social fabric of learning and fosters interactions" (Wenger, 1998, p29). Practice is a set of frameworks, ideas, information, and stories that community members develop, share, and maintain (Wenger, 1998). A shared domain of interest, mutual engagement within the community, and a shared repertoire of resources and practices are critical features of CoP (Wenger, 1998).

CoP often occurs in contexts where learners are situated (Lave & Wenger, 1991). Situated learning theory (SLT) emphasizes "learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life" (Collins, 1988, p2). In environmental education, learning in contexts has an additional layer of meaning—promoting a sense of place and motivating students through humanistic and scientific engagement with their surroundings (Gruenewald & Smith, 2008). Generally, a sense of place describes a human's relationship with places, expressing human life in different ways such as emotions, biographies, imagination, stories, and personal experiences (Basso, 1996). It is suggested that environmental education should strive to reach a range of community members through building on individuals' unique perspectives rather than privileging only a rooted sense of place (Ardoin, 2006). This aligns with the idea of learning through CoP in situated learning and valuing diversity and different perspectives in inclusive education. CoP creates opportunities for learners in inclusive learning environments (Putte & Hove, 2010; Carroll & Mallon, 2021).

Nowadays, community members are less linked by locations but more by shared interests and goals (Li et al., 2009), especially during the Covid pandemic. When learning must be switched to the online mode because of the pandemic, instructors not only need to adjust their instructional design to effectively convey content information but also need to pay specific attention to their contact with students and the reciprocity and interaction among students, as well as the level of students' active participation (Murdock & Williams, 2011). As described above, these elements are relevant to strategies for fostering inclusive education (Lin & Kennette, 2021). These elements are also essential to developing online learning communities, which strengthen the bond between students taking the course and make the course material more interesting (DiRamio, 2005). Focusing on all students in the community requires active engagement in learning, which is about being recognized, accepted, and valued for oneself (Booth & Ainscow, 2022). Building bonds in online learning communities facilitates supportive peer networks, allows community members to take social and academic roles simultaneously, and fosters interactive, collaborative learning (Motteram & Forrester 2005). Furthermore, as online learning environments enable all community members to share ideas in their public spaces equally, it contributes to inclusive and democratic participation (Blayone et al., 2017).

Research has employed social media like Facebook, Twitter, and Instagram to support online learning communities (Cuesta et al., 2016; Hotho et al., 2014; Liliia & Gulnara, 2016; Lim et al., 2017; Mills, 2011; Shaltry et al., 2013). In these studies, student participants built profiles, shared course-relevant content, and interacted with peers on social media. For example, Mills (2011) constructed a learning community to help students learn the French language and culture using Facebook. Liliia & Gulnara (2016) used Instagram as an educational environment to teach English as a foreign language and revealed its efficiency in enabling students to learn "anytime and anyplace." However,

these studies did not discuss students' behaviors and experiences in the communities from the perspective of inclusiveness, although there were contextual differences.

Network Analysis and Community Inclusiveness

In a learning community, interactions between diverse demographics of students are the foundation of an inclusive learning environment (Brewer et al., 2010). Social network analysis (SNA) provides a method to quantify and visualize the social structure of interactions in a community. A social network comprises students (actors) and their interactions (ties). In social networks, the prominence of actors is usually expressed with centrality measures (Marbouti et al., 2016). Centrality, also known as social network position (Lin et al., 2015), includes degree centrality, eigen centrality, reach centrality, betweenness centrality, etc. Previous studies on social network analysis have shown centrality metrics are related to learning ability, engagement, and performance (Banati & Arora, 2014; Cadima et al., 2010; Claros et al., 2015; Liu et al., 2016). However, studies on how centrality within a community includes students from diverse demographics are rare (Pearson et al., 2018).

Link analysis algorithms provide additional centrality measures for the network members (De-Marcos et al., 2016). Hyperlink-induced topic search (HITS) (Kleinberg, 1999) computes two separate values for each individual: hub weight and authority weight. HITS is an iterative algorithm in which a good hub represents a page pointing to many other pages, while a good authority means a page linked by many different hubs (Manning, 2008). Hub weight and authority weight are correlated (Rose et al., 2014) and were used to model students' engagement and interactions in MOOCs (Yang et al., 2013) and predict attrition behaviors (Rose et al., 2014). Deborah et al. (2019) discussed differences between hub, authority and centrality metrics and stated that people with high centrality values are more likely to be "spreaders" while those with high hub values more likely to be "writers" and those with high authority values are more likely to be "influencers". In table 1, some commonly used centrality metrics, hub, and authority weights are summarized.

Previous studies have used SNA to measure community inclusiveness (Scott, 2000; Garcia et al., 2008; Pearson et al., 2018). Scott (2000) proposed the network inclusiveness index (i.e., the proportion of network members interacting with other members). However, this global index cannot provide more detailed information on community inclusiveness regarding multiple demographic factors (gender, ethnicity, age, etc.). More recently, Garcia et al. (2008) and Pearson et al. (2018) addressed this issue by summarizing the degree centrality levels between groups with different demographic factors to analyze the community inclusiveness of gender and ethnicity.

Table 1: Network metrics calculation and meaning

<i>Network metrics</i>	<i>Calculation in this study</i>	<i>Meaning</i>
Degree centrality	Sum of in-degree and out-degree interactions (Golbeck, 2005)	A node's activeness
Eigen centrality	Calculated by eigenvalue of network matrix	The prominence of a node considering the neighbors (Marbouti et al., 2016).
Reach centrality	the number of other nodes a node can reach directly	The direct influence of a node on its neighbors

Betweenness centrality	the number of these shortest paths that pass through the vertex	direct or indirect influence a node has on other nodes (Freeman, 1997)
Hub weight	HITS algorithm (Kleinberg, 1999)	Quality of links of an individual
Authority weight	HITS algorithm (Kleinberg, 1999)	How valuable the information of a given individual is

Research Questions

As summarized in the literature review, there is limited research on creating and analyzing inclusive social media-based learning communities. In order to build an online inclusive learning community, this study, informed by CoP and SLT, engaged students with diverse demographic characteristics (i.e., gender, ethnicity), degree programs, and learning locations in sharing and commenting on posts concerning environmental psychology concepts and individuals' surrounding environments on Instagram. Network analysis was employed to measure the interaction patterns of community members, to assess whether the online learning community was inclusive for all members regardless of their different demographic characteristics and locations. To understand the inclusiveness of the designed social media-based learning community, we asked the following research questions:

RQ1: Does the centrality of students of different genders, ethnicity, degree programs, and learning locations in the interaction network differ?

RQ2: Who (i.e., gender, ethnicity, year of school, location) became hubs and authorities in this community? What are the characteristics of their profiles and posts?

RQ3: What did students think of the inclusiveness of their online learning community?

In the hypothesis of RQ1, we argue that in inclusive education, gender, ethnicity, year of college (approximation of age), program, and location of study should not determine students' interaction with other community members (e.g., interaction being measured using centrality, hubs, authorities) in their learning community. In other words, centrality means should not be significantly different between different characteristic groups. Similarly, in the hypothesis of RQ2, we did not expect demographic factors would be the main reason for becoming hubs and authorities. We did not have a hypothesis of RQ3 before analysis.

Methods

This section first summarizes the characteristics of participants and then describes the research design and context. Finally, we describe how participants' posts, posting behavior, and interview data were collected and analyzed to answer the research questions.

Participants

The participants of this study were undergraduate students who took the *Introduction to Environmental Psychology* course open to students from all majors (e.g., social sciences, engineering, and life sciences) and all years of study in a private university in the USA in 2020. 365 students enrolled in this course, and 115 participated in the online learning community component through Instagram. However, as some participants changed their Instagram ID or canceled their accounts, the postings of 68 participants remained accessible when we collected the data one semester later. Therefore, the final sample size of this study is 68. Table 2 shows the participants' characteristics. Most participants were

in the US when taking the course, whereas seven international students were in Asian countries like China, Korea, and India.

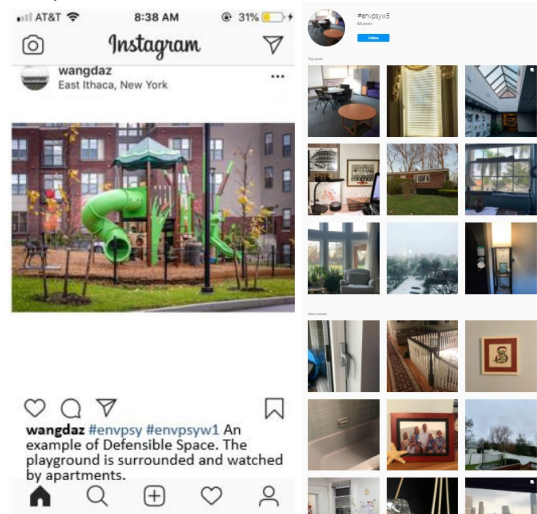


Figure 1: A post example and a screenshot of a typical week's posts

Table 2. Summary of participant characteristics

Gender		Year of school					Location		
Male	Female	Freshman	Sophomore	Junior	Senior	On campus	Off-campus	Outside the US	
N	28	40	23	23	13	9	13	48	7

Note: "On campus" means students located on campus or in the town of the campus; "off campus" means students located in the US but outside the university town.

Course and community design

The course was delivered through Zoom due to the COVID-19 lockdown. Students from different locations took two lectures each week over eight weeks. To foster an inclusive learning community, we created a photo-sharing community around course topics (i.e., home, city, work, and earth) through Instagram. The design of this community was guided by the three elements of CoP: domain, community, and practice (Wenger, 1998). In the community, participants from diverse physical surroundings and with various personal traits could introduce their physical surrounding environments, cultures, attitudes, and lifestyles by completing their weekly tasks. They were encouraged to browse peers' posts and give "likes" and comments to create a community as a "social fabric of learning" (Wenger, 1998, p29). When participants took photos of their surrounding environments or searched for inspiration from their albums, they "practiced" what they learned in lectures and shared understanding with other community members.

Figure 2 describes the conjecture mapping diagram (Sandoval, 2014) of this study. The embodiment articulates its reification in features of learning environment design which includes how tools, materials, tasks, discursive practice, and participants' structures were considered systematically in the study design. In our designed community, all participants could share photos of their surrounding environments and comment on the photos using environmental psychology knowledge they learned in weekly lectures (e.g., human

environmental relationship processes). For example, in week 3, the instructor discussed definitions, theories, and factors related to "homeyness" and personal space. Then participants posted photos from their surrounding environment on these concepts and briefly explained the posts. This way, the participants could apply their knowledge to real-life, familiar contexts. Mediating processes were enabled by design features in embodiment and intended to produce desired outcomes (Sandoval, 2014). In this study, interaction networks and post content were observable interactions between participants, which can also be analyzed to understand whether the desired outcome-inclusive community was achieved.

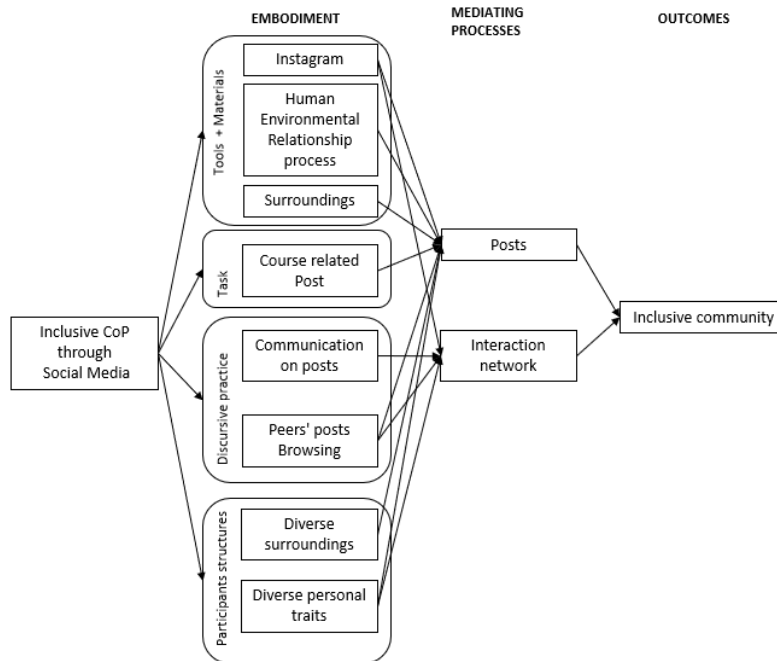


Figure 2: Conjecture map of the learning community design

In the first four weeks of the study, we did not require every participant to make their Instagram accounts open to help them become comfortable with the project. At week 5, all participants were required to make their accounts open to the public and were encouraged to comment/like their peers' posts. This study focused on analyzing data collected in the last four weeks.

Data collection

This study had three main data sources: (1) participants' demographic and contextual characteristics such as gender, ethnicity, year of school, and location of study; (2) 252 posts published by the 68 participants and their 452 times of interaction, including "like" or "comment" between each post, in the last four weeks of the project via Instagram; (3) 22 semi-structured interviews of participants to understand participants' experience in the community. These interviewees were selected from 41 volunteers who indicated a willingness to participate in the interviews based on forming a representative sample in terms of students' location, gender, and study program.

The interviews were conducted via ZOOM meetings individually. Before the interviews, all 22 participants consented to the conversation being recorded. Each interview

lasted from 15 to 20 minutes. In the first part of the interview, the interviewee was asked to recall their most recent post in this project, describe the topic, and explain why and how they chose the specific photo to post. We then asked them whether and how this project influenced their learning experience, using questions like "How do you feel when you see others' posts?" and "How do you feel when others comment on your posts?".

Data analysis

Social network analysis

To respond to RQ1 regarding the social network centrality of students of different genders, ethnicities, years of school, programs, and locations of study, we conducted the social network analysis using the *igraph* package (Csardi & Nepusz, 2006) in R (Ihaka & Gentleman, 1996). The network visualization was rendered using Fruchterman Reingold algorithms (Fruchterman & Reingold, 1991), a widely-used force-directed layout algorithm. We visualized the networks to show the overall interactions between participants.

To respond to RQ2, we calculated hub and authority weights through a hyperlink-induced topic search algorithm (Kleinberg, 1998). In this study, hub and authority weight were adopted to represent the participation and influence of each participant.

Qualitative analysis of interview transcripts

To respond to RQ3, we interviewed 22 voluntary participants. They had diverse backgrounds: learning from different locations, and having different ethnicities, genders, year of school, and program backgrounds.

We used a grounded theory approach (Strauss & Corbin, 1997) to analyze the interview data. After transcribing audio recordings, we imported them into Atlas.Ti, a qualitative data analysis software to code and synthesize data to answer RQ3. Two researchers created the interview protocol and did the first round of open transcripts coding by assigning codes to important instances. Then, two coders sat together and compared codes, and then merged similar ones (different in wording) into a consistent name such as "sense of belonging," "commenting on others' posts," "browsing others' posts," and "showing personal lives."

Results

Descriptive statistics

We did not find substantial variations between weeks regarding basic metrics (e.g., edges, density, transitivity). Therefore, we treated the four weeks as repeated tests and summed all interactions in the total network. The total network had 452 links between nodes, including 288 likes and 164 comments. Figure 3 includes two representative network visualizations. The graph on the left is a simplified visualization showing that nodes plotted in the peripheral of the network lacked links to other nodes, while nodes plotted in the central part linked densely with other nodes. In the right graph, the colors of nodes represent gender, the size indicates the eigen centrality, and the thickness of an edge shows interaction times. The graph did not show obvious centrality patterns in terms of gender. Similarly, we did not find apparent patterns regarding location or ethnicity.

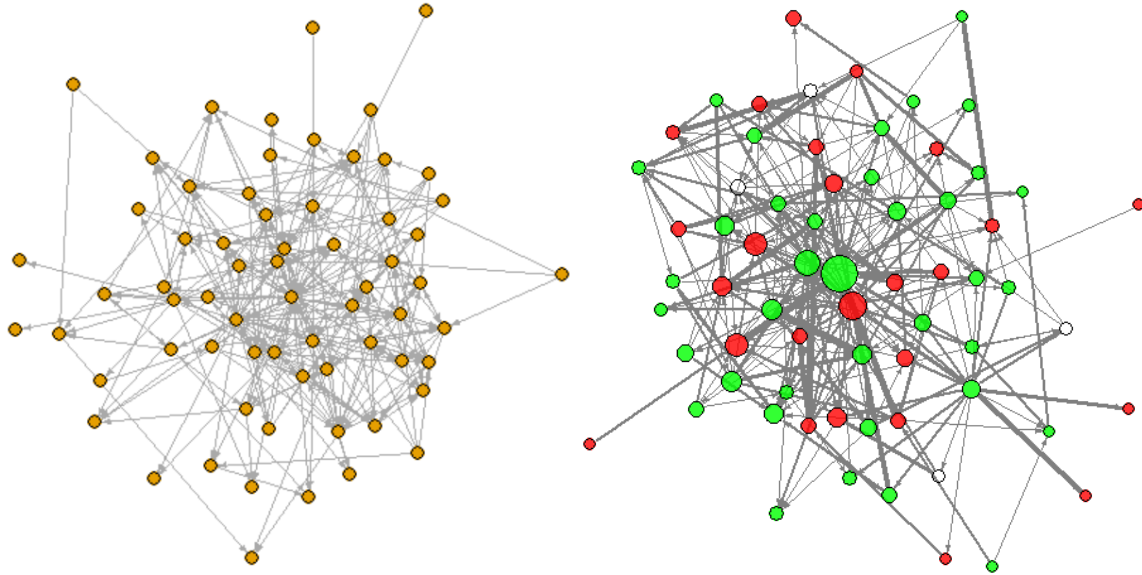


Figure 3: left: simplified network visualization in total; right: node size represents eigen centrality value, node color represents gender, weight thickness represents interaction times.

Response to RQ1

Table 3 shows that participants with different ethnicity, gender, and program did not significantly differ in any of the centrality metrics. This result suggests that the community was inclusive regardless of community members' ethnicity, gender, and program because these demographic factors did not significantly influence participants' interactions with peers in the network. In contrast, participants learning at different locations (i.e., on campus, off campus, outside the US) had significant differences ($p < 0.05$) in terms of all centrality metrics. Tukey's post-hoc analysis (Pereira et al., 2015) suggests that the participants learning off-campus within the US had significantly higher centrality metrics than participants learning on campus or outside the US. However, it should be noted that the significance is not robust (Huber, 1981). After excluding two outliers determined by the 1.5 IQR rule (Tukey, 1977) located off campus within the US, the relationship is no longer significant. Concerning year of school, some centrality metrics (i.e., eigen-centrality, reach centrality, hub weight, and authority weight) were marginally different ($p < 0.1$) in different years of school. Post-hoc analysis shows that freshmen and seniors were more influential in the network than sophomores and juniors, and this relationship is robust. For example, the relationship between year of school and authority weight is even intensified ($p < 0.05$) after excluding outliers by Tukey's IQR rule (Tukey, 1977). MANOVA analysis (Keselman et al., 1998) between the year of school and all these centrality metrics shows the same result ($F = 1.91, p = 0.02$), and its post-hoc analysis indicates that freshmen and seniors have different centralities from other participants.

Table 3: ANOVA test results of centrality metrics

	<i>Location</i>	<i>Ethnicity</i>	<i>Gender</i>	<i>Year of school</i>	<i>Program</i>
Degree	0.02**	0.94	0.61	0.14	0.93
Eigen	0.04**	0.95	0.85	0.06*	0.91
Betweenness	0.03**	1.00	0.50	0.38	0.89
Reach	0.04**	0.78	0.61	0.09*	0.89
Hub	0.04**	0.95	0.85	0.06*	0.91
Authority	0.04**	0.95	0.85	0.06*	0.91

** $p < 0.05$, * $p < 0.1$

Response to RQ2

Table 4 also shows the demographic information of the selected common hubs and authorities to indicate who tended to become hubs and authorities. The HITS algorithm (Kleinberg, 1998) calculated each hub weight and authority weight. In this community, hubs are those who give likes, and comments to peers frequently, especially to top authorities; authorities are those who receive peers' likes and comments often, especially from top hubs. We listed the top ten posters in hub weight and authority weight each week. Five participants repeatedly appeared in the top ten hub lists each week, and eight participants repeatedly appeared in the top ten authority list each week. As shown in Table 4, we selected five authorities among the eight, so both lists had five participants. Two participants were both hubs and authorities. This result is not surprising because hubs and authorities are highly correlated because of the HITS algorithm (Golbeck, 2005), and the participants who commented or liked others were more likely to receive others' comments and likes.

These top hubs and authorities identified from the algorithm include two outliers (participants A and E) in the previous analysis. These top hubs and authorities had diverse personal traits like gender, year, location, ethnicity, and program. In this section, we separately summarize the Instagram profiles and content posted by hubs and authorities and show how this content helped foster a greater sense of community and enhanced inclusiveness.

First, by comparing their profiles (Figure 4), we found that top authorities had many followers and took on profile strategies to attract others in the learning community. Hubs, however, generally had fewer followers and did not necessarily have more followings. Participant A had 66 followings, meaning he almost followed all the members in this community and gave likes or comments to more than ten members, including top authorities, weekly. Participants B and C are also on the list of the top hubs, mainly because they actively interacted with top authorities. They did not have considerable followings or followers. Most authorities, however, had many followers. Another noticeable point is that most authorities added a link on their profile page to their personal Instagram account with hundreds or even thousands of followers (participants D, E, G and H). This connection led other community members to explore the authorities' personal lives outside the course community. This may explain why authorities had more followers than their peers. It also

indicates that these participants are experienced on Instagram and may have strategies to post attractive and popular posts.

Second, by looking into the characteristics of these posts, we found that authorities' posts contained multiple social cues. One major difference between hubs and authorities was that authorities' posts include more social cues. In social media, voluntary self-disclosure information can serve as a social cue, indicating an eagerness to communicate with others (Jang et al., 2015). According to Social Information Processing Theory (SIPT), social cues include demographic information (i.e., age, gender, socioeconomic status, residence) or personal characteristics (e.g., appearance, mood, attitude) (Bordia, 1997; Walther & Parks, 2002). Most authorities' posts in our research had social cues, including their lifestyles (D), activities (D), favorite books (F), pets (E), selfies (D, E), or part of their bodies (H). Walther (2015) has asserted that based on SIPT, social cues increase the favorability of posts and others have noted positive relational outcomes, such as conversational effectiveness (Jang et al., 2015; Tidwell & Walther, 2002). For example, more than seven students commented on E's posts to express how lovely and cute her cat was. This post expanded the concept of environmental psychology to animals and deepened their understanding of the concepts being taught in this session of the course.

Table 4: Demographics of top hubs and authorities in the community

<i>Poster</i>	<i>Gender</i>	<i>Year</i>	<i>Location</i>	<i>Ethnicity</i>	<i>Followers</i>	<i>Following</i>	<i>Hub</i>	<i>Authority</i>
A	M	1	Off-campus	Asian	17	66	0.50	0.03
B	F	2	On campus	White	4	1	0.31	0.01
C	F	4	Off-campus	White	4	0	0.24	0.13
D*	M	2	On campus	White	26	28	0.39	0.48
E*	F	1	Off-campus	White	23	51	0.25	0.43
F	M	1	On campus	White	6	1	0.16	0.44
G	M	2	On campus	White	20	1	0.07	0.48
H	F	4	Off-campus	Asian	52	37	0.12	0.63

** D and E are both top hubs and top authorities.*

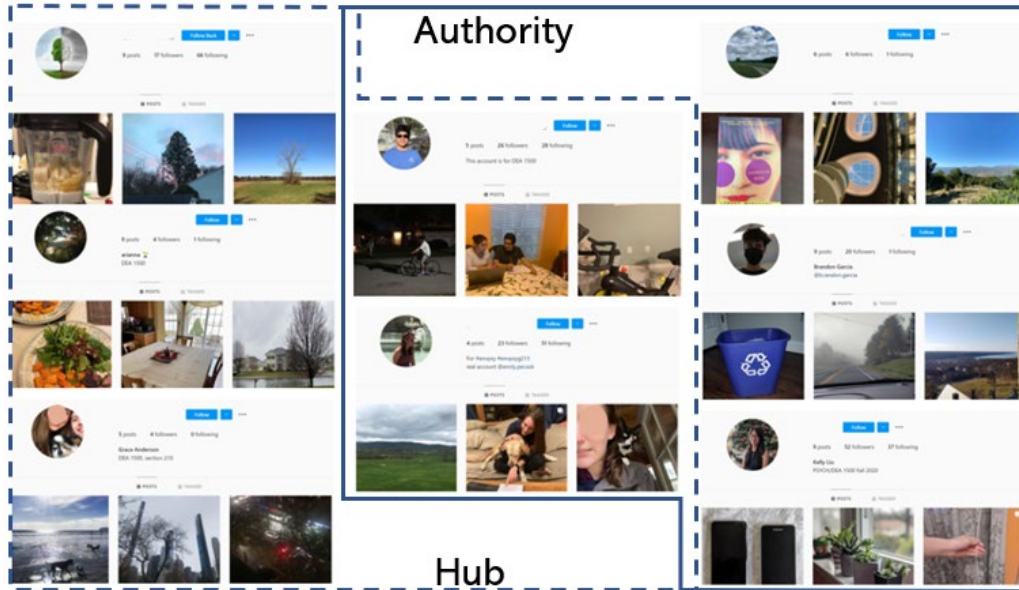


Figure 4: Posting screenshots of top authorities and hubs. From top left to bottom right are posts from A, B, C, D, E, F, G and H in Table 4.

Response to RQ3

The following themes emerged from the interview transcripts concerning students' perceived inclusiveness of their online learning community: belongingness to the community, helping interpret concepts they learned, and introducing their culture to others. Participants had various ways to perceive a sense of belonging: (1) by browsing content that induced shared identity, participants felt that they were not alone; (2) by commenting on others' posts, participants felt connected and started building relationships with those who had similar interests. (3) by posting content that showcased who one was as a unique person and where they lived, participants got to know each other's "lives" better. As a result, they enhanced a sense of belonging attached to the course community.

First, when participants found posts that reflect shared identities, the sense of belonging was reinforced. An identity shared by all the participants was they all belonged to the same university, which not only helped first-year students feel they belonged by seeing the campus-relevant posts from more senior students but also reminded more senior students of the time there were physically together on campus. One first-year student (P4) mentioned that even though he could not physically come to the school for the first semester, looking at senior students' posts showcased the campus gave him a sense of belonging. He was excited to go to school and visit those places others posted after the pandemic:

"I am a freshman and have never come to the campus before... skimming through like all the posts and seeing what our classmates are doing. I felt like I was on campus when I saw my classmates' posts." (P4)

Similarly, all interviewees agreed that a sense of belonging could be triggered when others posted similar content, such as objects and metaphors. Participants reflected that seeing others post those photos reminded them of good memories during pre-pandemic times when they could go to libraries and cafes together. *"It is so interesting to see different*

people take a photo of the same place, like the tower on campus. It reminds us of a great time of being together under the tower physically" (P6).

In addition to this university-wide shared identity among all students, some other types of identities or memberships that triggered a sense of belonging included: being in the same interest club, the same registered class, and even close-by apartment buildings. One participant said she discovered another classmate who was in the same yoga club by reading a post where the classmate was practicing meditation in the same activity room. They started a chat after learning that.

"I was like, oh, she is also in the same club as me! It's a pretty large club for yoga and meditation, and before pandemic we had a lot of off-line time together practicing. COVID changed many things; now the instructor is online, and I did my practice in my bedroom. It is just so funny to see someone is having the same experience as me!" (P18)

Second, Instagram functions such as like, comment, share, and direct messages facilitate the formation of a sense of belonging. We observed that with the progress of this project, a growing number of participants started commenting and liking each other's content. Most of the public comments underneath the posts were encouraging and positive. One participant mentioned that he felt "a sense of connection, especially feeling closely bonded with others" (P4) after receiving Instagram notifications on his phone. Another respondent mentioned, "in the pandemic, interaction with course classmates is really important" (P1). Approximately half of the interview participants (10 out of 21) said that they interacted with the comments they received.

However, a few interviewees expressed moderate to low expectations of receiving feedback. Especially for task-based Instagram postings, they perceived that comments were "not required in the activity" (P7). Future work can examine potential methods to increase engagement among this specific group of participants.

Hashtags also played a vital role in helping participants rapidly locate the content they were looking for. Searching a commonly used hashtag made participants feel like they "operated within a community" (P20). Browsing content posted by others also provided opportunities to learn from each other to understand course materials better. For example, one respondent 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:

"If I got stuck on something, I would look at other people's posts, just to see how they were applying the principles for the post, and then it would encourage me to think as they did." (P4?)

Lastly, posting Instagram photos allowed respondents to invite other fellow participants to know more about the environment in which they lived. The environments ranged from the bedroom or the apartment the respondent lived in (indoors) to outdoor areas and broader regions. For example, one participant expressed that she obtained a lot of "inspiration to decorate my apartment room" from others (P21) by looking at images posted by classmates. Another participant mentioned that he was able to discover others' locations through geo-tags in Instagram posts. He expressed that he was grateful to see much natural beauty in a centralized location under the unique hashtag for each class.

"That's amazing because I always wanted to visit Hawaii. He took a lot of photos of quiet beaches, and they are so beautiful! The most exciting thing, next to this picture,

it's another picture of a mountain – this class makes me feel like I'm traveling around the world" (P12)

In this interview study, two international students stayed in their home countries due to travel restrictions. They turned this project into an opportunity to introduce their cultures and unique environments to classmates. Their posts were among the most popular content and led to a handful of insightful discussions. For example, a student in Shanghai took photos of alleyways with mixed commercial and residential areas to show how “new urbanism” works. This post led to discussions about what caused this mixed pattern. Some students listed the advantages of this “new urbanism” while others doubted if this brought comfort and good experiences to people living there. The instructor also used those international students’ posts in lectures to introduce new concepts. One of the participants reflected that:

"I think it's cool to see other people's examples and especially from those who are still living outside of the country. It is cool to see their examples and see different environments." (P4)

Discussion and conclusion

This study examined whether we could create an inclusive Instagram-based learning community for students with different demographic characteristics and study locations by supporting students sharing identity and contextual diversity through posting and discussing their surrounding environments and environmental psychology concepts. We found that participants with different ethnicity, gender, locations, and programs did not significantly differ in their centrality in the social network, indicating the inclusiveness of the learning community because none of the demographic factors could determine participants' centrality within the network. This finding well aligns with what is advocated in inclusive education literature: that we should embrace difference and diversity in terms of gender, race, and socioeconomic class (Borson, 2017; Liasidou, 2012). The contributions from students with different backgrounds can help community members understand things from different perspectives and advance their community knowledge (Scardamalia, 2002; UNICEF, 2021).

The hub and authority analysis results further confirmed that participants with different demographic characteristics were all likely to play active roles in the learning community or be accepted by other community members. The Instagram project not only allowed the participants to post their surrounding environments and describe their relationships with places, but also enabled them to disclose who they were to their peers in the learning community. The most influential participants tended to express their identities by social cues such as posting their lifestyles, pets, and activities. Identity is a label we use to define, describe, and locate ourselves, and we filter information according to our identities (Clayton, 2012). Some identities like ethnicity are fixed, while some (e.g., environmentalist) can change over time. This project allowed participants to demonstrate different identities. By posting personalized content, students delivered underlying messages about who they were, and this might enhance the inclusiveness of the community. Like a participant said, *"Looking at these posts like I am reading a story, and I really enjoyed that!"* (P1). Similarly, Bellino and Adams (2014) found that photo-voice and mental mapping approaches adopted in a participatory urban environment course allowed

marginalized racial and ethnic students to describe their experiences and view a community as a dynamic and socially constructed space.

We also found that location and year of school were correlated with centrality metrics. First-year students and students who lived outside the campus were more likely to be active and involved in this community. One possible explanation is that these students had more social needs to connect with peers. For instance, in the interviews, P4 and P7, who were both freshmen and lived outside the campus during the course, expressed their desires to "meet their classmates in person." Other factors such as students' perception of social media, different levels of social needs, and various personalities might also influence their centrality. For instance, some low-level centrality participants did not consider "like" or comments on each other's posts as necessary or meaningful. Furthermore, participants' authority and involvement were not related to who they were but to what they posted (e.g., how they expressed themselves). Taken together, we can see that the students' activeness and involvement were not related to most demographic characteristics (RQ1 result) but related to the students' choices of content and posting skills (RQ2 result) as well as students' social needs (RQ3 result), indicating the inclusiveness of the learning community.

It is worth clarifying that "equal participation" does not indicate inclusive educational values. In this study, inclusiveness means that participation patterns—measured by centrality and authority scores in the community interaction network—have no significant correlation with demographic factors such as ethnicity, gender, and program. However, in a learning community, it is common to have some more active, engaged, and influential students and some less active ones. How to improve the participation of these low-centrality students is an interesting topic and worthwhile to explore in future studies.

Implications and limitations

Implications

This study explored creating and analyzing an inclusive community through social media. The findings provide several implications. First, this study implies that an online learning community can afford those with more social needs and a greater willingness to present their identities (e.g., first-year students) and share their stories. This is particularly important when physical meetings are not available. Second, this study indicates that the expression of their identities matters to students' influence and acceptance. Accordingly, teaching assistants (TAs) and course instructors may consider designing activities to help students express their identities through posts. For example, TAs may request that students describe the stories associated with their posts, select these posts, and make an album weekly. The album may enhance participants' interest and improve their engagement in the community. Third, the interviews suggest that participants perceived a sense of belonging from browsing others' posts. However, Instagram algorithms rank most highly the recently received posts with more "likes" and comments. This ranking is not an ideal way to encourage the participation and involvement of all community members. Therefore, future research might seek to build a learning platform that ranks posts differently to make new posts or posts with fewer likes or comments more visible. Finally, it might be worth considering how to encourage a deeper level of interaction by developing course-relevant scaffolding to support students' comments.

Limitations

This study has some limitations in data collection, analysis, confounding factors, and scope of inclusiveness. First, the study may have a self-selection bias because the participants decided to participate or withdraw voluntarily. Not all data from the 115 students participating in the Instagram project were collected because some participants canceled their accounts or changed their account names after the project, which left 68 participants as the final sample size of this study. However, the 68 participants' demographic characteristics were diverse and allowed us to explore the inclusiveness of the learning community. Second, we applied a hub and authority algorithm initially developed for webpage ranking. It is noted that this algorithm dramatically increases the weight value of a node if it is linked by another node with a great hub or authority value. This may cause some bias when we determine the authorities and hubs. Third, a few students knew some others, so the community was not built from scratch, which might raise the concern of the generalization of creating such a community in other contexts. Lastly, this study defined inclusiveness as students' participation and network position unrelated to demographic factors such as gender, age, program, and learning location. Future studies can take group members' diverse ideas and opinions into consideration when studying the inclusiveness of online learning communities.

Statements on open data, ethics, and conflict of interest

Data and R scripts used for supporting study results are available from the corresponding author upon request.

This study was approved by the IRB of Cornell University (Protocol ID#: 2009009798). Identifiable data were removed by researchers, and the data analysis was performed after identifiable data had been removed.

The authors have no conflicts of interest to declare about this work.

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