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Online professional development for environmental educators: strategies to foster critical thinking and social interactions

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ABSTRACT

Massive open online courses (MOOCs) offer opportunities for professional development of environmental educators globally, yet we lack understanding of participantsTM cognitive and social learning processes and of how instructors can enhance these processes. Based on the Community of Inquiry framework, we used a survey and coded participant discussion board and Facebook posts to examine the cognitive, social, and teaching presence in the Environmental Education: Transdisciplinary Approaches to Addressing Wicked Problems MOOC, offered by Cornell University. Rather than train educators in a specific curriculum, the goal of the MOOC is to expand educatorsTM critical and transdisciplinary thinking about the field of environmental education and to enhance social interactions to support learning, educators, and knowledge co-creation. Results indicate that cognitive presence is higher on the discussion board whereas social presence is higher on Facebook. Over half of cognitive posts focused on exploration, a lower level of learning, whereas just less than a fifth reflected higher level integration, suggesting room for enhancing cognitive learning. Our results suggest strategies to encourage higher levels of thinking and more meaningful social interactions to foster learning, educator support, and co-creation of knowledge, thereby improving online professional development.

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Introduction

In response to charges of bias and lack of a scientific basis leveled against environmental education (EE) in the US, professional development became a major focus of EE starting in the 1990s. For example, the North American Association for Environmental Education led a 20-year process of developing and training educators to use guidelines for excellence (Marcinkowski 2009) and additional professional development efforts focused on place-based (Meichtry and Smith 2007; Linnemanstons and Jordan 2017), Project Learning Tree (McConnell and Monroe 2012), and other EE and Education for Sustainable Development initiatives (Whitehouse 2008; Mulà et al. 2017; Ateskan and Lane 2018). Wesselinck and Wals (2011) proposed that environmental educators develop professional competencies in instruction, program leadership, and organizational management, whereas Wood (2001) called for examining how a program interacts with its pre-existing context to influence professional development outcomes.

In addition to instruction and materials, social interaction among educators is an important component of professional development in science and sustainable development education (Bell and Gilbert 1996; Pedersen 2017). Social interactions can facilitate understanding and co-construction of knowledge, which is critical in environmental and education fields that address “wicked problems” whose resolutions require diverse perspectives (Krasny and Dillon 2013). Further, social interactions during professional development can build networks to support educators facing difficult situations, including the daily work of teaching about an environment increasingly threatened by development and climate change (Fraser and Brandt 2013). In a study assessing social dynamics in an online EE professional development course, Li, Krasny, and Russ (2016) found that student–student interactions were associated with motivation to learn, instructor–student interactions appeared to facilitate students communicating with each other, and student–content interactions were associated with motivation to learn, intent to adapt ideas, and adapting ideas into practice. A study of a sustainable energy online course for in-service teachers found limited social interactions, which the authors attributed to the relatively small number of course participants (Kaul, Aksela and Wu 2018).

As professional development moves online to save time, money and fossil fuel use, and to take advantage of new technologies, the question arises of how online environments can provide opportunities for cognitive and social learning and peer support. Although massive open online courses (MOOCs) are often viewed as one-way delivery of content, in fact many incorporate student discussions through course discussion boards. However, students often find it difficult to engage in meaningful interactions through course discussion boards, and thus MOOCs have turned to Facebook and other social media that are familiar to students and readily lend themselves to student discussion and sharing (Kellogg, Booth and Oliver 2014; Margaryan, Bianco and Littlejohn 2015; Laurillard 2016). Importantly, when social learning is incorporated into MOOCs, which generally include students from 50 to 150 countries, students have the opportunity to learn from peers representing a diversity of cultural perspectives and experiences.

MOOCs offer a number of advantages over face-to-face professional development (Dede 2006; Wiske, Perkins, and Spicer 2006). For example, pre-recorded lectures and online asynchronous discussions provide opportunities to explore resources, reflect, and compose discussion posts on one’s own time, thus reducing performance pressure and avoiding classroom discussions dominated by a few individuals. Participants in online learning also can decide which lectures, readings, and other resources to engage with, in effect creating a personalized learning environment (Trust 2012; Dede et al. 2016). However, learning in MOOCs can be hampered by students experiencing social identity threat (i.e., feelings of inadequacy especially among students from developing countries, Kizilcec et al. 2017), language differences, and lack of familiarity with dominant western pedagogical approaches (Jung and Gunawardena 2014; Nkuyubwatsi 2014). Means of addressing language and cultural issues include discussions on social media, project-based learning in which students adapt MOOC content to local contexts, and hybrid learning in which local groups meet in person, often with a mentor, to discuss MOOC content (Whitehouse 2008; de la Varre, Keane, and Irvin 2011; Bartholet 2013; Nkuyubwatsi 2014). For example, in the MOOC that is the subject of this paper, students from Iran were initially reluctant to share their ideas for fear of what students from other countries might think of them, but eventually posted online their final projects applying the course content to ecotourism in Iranian villages (Krasny et al. 2018). Essential to the Iranian students’ accomplishments was support from a volunteer local group leader, who was fluent in Farsi and English and who organized face-to-face meetings of MOOC students in Tehran.

Previously, Krasny et al. (2018) examined in-depth interactions in MOOC hybrid learning local groups for environmental educators. In this paper, we use the empirical case of a MOOC that enrolled over 2000 professionals and university students (*Environmental Education: Transdisciplinary Approaches to Addressing Wicked Problems*) to investigate the learning processes within the course discussion board and Facebook group. Our overall goal is to enhance our

understanding of how to design online EE professional development that incorporates not just content, but also critical thinking and social interactions. Our research questions are guided by the community of inquiry (COI) framework, perhaps the most prominent and well-cited model for online learning (Peacock and Cowan 2016). The COI recognizes that learning is a “social enterprise” (Garrison 2013, 2) and suggests that online learning occurs as the result of the interaction of cognitive, social, and teaching processes or “presences” (Garrison, Anderson, and Archer 2000). Our specific research questions are: (1) What types of cognitive, social, and teaching presences are demonstrated by participants in an EE professional development MOOC? (2) How do these presences differ in the online course discussion board and course Facebook group?

To place our study in the broader context of interactive learning (Illeris 2007; Wals, van der Hoeven, and Blanken 2009), our literature review begins with a discussion of social processes in online courses and learning communities, following which we introduce the elements of the COI framework. After presenting our results from applying the COI model to our MOOC, we discuss how an understanding of cognitive, social, and teaching presence can be used to guide online professional development. We focus in particular on professional development that recognizes the importance of social interaction for the purposes of providing peer support, supporting cognitive learning, enabling knowledge co-construction, and generating and sharing innovations in EE practice.

Theoretical background

Since its inception, online professional development has sought to incorporate constructivist and social learning approaches. For example, before the widespread adoption of content-driven MOOCs by Stanford, Harvard and other elite universities (xMOOCs), Canadian universities developed connectivist MOOCs (cMOOCs) that created an open online environment where individual learners could access resources and create their own learning trajectory (Cormier and Siemens 2010; Stewart 2013; Saadatmand and Kumpulainen 2014). Whereas small online courses have been used in EE professional development since at least the late 1990s (Midoro et al. 1998), today, online professional development across multiple fields encompasses small online courses and MOOCs, incorporates project-based learning (Whitehouse 2008; Lin et al. 2013), and emphasizes social learning in the form of learning communities and networks that use Facebook, Twitter, and other social media to foster discussion, reflection, and sharing resources among participants (Kellogg, Booth and Oliver 2014; Carpenter and Krutka 2015; Macià and García 2016; Trust, Krutka, and Carpenter 2016). In addition to online courses, online learning communities (or communities of practice) emphasize collective activity including co-creation of artifacts useful to other educators (Hammond 2017; Jeong et al. 2017), and online teacher professional learning networks that enable educators to pick and choose resources and thus play an active role in designing their own professional development (Trust 2012; Macià and García 2016; Trust, Krutka, and Carpenter 2016). MOOCs, online learning communities, and online networks are asynchronous yet enable quick responses to inquiries or requests for resources, and allow teachers to expand and diversify the professionals with whom they interact and from whom they learn, to access new resources, and to reflect on their practices as a result of writing and receiving feedback (Macià and García 2016).

Drawing on constructivist, collaborative, and inquiry learning theories (including the work of John Dewey), Garrison, Anderson, and Archer (2000, 2010) developed the COI as a conceptual and analytic framework to guide the design and understanding of the processes of online learning. COI emphasizes the social environment as a critical facet of inquiry and conceptualizes student and teacher interactions in the context of asynchronous discussions in MOOCs (Peacock 2015). A COI is defined as “a group of individuals who collaboratively engage in purposeful

critical discourse and reflection to construct personal meaning and confirm mutual understanding” (Garrison 2011). Although designed to understand learning processes rather than predict learning outcomes (Garrison, Anderson, and Archer 2010), COI provides a framework to assess levels of learning and social interaction, and thus provides insight into student cognitive and social learning outcomes in online courses.

Three interacting and reinforcing “presences”—cognitive, social, and teaching—form the core of a COI, contributing to a collaborative learning environment where individuals construct their understanding of the course content within a community of learners (Akyol, Garrison, and Ozden 2009). Cognitive presence is defined as “the extent to which the participants in any particular configuration of a COI are able to construct meaning through sustained communication” (Garrison, Anderson, and Archer 2000, 89), and drawing on the work of John Dewey, includes four phases of practical inquiry: triggering event (a problem, issue, or dilemma to spark thinking and discussion); exploration (brainstorming, questioning and exchange of information with fellow students); integration (co-construction of meaning); and resolution (applying what has been learned by means of direct or vicarious action). The latter two phases require significant teaching presence and are difficult to achieve in face-to-face as well as in online environments (Garrison, Anderson, and Archer 2001).

Social presence is defined as “the ability of participants in a COI to project themselves socially and emotionally, as ‘real’ people (i.e., their full personality), through the medium of communication being used” (Garrison, Anderson, and Archer 2000, 94). It includes emotional expression (ability and confidence to express feelings related to the educational experience), open communication (which incorporates reciprocal and respectful exchanges including mutual awareness and recognition of others’ contributions), and group cohesion (activities that build a sense of group commitment, Garrison, Anderson, and Archer 2000). These interactions serve multiple purposes in both online and face-to-face learning, including providing opportunities to exchange ideas about course content, to co-construct knowledge and generate innovative practices, and to develop trust, a feeling of being part of a community of learners, and an identity as a learner in a vast community of students and professionals (Macià and García 2016; Kizilcec et al. 2017; Macià and Garcia 2017). In these ways, social presence can reinforce cognitive presence (Peacock and Cowan 2016) and help provide the emotional support that enables environmental educators to persist in their difficult work (Fraser and Brandt 2013).

Finally, teaching presence is the design and facilitation of the educational experience “to support and enhance social and cognitive presence for the purpose of realizing educational outcomes” (Garrison, Anderson, and Archer 2000, 90). It includes design and organization of the learning experience, facilitating discourse during the course, and direct instruction during the course such as identifying student misconceptions, sharing resources to address student interests, and summarizing discussions (Akyol, Garrison, and Ozden 2009). Although one can use similar methods (e.g. content analysis, surveys) to assess cognitive, social, and teaching presences during a course, the presences differ conceptually and in their uses. Whereas assessing cognitive and social presence provides an indication of the types of learning and interactions that are occurring, teaching presence influences cognitive and social presence and thus is of primary concern in course design.

Several authors have critiqued the COI framework, claiming it suffers from a weak theoretical foundation and limited ability to capture factors related to course design, metacognitive and other important outcomes and learning processes, the role of learner self-regulation and other learner characteristics, and the influence on student outcomes of the interaction among presences (for a review, see Peacock 2015, Peacock and Cowan 2016, Kaul, Aksela, and Wu 2018; Kozan and Caskurlu 2018). While arguing that the parsimony of the three presences and their interactions is important to the framework’s usefulness as a tool for designing and assessing online learning, COI co-originator Anderson (2016) does pay heed to the need to incorporate learner agency into the framework. Incorporating learner agency would enable online course designers

to capture the multiple ways in which learners use online courses outside of those intended by course designers, such as to foster in-person and social media learning groups that continue beyond the lifetime of a course (Kozan and Caskurlu 2018).

Methods

We used a mixed methods approach integrating a survey to assess student perceptions of cognitive, social, and teaching presence (Arbaugh et al. 2008), and coding of student discussion board and Facebook posts for the three presences to provide insight into the complexity of the online educational experience (Garrison 2009). Discussion board and Facebook group posts represent the primary means of interaction among course participants and between course participants and instructors. Combining these two approaches enhances the validity of the analysis by allowing us to contrast self-report with transcript analysis of student data.

MOOC context: Environmental Education: Transdisciplinary Approaches to Addressing Wicked Problems

This research focuses on the 12-week *Environmental Education: Transdisciplinary Approaches to Addressing Wicked Problems* MOOC offered by Cornell University in Spring 2016, using the Canvas Learning Management System. The goal of the course was to create an EE “trading zone” (Galison 1999), or an online space where instructors, university students, and professionals learn about research from multiple disciplines that sheds light on how to change environmental behaviors and improve environmental quality. The course included 65 pre-recorded short lectures offered by scholars from 14 countries covering EE, communication, psychology, sociology, and governance. The course also promoted social learning through the discussion board, where students posted responses to assigned discussion questions and commented on each other’s responses; more open-ended discussions and sharing resources and practices on course Facebook, WeChat, Telegram, and KakaoTalk social media groups; and optional student-led community groups which met in person or shared ideas using social media (Krasny et al. 2018). Students also completed a final project that involved creating a case study applying the course content to a local EE program. Students who completed weekly discussion-based assignments were awarded an achievement certificate while those who also completed the course project earned an expert certificate.

Of the 3306 individuals who registered for the course, 2294 students from 140 countries entered the course site, 2355 joined the course Facebook group, and 1257 completed at least one assignment. Of students who registered for course, 15.4% earned the achievement certificate and 8.2% earned the expert certificate. Of the 304 students who joined optional community groups, 29.3% earned an achievement and 36.5% an expert certificate. These are relatively high rates of completion for MOOCs, in which some students enroll just to receive the resources with no intent of earning a certificate and others drop out during the course.

Data collection

Survey respondents included all participants who completed the course ($n = 487$, the COI survey questions were incorporated into a post-course survey required to earn a course certificate). The COI survey uses 34 Likert-scale questions inquiring the degree to which participants agree with statements about their experiences in the course pertaining to cognitive (e.g. “Course lectures increased my curiosity”); social (e.g. “I was able to get to know other course participants”); and teaching presence (e.g. “The lecturers clearly communicated course topics,” Akyol, Garrison, and Ozden 2009).

The sample for transcript analysis was drawn from any student who posted to the discussion board or Facebook group, whether or not they finished the course. Transcript analysis was conducted on 100 discussion board and 100 Facebook threads randomly chosen from dates throughout the 12-week course. These threads, including initial post and any replies, were the units of analysis for the portion of the study comparing cognitive, social, and teaching presences on the course discussion board and Facebook platforms. Over the course, students and instructors made 36,891 total posts on the discussion board and 3790 posts on Facebook. In the sample of 100 threads for the discussion platform, there were 85 replies, with the top number of replies per post being 7 and 47 posts having at least one reply. For the Facebook group there were 331 replies for 100 posts, with the top number of replies per post being 28 and 67 posts with at least one reply, not including “likes.”

Data analysis

Survey data are reported as mean Likert-scale response. The discussion board and Facebook coding is based on a slightly revised version of the COI framework (Akyol, Garrison, and Ozden 2009) including cognitive, social, and teaching presence. For social presence, we altered Akyol, Garrison, and Ozden’s (2009) codes to capture social interactions that we felt were relevant to learning in our MOOC and to forming a professional development learning community. In particular, we removed “emotional expression” and separated “group cohesion” into “facilitate network” and “facilitate discourse.” We also added the codes “sharing information,” “sharing event,” and “supportive comments” to capture common forms of social engagement we had observed in online EE learning environments. In addition, we slightly revised Akyol, Garrison, and Ozden’s (2009) teaching presence codes (for list of codes, see Table 1). Finally, to help us better understand cognitive learning, we coded the posts using the Revised Bloom’s Taxonomy

Table 1. Revised COI indicators for discussion board and Facebook Analyses (adapted from Akyol, Garrison, and Ozden 2009).

COI	Indicator	Description
Cognitive presence	Triggering events	Recognize problem/sense of puzzlement
	Exploration	Information exchange/discussion of ambiguities
	Integration	Connect ideas/create solution
	Resolution	Vicariously apply new ideas/critically assess solutions
Social presence	Support ^a (revised emotional expression ^b)	Write supportive comment re student (humor/self-discourse ^b)
	Open communication	Mutual awareness/recognition of each other’s contributions
	Share event ^a (Group cohesion ^b)	Post event that is locally accessible (Encourage collaboration ^b)
	Facilitate network ^a (Group cohesion ^b)	Facilitate students connecting with each other (Encourage collaboration ^b)
	Facilitate discourse ^a (Group cohesion ^b)	Facilitate group discussion by asking question and asking for feedback (Encourage collaboration ^b)
	Share information ^a (Group cohesion ^b)	Post resources or event universally accessible (Encourage collaboration ^b)
Teaching presence	Instructional design	Set curriculum, design methods/assessment
	Facilitating discourse	Create effective group consciousness
	Direct instruction	Assess discourse and efficacy of educational process
	Post resource ^a	Posts resource for all participants
	Support ^a Facilitate network ^a	Like or write supportive comment re student Facilitate students connecting

^aRevised/new indicator.

^bRelated (Akyol, Garrison, and Ozden 2009) indicator.

Indicators with no asterisks from Akyol, Garrison, and Ozden (2009).

(Anderson and Krathwohl 2001) for analyzing asynchronous online discussions (Hou et al. 2015, see Appendix A).

Two researchers (the first and third authors) first coded the same 20% of the text independently and then discussed discrepancies between their codes. This process was repeated until agreement was reached about codes that best captured data to answer our research questions and to ensure consistent coding. Final inter-rater reliability for cognitive presence was determined using Spearman's rank, which allows for measuring agreement in the directionality of the hierarchical codes (e.g. a triggering event was the lowest and resolution was the highest-level indicator): discussion board $r = .77$, Facebook $r = .77$. For social presence, percent agreement was used to allow for heterarchical codes with no directionality among the indicators: discussion board 100%, Facebook 93%. Following this process, the first author completed the remainder of the coding. We also compiled discussion board and Facebook quotes from students and instructors to illustrate the coding categories.

Results

On Likert-scale questions, students ranked teaching presence highest whereas social presence was perceived as lowest of the three presences (Table 2). In contrast, based on coding data, cognitive presence was the most common post on discussion boards (87% of discussion board and 20% of Facebook posts) and social presence was most common on Facebook (47% of discussion board and 88% of Facebook posts; Table 3). Teaching presence represented only 1% of discussion board and 24% of Facebook posts (Table 3), and thus was perceived by students at a higher level relative to actual instructor posts on the course and social media platforms.

The most frequent type of cognitive presence post was exploration for both platforms (Table 4). For the discussion board, nearly one in five comments included the integration of two or more course concepts, while only five percent of Facebook posts did so. Thus discussion board posts reflected higher level thinking relative to the Facebook posts. Similarly, coding using the revised Bloom's taxonomy revealed a predominance of posts in the lower levels of learning and greater evidence of learning on the discussion board relative to Facebook (Appendix A).

The most frequent social presence post was open communication, which occurred at slightly higher rates on discussion board than on Facebook (Table 5). All other forms of social presence were more common on Facebook than on discussion board, with the second most common code being sharing resources (28% Facebook vs 4% discussion board). Offering support and facilitating discourse occurred less frequently (13% and 10% on Facebook, and 8% and 2% on discussion board, respectively).

For teaching presence, 8% of Facebook posts were efforts of course leaders to facilitate networking amongst participants and another 8% were about sharing resources, whereas no other

Table 2. Self-reported cognitive, social, and teaching presence from MOOC exit survey.

N	Cognitive presence		Social presence		Teaching presence	
	M	SD	M	SD	M	SD
487	3.79	1.31	3.21	1.33	4.12	1.07

Likert scale (1–5, where 1 = strongly disagree, and 5 = strongly agree).

Table 3. Number and percent total of cognitive, social, and teaching presence in discussion board and Facebook.

Presence type	DB (N = 185) N (%)	FB (N = 431) N (%)
Cognitive presence	161 (87%)	86 (20%)
Social presence	87 (47%)	379 (88%)
Teaching presence	2 (1%)	103 (24%)

Table 4. Cognitive presence percentage of posts by category and example quotes.

Code	Percentage		Example quote
	DB (N = 185)	FB (N = 431)	
Total	87%	20%	
Triggering events	11%	5%	<i>I think that an EE program must have a really interesting issue that has to be known and treated.</i>
Exploration	55%	7%	<i>As Monroe, Day, and Grieser state in Chapter 1 of Environmental Education and Communication for a Sustainable World, EE "teaches students 'how to think' not 'what to think'" (p. 5). Environmental educators can help build capacity in learners to improve environmentally literacy, make well-informed decisions, and adopt environmentally-friendly behaviors. "The goal is to instill in learners the knowledge about the environment, positive attitudes about the environment, competency in citizen action skills, and a sense of empowerment" (p. 5)</i>
Integration	18%	5%	<i>The concept of structure within EE can be incorporated to provide a new approach in educating others on environmental aspects. This includes addressing the human and environmental constraints one may feel, and approaching the teaching in a way that allows for these constraints to be changed or overcome to produce success. For example, if society believes landfills don't produce greenhouse gases, then shaping the way one teaches about waste and greenhouse gas release will need to shift to overcome this constraint so that positive action can take place to reduce gas emissions resulted from throwing items away that could be recycled or reused</i>
Resolution	3%	3%	<i>You [fellow student] bring up an interesting point about authenticity and perhaps an aversion to polished messaging, which we may tune out like so many commercials. I definitely think multiple platforms have the ability to reach wider audiences though—perhaps a particularly knowledgeable person can only have such one-on-one encounters as you describe with hundreds of people per year, when thousands need to be reached. I think a combination is ideal: have the authentic experience if possible, and supplement that with video graphics, for example, that illustrate the loss (in my case land loss, in yours biodiversity) the elder describes</i>

Percentages are based on total posts. Because not all posts include each presence, percentages do not add to 100. Some posts were coded for more than one type of presence.

teaching presence type was observed at greater than 5% frequency (Table 6). Only one discussion board teaching presence type was found, i.e., facilitate discussion (1% of total posts).

Discussion

In an EE professional development MOOC, the social media platform Facebook was more effective in facilitating student discussion and sharing, whereas evidence of cognitive learning was more prevalent on the course discussion board. Further, despite the fact that instructor posts were relatively rare during the course, students perceived a high level of teaching presence in a survey, suggesting that course design and course elements not captured in the discussion board or Facebook group play a role in students' perceptions of teaching presence (Arbaugh et al. 2008; Kaul, Aksela, and Wu 2018). The findings that MOOC students demonstrated modest evidence of higher-level cognitive learning are similar to those found for teacher professional development MOOCs (Kellogg, Booth, and Oliver 2014) as well as small online courses for university students (Hou et al. 2015). Below we focus on our findings for social and cognitive presence and on ways instructors might enhance social interactions and levels of cognitive learning in online environments.

Within social presence, the relatively high scores for open communication and sharing resources, followed by providing support, suggest that students are choosing to interact on Facebook both to build knowledge and to share and support each other. This implies that the Facebook

Table 5. Social presence percentage of posts by category and example quotes

Code	Percentage		Example quote
	DB (N = 185)	FB (N = 431)	
Total	47%	88%	
Open communication	33%	28%	<i>[name redacted], I agree that addressing misconceptions is important when communicating about climate change. I am a professor of teacher education and one of the teacher education standards around content literacy is addressing misconceptions is built into the teacher education standards on the state and national levels, especially as pertains to science. (DB post)</i>
Facilitate network	0%	8%	<i>Hi [name redacted] We would welcome you to the Southern New England group if you would like to connect there! https://www.facebook.com/groups/745835492214561/</i>
Share information	4%	28%	<i>Welcome to the course. There is a group for Caribbean participants. Just search Global EE- Caribbean</i>
Share event	0%	1%	<i>Happening Now. Martin Keeley from the Mangrove Action Project teaching the EARTHCARE Eco Kids about the value of Mangroves. #EARTHCAREEcoKids #EARTHCAREEcoKidsrule #mangroveactionproject #mangrovesrock #awesomefieldtriptocome</i>
Support	8%	13%	<i>Oh! That is really amazing bc you do care environment rather than Human health. Its better to say you're environmental nurse. Thank u again and again please keep going ...</i>
Facilitate discourse	2%	10%	<i>According to the website list there is supposed to be a group for changing behavior around recycling, however it doesn't have a link. Does it exist? Also - is there any interest in having an ecopsychology group?</i>

Percentages are based on total posts. Because not all posts include each presence, percentages do not add to 100. Some posts were coded for more than one type of presence.

group incorporated characteristics of both online knowledge communities designed around learning and contributing to a new body of knowledge, and online communities of practice where participants share and connect practice to learning (Clarke and Kinne 2012). Interestingly, students also assumed teaching roles in the Facebook group, for example by facilitating networking and discussion. While recognized as a component of professional development more broadly, in the seemingly anonymous and for some students threatening MOOC learning environment, social presence gains importance as a means for students to feel welcome, to develop a sense of community and of collective identity as learners, and to co-create knowledge, while also contributing to course satisfaction and cognitive learning (Garrison, Anderson, and Archer 2010; Ke 2010; Salmon et al. 2015; Peacock and Cowan 2016).

Similar to Liu and Yang's (2014) study of a small university online course, our results suggest that although instructors devote significant effort to course design, it is difficult to sustain teaching presence or facilitation throughout an online course. This is in part due to the limitations of online learning management systems, including their generally "clunky" and slow response discussion boards, and for MOOCs, instructors feeling overwhelmed by the vast number of student posts. The result that teaching presence was more common on Facebook suggests the ease of use of this platform not only for students but also for instructors. Relative to course discussion boards, Facebook has the advantages that both adult learners and instructors may be already visiting this social media on a regular basis, its notification system encourages learners and instructors to post and read what others post, and it is seen as a place for social interactions (Hou et al. 2015) including those focused on professional development.

Limited or less informed teaching presence may be one explanation why cognitive presence is often restricted to lower level cognitive tasks (although achieving higher order thinking may also present a challenge for inperson learning, Vaughan and Garrison 2005). In a study of ten small online university classes, Ke (2010) found that students adapt their cognitive and social performance based on instructor presence prior to (course design) and during (facilitation and

Table 6. Teaching presence percentage of posts by category and example quotes.

Code	Percentage		Example Quote
	DB (N = 185)	FB (N = 431)	
Total	1%	24%	
Instructional design	0%	1%	<i>The course is described at www.globalee.net. To be part of the Facebook group, you should register for the course. To do so, pls contact [name redacted] as the course registration is officially closed. Hope you can register and start doing the assignments! [name redacted]</i>
Facilitate discourse	1%	3%	<i>Welcome [name redacted] from Vermont. You pose an interesting question—now that you have legislation about waste diversion, is there still a problem getting people to follow the law? What are the incentives, fines, and education/communication campaigns? Thanks!</i>
Facilitate network	0%	8%	<i>Welcome [name redacted]. You might search this FB group for Ireland to find others from nearby. I would love to learn more about the education program of the Irish Sustainable Energy Authority!</i>
Post resource	0%	8%	<i>Thanks for sharing. I am sorry for your loss. Keith Tidball and I edited a book called <i>Greening in the Red Zone</i> that has examples from around the world about how people often turn to planting and other forms of green stewardship to memorialize loved ones lost in disaster and war. There's a blog for people to share stories. http://greeningintheredzone.blogspot.com/</i>
Support	0%	1%	<i>A lot of wisdom in that response. Thanks for that! I think the questions at the end are helpful. I might add two more: - HOW are you going to sustain whatever it is you want to sustain? How will you know whether you're succeeding in doing so? We will need some criteria to for this otherwise we risk sustaining things that might turn out to be unsustainable...</i>
Direct instruction	0%	3%	<i>[name of student which post is responding to] For the case study, it needs to address one of the course issues or wicked problems. So would yours address energy or nature connectedness and health for example? It has to include how EE and two other course disciplines (e.g. environmental psychology, natural resources management) are used in the program to address the issue. At the end, you need to describe how the case is impacting the issue or could impact the issue/wicked problem. Any program where you can write about these components is good. A list of all case studies to date (provided by course instructors as examples) is available at the course site. www.globalee.net</i>

Percentages are based on total posts. Because not all posts include each presence, percentages do not add to 100. Some posts were coded for more than one type of presence

direct instruction) courses, and that grading discussion forum responses resulted in a decline in discussion quality. Several methods are available to enhance the depth of cognitive learning, including designing discussion questions to foster integration and resolution (Kaul, Aksela, and Wu 2018) and to focus on particular topics. In a smaller online course, topics related to life experience and case-study analysis fostered higher levels of knowledge construction relative to theory exploration and discussion of controversial topics (Liu and Yang 2014). Whereas Liu and Yang's (2014) study was conducted with university students, results are consistent with principles for high quality online adult education and related professional development, including assignments that acknowledge and connect new knowledge to students' prior experience and have immediate applications to adult learners' professional life (Cercone 2008). Similar to cognitive presence, depth of social interactions is often limited in online courses (Liu et al. 2016), but can be enhanced through instructor choices about online platforms (e.g. discussion board vs social media, Clarke and Kinne 2012, Hou et al. 2015, Salmon et al. 2015) and type of discussion question posed (Ke 2010). Similarly, Li, Krasny, and Russ (2016) found that instructor-student

interaction as determined by posts in a small online course discussion forum was correlated with students forming connections with each other, suggesting that instructors can foster interactions among students.

The result that students perceived high levels of teaching presence despite the low number of instructor posts could be explained by students recognizing the instructors' efforts in designing the course and by instructors being more recognizable or making more significant contributions to the online discussions. It also may reflect the fact that some interactions between instructors and students occurred outside of the discussion board and Facebook group. For example, the first author on this paper supported students who volunteered to lead face-to-face and web-mediated small groups of learners in a hybrid learning approach (de la Varre, Keane, and Irvin 2011). Leaders and members of these and similar small groups translate and help explain and lead discussions of course materials (Colas, Sloep, and Garreta-Domingo 2016; Krasny et al. 2018) and help students adapt online course resources and ideas to local contexts (Nkuyubwatsi 2014). Akyol, Garrison, and Ozden (2009) found that participants in hybrid learning courses demonstrated greater social, cognitive, and teaching presences compared to online only participants, which they attributed to greater opportunities for reflection.

Recommendations and conclusion

In this study, we explore professional development that attempts to expand educators' critical and transdisciplinary thinking about the field of EE and to enhance social interactions to support learning, learners, and knowledge co-creation. In this way, our professional development efforts differ from those designed to train educators in a particular curriculum or set of guidelines, but are consistent with social learning and other pedagogical strategies used in EE programs. Our results suggest strategies to enhance cognitive, social, and teaching presence, and thus critical thinking and social learning, within the context of online and hybrid online/in-person professional development.

The predominance of lower levels of cognitive learning on the course discussion board and Facebook platforms, coupled with the finding that nearly a fifth of discussion board posts demonstrated higher level cognitive presence, suggest the potential for reaching higher levels of learning in the MOOC environment. To foster deeper levels of cognitive thinking, instructors should design discussion questions that require integration and application of content, provide guidelines for and model interactions that challenge learners' assumptions and thus lead to reflection, and ask adult learners to apply their learning to their professional and volunteer lives and local context.

Further, as illustrated in the social presence interview quotes in this study, MOOCs afford EE professionals opportunities to learn from fellow professionals and practices in countries around the world, and thus can spur global learning communities and networks that support and enhance EE practices. To enhance learning and networking, instructors can leverage the diversity of the MOOC student body by encouraging students to share their experience and knowledge on the course and social media platforms and by compiling course projects where students apply course content to their local context. We have found that when compiled into ebooks and made accessible online, student projects can become resources for a global community of learners beyond individual MOOCs (Krasny and Snyder 2016). We have also observed social media and local groups formed during courses continue to post new materials and expand beyond the period when individual courses are offered. For example, in China, a course WeChat group has grown to over 2000 participants and our courses have spurred the formation of a network of university student environmental clubs, whose members have taken multiple courses and designed online professional development "camps" (Krasny, Golshani et al. in review). Course social media groups thus become self-sustaining global online learning networks and create new

resources, reflecting student agency not captured in the three presences during the course (Kozan and Caskurlu 2018). Online course instructors can spur development of online communities by making students feel as if they belong, for example, through asking students to introduce themselves and to welcome each other on the course discussion board and social media groups, and through modeling knowledge sharing behaviors.

Whereas MOOCs and online courses are often perceived as one-way content delivery, by incorporating online discussion forums and social media groups, even large courses can facilitate social interactions, including open discussion, resource sharing, and peer support among students. However, the fact that students in this study perceived social presence as being relatively low suggests the potential for enhancing social learning and networking aspects of the course. Given the diversity and sheer numbers of people who identify as environmental educators in the US (Gupta et al. 2018) and globally (e.g. our MOOC students include water engineers from Nigeria, environmental sciences university students from Iran, EE business entrepreneurs in China, and teachers, informal educators, and university students from North and South America), teaching presence can be designed to address identity threat (Kizilcec et al. 2017), build trust, and gently challenge student assumptions. Importantly, to avoid one-size-fits-all educational strategies for such diverse students (Jung and Gunawardena 2014) and to build reflective and critical thinking skills, MOOC instructors can design final projects in which students, often working in small local groups, adapt course content to their own context. In short, with careful attention to cognitive, social, and teaching presence, MOOCs can foster ongoing knowledge co-creation among diverse professionals that contributes to professional development of course participants and other professionals globally.

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Appendix A.

Revised blooms taxonomy percentage of posts by category and example quotes

Code	Percentage		Example
	FB (N = 431)	DB (N = 184)	
Remember (RBT, B1)	4%	26%	As Monroe, Day, and Grieser state in Chapter 1 of <i>Environmental Education and Communication for a Sustainable World</i> , environmental education "teaches students 'how to think' not 'what to think'" (p. 5). Environmental educators can help build capacity in learners to improve environmentally literacy, make well-informed decisions, and adopt environmentally-friendly behaviors. "The goal is to instill in learners the knowledge about the environment, positive attitudes about the environment, competency in citizen action skills, and a sense of empowerment" (p. 5)
Understand (RBT, B2)	6%	41%	There's no reason that EE programs can't or shouldn't focus on specific behaviors. We're trying something at our zoo this weekend for Earth Day (it's being driven by one of our employees who is a graduate student in sustainability). We have various activity stations, each one focused on a specific sustainable behavior. Guests go through the steps of completing the behavior at the station and then are able to take

(continued)

Continued.

Code	Percentage		Example
	FB (N = 431)	DB (N = 184)	
Apply (RBT, B3)	2%	20%	<p>home the materials to keep going with the behavior. An example is creating their own non-toxic cleaner at the zoo then taking it home along with the recipe. We're pairing this with a six-week social media campaign following Earth Day with each week focused on one of the behaviors that was learned at Earth Day</p> <p>The young generation is the backbone of the nation. However, as they are much more connected to electronic and technological products youth became primary victims of consumerism. In this case, it is the responsibility of environmental educators and parents to focus on involving the youth in decision-making process and to enable them make the right choice so that they can play a central role in saving planet earth</p>
Analyze (RBT, B4)	4%	5%	<p>This is a great example of a conflicted communication space, and I appreciate Mr. Guerta raising the conflicting ideas of traditional/cultural use and environmental concerns. One line of inquiry might be to understand other dimensions of other dimensions of the experience and relationship with this heating material - in harvest, quality of warmth, meaning, etc. to help explore more other options that might also offer a robust cultural and somatic depth of experience, honoring the experience of the people who are currently engaged in the practice. It also brings to mind, for all of us, related to CC-related and carbon sequestering practices, how we might need to be invited more continuously to consider alternate meaning making and meaning systems for our cultural practices given our changing context</p>
Evaluate (RBT, B5)	1%	1%	<p>The youth can change their lifestyle by adopting environmentally friendly lifestyle and by recycling of different materials as well as preserving resources, Thus, engaging youth in environmental protection not only creates direct impact on changing youth behaviors and attitudes, but possibly influence their parents, relatives, families, schools and local institutions</p>
Create (RBT, B6)	1%	0%	<p>~ A Framework of Caring for the Environment ~ I'd love to get feedback on this concept I came up with for my honors thesis, as it's something I'm considering developing further. A very short summary: 'Caring for the Environment' is a potentially useful idea that combines the ideals of EE into a more easily accessible concept for the wider community. Based on my research I believe that caring comprises of knowledge (needing to both know of an issue and potential solutions to the issue), attitudes (having a favorable emotional connection to the issue) and behavior (actually doing something to resolve the issue). In a moment of clarity I realized these correspond to the widely accepted ideals of education in, for and about the environment in EE. Therefore my framework combines the two elements, the caring for the environment with the framework of EE, with the aim of trying to make academic understandings of EE more accessible. I also hope that breaking 'caring for the environment' down like this will enable educators (particularly Scout Leaders, who this was developed for) to cover all aspects of EE, not just knowledge, or behavior, or attitudes. I also include formative experiences in what I call 'The Tree of Caring', as these have been shown to be hugely important in developing pro-environmental attitudes and behaviors</p>
Unrelated (RBT, B7)	7%	0%	<p>Thank you. I'm gonna check :)</p>