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Influence of Learning Design of the Formation of Online Communities of Learning

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Résumé de l'article

This paper presents the findings of a study on a fully online Bachelor's level course in Health Sciences at a European University conducted to explore the influence of learning design on the formation and evolution of different types of communities of learning. The impetus for the study came from the well-established effectiveness of community-based learning, a need for understanding learning design and analytics within networked structures and, the lack of theoretical grounding for social network analysis (SNA) in previous literature. Our study uses the Integrated Methodological Framework (IMF) which employs SNA as the key methodology for exploring community-based learning in light of the Communities of Practice (CoP) and Community of Inquiry (CoI) frameworks. The course comprised of three differently designed successive discussion forums spanning three weeks each. Network diagrams and SNA measures clearly showed the impact of the different learning designs on student engagement in the discussion forums. Based on CoP and CoI structural components within the IMF, a comparative analysis of whole-network properties of the three networks indicated the formation of a CoP, initiated and mediated by the tutor in discussion 1, sustained by the students in discussion 2, and disintegrated due to lack of guidance and facilitation in discussion 3. Qualitative analysis on the content of discussion posts revealed the importance of group oriented messages in the formation of the CoP. The paper discusses findings in terms of implications for learning design and analytics in online learning and the role of the tutor in community formation.

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Abstract

This paper presents the findings of a study on a fully online Bachelor's level course in Health Sciences at a European University conducted to explore the influence of learning design on the formation and evolution of different types of communities of learning. The impetus for the study came from the well-established effectiveness of community-based learning, a need for understanding learning design and analytics within networked structures and, the lack of theoretical grounding for social network analysis (SNA) in previous literature. Our study uses the Integrated Methodological Framework (IMF) which employs SNA as the key methodology for exploring community-based learning in light of the Communities of Practice (CoP) and Community of Inquiry (CoI) frameworks. The course comprised of three differently designed successive discussion forums spanning three weeks each. Network diagrams and SNA measures clearly showed the impact of the different learning designs on student engagement in the discussion forums. Based on CoP and CoI structural components within the IMF, a comparative analysis of whole-network properties of the three networks indicated the formation of a CoP, initiated and mediated by the tutor in discussion 1, sustained by the students in discussion 2, and disintegrated due to lack of guidance and facilitation in discussion 3. Qualitative analysis on the content of discussion posts revealed the importance of group oriented messages in the formation of the CoP. The paper discusses findings in terms of implications for learning design and analytics in online learning and the role of the tutor in community formation.

Keywords: online learning, learning design, learning analytics, communities of practice, community of inquiry, social network analysis, online facilitation

Introduction

Learning within networked structures, such as communities, is increasingly being considered as the most effective way to learn in the 21st century (De Laat, 2012; Dawson & Siemens, 2014). Engaging learners meaningfully is one of the fundamental guiding principles in designing for networked learning (Boud & Prosser, 2002). A networked learning environment that directs learning processes towards deep learning can be designed but the actual learning or learning experience that occurs cannot be prescribed (Goodyear, Banks, Hodgson, & McConnell, 2004; Wenger, 1998). Learning designs indicate and execute the designer's pedagogical intentions but cannot control student perception and consequent actualization of the intended design. Neither do learning designs identify how students engage in the design during or after a learning activity (Lockyer, Heathcote, & Dawson, 2013), this being a function of learning analytics. Therefore, to inform teaching and learning practice within networked structures, the inseparable iterative relationship between learning design and analytics must be cultivated especially since the proliferation of anywhere, anytime, online learning and consequent access to "big data" from learning management systems (LMS). In a recent book, Carvalho, Goodyear, and De Laat (2017) identify the critical need for understanding approaches to analysis and design for networked learning. Social learning analytics, specifically, social network analysis (SNA), has been used considerably to investigate online networks and communities (Cela, Sicilia, & Sanchez, 2015); however, researchers have pointed to the lack of theoretical grounding for the SNA, which makes pedagogical interpretation and application of findings difficult (De Laat & Prinsen, 2014; Shea et al., 2013). This paper attempts to contribute to research on learning design and analytics in the context of higher education online learning (HEOL) by investigating the influence of learning design on the formation and evolution of communities of learning using the theoretically grounded Integrated Methodological Framework (IMF) (Jan & Vlachopoulos, 2018), which employs SNA as a central methodology. In a case study involving three differently designed discussion forums, the IMF is used to investigate the type of community formed in each discussion activity and the key factors that contribute to the formation of the community. The paper begins by a brief overview of the significance of, and design for, community-based learning. Following this, the case study is presented, findings are reported, and finally practical pedagogical implications for learning design and analytics in the context of HEOL are discussed.

Literature Review

Community-Based Learning

The terms *network* and *community* are frequently used interchangeably in literature on online learning despite the different educational affordances of the structures. Briefly, a network is defined as, "A set of connections among people, whether or not these connections are mediated by technological networks. They use their connections and relationships as a resource in order to quickly solve problems, share knowledge, and make further connections" (Wenger, Trayner, & De Laat, 2011, p. 9). On the other hand, "A community is a group of individuals identifiable by who they are in terms of how they relate to each other, their common activities and ways of thinking, and their beliefs and values" (Biza, Jaworski, & Hemmi, 2014, p. 162). While a network is simply a group of entities joined together by relationships, a community takes time to form. The effectiveness of community-based learning is a widely-held belief resting on decades of research. The pedagogical foundations for learning communities lie in Dewey's

(1980-1904) concept of student-driven learning via engagement, active learning and, collaboration (Fink & Inkelas, 2015). The precursor of the learning community dates to the 1920s when the "experimental college" program was introduced by Alexander Meiklejohn (Smith, 2001). The 1960s saw a rebirth of this idea which gained further momentum in the 1980s with the recognition that learning in a community leads to higher levels of learning and development (Zhao & Kuh, 2004). This momentum continued into the 1990s with several studies reporting links between participating in learning communities and favorable outcomes for college students (Matthews 1994; Pike, 1999; Tinto, 1998). Onwards, with the pervasiveness of online learning and the interactivity afforded by Web 2.0 technologies, learning in communities became the holy grail of online learning as stated by Palloff and Pratt (1999), "without the support and participation of a learning community, there is no online course" (p. 29). Kop and Hill (2008) state that "the starting point for learning occurs when knowledge is actuated through the process of a learner connecting to and feeding information into a learning community" (p. 1). With the development of frameworks, such as, Communities of Practice (CoP) (Lave & Wenger, 1991; Wenger, 1998) and Community of Inquiry (CoI) (Garrison & Anderson, 2003), the last two decades have seen an explosion of research on learning communities re-affirming that learning in communities is the way to learn. Given the effectiveness of community-based learning, can we assume that students, in a course of study, whose learning is embedded within online networked structures, naturally form a community of learning? If a community is not formed naturally, can a particular type of learning design influence the formation of a specific type of community?

Designing for Online Communities of Learning

The use of the term learning design is contested in literature and to date there is no one agreed upon definition of what constitutes learning design. For instance, Agostinho, Oliver, Harper, Hedberg, and Wills (2002) refer to learning design as "the sequence and types of activities and interactions that are selected to shape the student learning experience" (p. 3). Donald, Blake, Girault, Datt, and Ramsay (2009) define learning design as a product that "documents and describes a learning activity in such a way that other teachers can understand it and use it (in some way) in their own context" and as a "process by which teachers design for learning, when they devise a plan, design or structure for a learning activity" (p. 180). Conole (2012) refers to learning design as a "methodology for enabling teachers/designers to make more informed decisions in how they go about designing learning activities and interventions…" (p. 7). Regardless of whether learning design is considered as a sequence, a product, a process, or a methodology, in HEOL the basic components of learning design remain the same. The learning environment comprises of the LMS, tools and technologies, content or curriculum, individuals and their roles (lecturer, tutor, student, support staff, etc.), and some other resources. A good learning design framework is expected to bring together these components in a manner that leads to the desirable learning outcomes. In the Activity-Centered Analysis and Design (ACAD) framework, Carvalho and Goodyear (2014) discuss three structures of learning design, i.e. set design (space, place, artefacts, tools, etc.), social design (dyads, groups, roles, communities, etc.), and epistemic or intended design, which intermingle to create the actual activity or learning that emerges organically and cannot be manipulated by design. In a similar vein, referring to communities of learning, Wenger (1998) speaks of learning as something "that cannot be designed but can be designed for" (p. 229), i.e. one can create a design with the intention of forming a community; however, there is no guarantee that the community will form. Good learning designs are seldom static and can be altered, as needed, as a course of study progresses. However, once an activity, for example a discussion forum, has commenced, it must be seen to completion and the only changes that can be made to the design are through intervention

(moderation) by a facilitator during the activity. Therefore, the role of moderation or facilitation forms a crucial component of online learning activities, and as such, has been the subject of substantial research over the past two decades. However, the impact, if any, of moderation on the formation of a specific type of community of learning remains unknown.

The Role of Facilitation in Community Formation

Numerous frameworks and models for online tutoring and e-moderation have been developed over the past couple of decades; however, most do not provide a clear a definition of e-moderation and online facilitation (Vlachopoulos & Cowan, 2010). The CoI framework (Garrison & Anderson, 2003), Salmon's (2000, 2003) 5-stage model of e-moderation and the ring-fence e-moderation framework (Vlachopoulos & Cowan, 2010) being the exception. The CoI framework comprises of three interconnected presences, social presence (SP), cognitive presence (CP), and teaching presence (TP). In a CoI, the role of the facilitator (lecturer or tutor) lies within TP. Teaching presence is not limited to facilitators and can be assumed by anyone, e.g., an actively engaged student.TP does not only encompass subject expertise but also includes design and facilitation of the learning environment such that a CoI would be created over the course of study (Anderson, Rourke, Garrison, & Archer, 2001). The essence of the role of the tutor in the CoI framework includes developing a sense of community amongst students by advancing social relationships (SP), among other things. (Garrison & Anderson, 2003). SP modelled by the tutor or lecturer encourages student engagement as students feel acknowledged and visible (Rourke, Anderson, Garrison, & Archer, 2001; Stacey, 2002, Shea & Bidjerano, 2010). However, SP and TP by themselves are not enough for deep and meaningful learning for which CP is critical. In a CoI, the facilitator should guide students to develop meaning, confirm understandings, integrate knowledge, and arrive at resolutions (Garrison & Cleveland-Innes, 2005). In a different vein, Salmon's (2000, 2003) 5-stage model of e-moderation describes a tutor as someone who progressively engages students in constructivist learning but who is not necessarily the subject expert. Like the CoI framework, Salmon's model is limited to online social learning; however, the model does not specifically concern community development (Moule, 2007). A community literally means, "a unified body of individuals" (Merriam-Webster, 2017) so when we think of a community of learning, it is natural to envisage a tightly-knit group of students. Based on this we can assume that a facilitator who intends to form a community of learning would aim to keep students tightly-knit towards the center of the community. The ring-fence e-moderation framework (Vlachopoulos & Cowan, 2010) comes closest to this idea postulating that e-moderation should be contained within "an enclosed learning arena" in which the learning is "student-centered and implicitly student-directed" (p. 31), and that distinctly encapsulates student and e-moderator activities only. Acknowledging that the tutor's activities within the ring-fence are influenced by predetermined outside and emergent inside factors, the framework clearly describes the role of the tutor as: identification of a significant posting; construction and posting in alignment with the tutor's style, purpose, and desired learning positions; and influencing, but not directing, student progress. There are several guides and books on best practices for online facilitation and moderation (Vlachopoulos, 2012); however, the role facilitation does and/or can play in the formation of a specific type of community of learning has yet to be investigated.

Research Questions

Considering the long-standing effectiveness of community-based learning and the gap in understanding design for community-based learning, especially the role of facilitation in community formation, we explore the influence of learning design on the formation and evolution of online communities of learning by specifically addressing the following questions: Given different learning designs of the same learning activity, can we identify the type of community formed within each design, if any, using SNA? If a specific type of community is formed, how does it evolve? And what are some of the key factors that contribute to the formation and evolution of the community? What practical pedagogical implications can we draw from our findings?

An Online Community of Learning – A Case Study

Context of the Study

The study was conducted on a fully online Bachelor's level course in the Health Sciences at a European University. The cohort comprised of a total of 20 students (13 female, 7 male) aged between 26 and 54 years. The students were qualified healthcare professionals who took the course to enhance their critical thinking skills and professional practice. The course comprised of three differently designed, successive discussion forums spanning 3 weeks each. Discussion 1 was guided and facilitated by the tutor who acted as the subject expert. In discussion 2, students were asked to discuss a practice online, for instance, something they did in the hospital, and exchange advice drawing on personal experiences. Discussion 3 was designed as a free-flowing discussion in which students could raise anything they wished in relation to the course or their practice. This discussion was not graded. The discussions were threaded with nested messages within each thread. Interaction data for each discussion activity was extracted from the LMS (Moodle) for analysis. All students had prior experience with online discussions as a way of learning and development as they had completed other online professional development courses at the same University. As such any maturation effect was not considered to be a methodological issue.

Analytical Framework for the Study

We use the Integrated Methodological Framework (IMF), shown in Figure 1, to conduct our investigation. The IMF uses SNA as the key methodology for identifying and exploring communities in higher education online learning (HEOL). The IMF embeds SNA in structural components of empirically tested and well-established CoP and CoI frameworks and includes selective qualitative analysis which supports the SNA. Definition of a CoP and CoI, explanation of the structural components of a CoP and CoI, and details on development and application of the IMF, can be found in Jan and Vlachopoulos (2018).

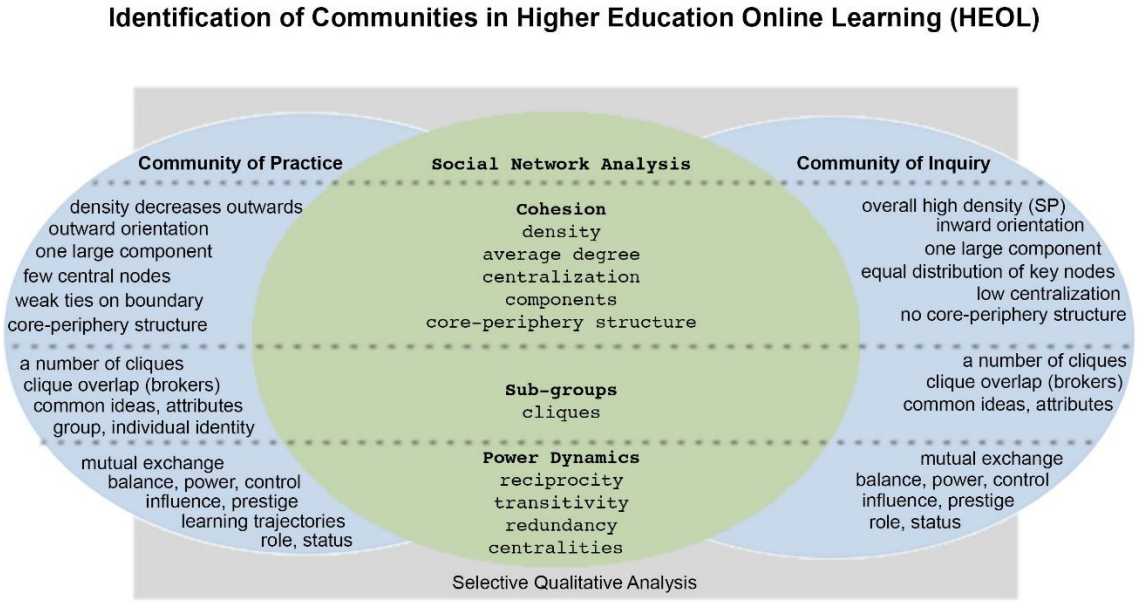

Figure 1. Integrated methodological framework (IMF).

Findings From SNA

Data was coded into matrices for SNA which was conducted in Ucinet 6.0 (Borgatti, Everette, & Freeman, 2002). The rows and columns of a matrix represented the nodes in the networks, i.e. the students and tutor. A value of 1 indicated an interaction (a direct response or reply to a message) between two nodes and 0 indicated no interaction. Multiple interactions between the same nodes were treated as one. The resulting networks were directed, indicating the initiator of each interaction, but not-weighted. The network diagrams shown in Figure 2 below were generated in Social Network Visualizer 2.3 (Socnetv, 2017).

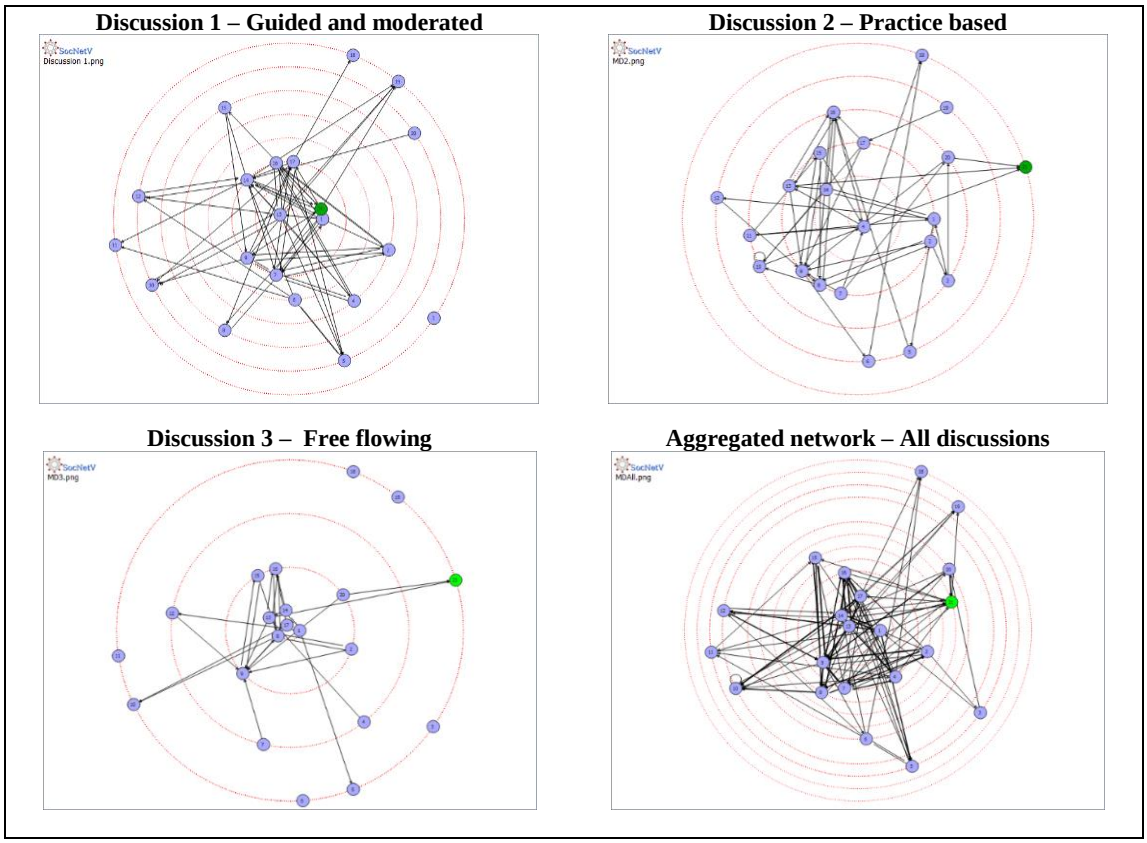

Figure 2. Discussion networks based on degree centralities.

The nodes in the network diagrams represent the 20 students and one tutor (shown in green) who was also the subject expert. The nodes are positioned within the networks based on the overall degree centrality of each node. The networks of discussion 1, 2, and 3 represent all interactions over the 3-week period of each discussion activity. The aggregated network shows all interactions over the total 9-week period.

Exploration of community formation and evolution using the IMF is a multi-stage process. First, we need to look at the structure of cross-sectional networks on a stand-alone basis. Cross-sectional networks are snapshots of interactions at a certain point in time, for instance, in Figure 2 the network diagrams of discussions 1, 2, and 3 are a cross-sectional representation of interactions at the end of each 3-week period. Second, to explore temporal dynamics of communities, we need to look at changes in the structure of the successive cross-sectional networks. Finally, we need to examine the aggregated network which captures cumulative interactions over the entire period under consideration. Although the aggregated network does not reveal community dynamics, the overall structure of the network indicates the global orientation of the community.

We begin our investigation into community formation and evolution by examining each network diagram from Figure 2 using constructs from the IMF. In discussion 1, the network comprises of one fully connected component. The density of the network decreases outwards from the center depicting weaker ties on the periphery and a clear core-periphery structure is visible. The tutor, who is the subject expert and moderator, appears highly central along with a few other students. In discussion 2, corresponding with the design of the discussion activity, i.e. practice-based and not moderated, the tutor moves out of the core to the periphery. While the network remains fully connected within one

component, it is relatively less dense. However, we still see a core-periphery structure as the density decreases outwards from the center. In the free-flowing discussion 3, the network structure changes significantly as the number of interactions and density decline and the network becomes disconnected. The core-periphery structure remains somewhat with the same number of nodes in the core as discussion 2; however, a few isolates appear on the periphery along with the tutor. Based on the overall structure of the networks depicted in the network diagrams, we conclude that the learning design of discussion 1 and 2 lead to the formation of a CoP; however, as a consequence of the design of discussion 3, the CoP is not able to sustain itself fully in discussion 3 and begins to disintegrate. If we consider the aggregated network, again a CoP structure is observed owing to the fully connected large component, greater density towards the center, and a clear core-periphery structure in which the tutor is positioned towards the outer boundary of the core with a few students taking on central roles implicating development of subject expertise.

Having identified the networks as a CoP, further analysis is restricted to the CoP portion of the IMF. A key component of a CoP is the notion of legitimate peripheral participation (LPP) in which newcomers enter a community and progressively move to the core from the periphery replacing old-timers or experts as the newcomers learn and develop identities (Lave & Wenger, 1991). LPP signifies the learning process which culminates into the learning experience or identity formation in CoP terminology. In the context of network structure, LPP is denoted by a changing core-periphery structure in successive cross-sectional networks as students, tutors, and/or lecturers move in and out of the core. To validate our earlier conclusion and verify LPP among other things, we need to take our investigation to the next step in the IMF. In Table 1 below, whole-network SNA measures corresponding with the network diagrams in Figure 1 are given.

Table 1

Whole-Network SNA Measures for Successive and Aggregated Discussion Networks

SNA measures	Discussion 1	Discussion 2	Discussion 3	Aggregated
No. of ties	62	46	28	136
Average degree	3.0	2.2	1.3	6.5
Centralization	30.5%	28.2%	32.1%	23.6%
Components (n>1)	1	1	1	1
Nodes in largest component	20	21	16	21
Cliques (n=3)	18	7	3	33
Core nodes	1,7,9,13,14,16,17,21(T)	4,8,9,13,15,16	1,8,9,13,14,16	1,7,8,9,13,14,16,17,21(T)
Reciprocity	3.2%	12%	21.7%	28.9%
Transitivity	22.6%	9.2%	11.4%	28.6%

In addition to quantifying the structural properties evident in the network diagrams, the SNA measures further reveal the structural dynamics or rhythms of the community as it re-configures itself under the influence of different learning designs. Additionally, SNA measures such as reciprocity and transitivity, implicate overall power dynamics within the community. Reciprocity is the degree of mutual exchange between nodes. Transitivity is calculated based on the percentage of transitive triads within a network.

A transitive triad occurs if A is connected to B, B is connected to C, and A is also connected to C. A high transitivity indicates the presence of alternate paths for flow in a network. The higher the transitivity, the lower the power and control of central nodes. The CoP framework does not discuss issues of power and control that are critical determinants of the flow of information and resources in a community (Hughes, Jewson, & Unwin, 2007), an important consideration in the pedagogical context. For instance, a network with low transitivity and high reciprocity indicates that it is dominated by a few central nodes who are actively engaging with one another and control the flow of the network.

As shown in Table 1, with a total of 62 ties, discussion 1 consists of one large connected component consisting of 20 nodes, that is, one tutor and 19 of the 20 students. The network has a relatively high centralization (30.5%), the largest core (eight nodes), and number of overlapping cliques (n=3 is the number of nodes all of which are connected to one another). Clearly, the activity in the network is dominated by the tutor and a few select students who form tightly-knit subgroups or cliques. Interestingly, the reciprocity or mutual exchange is lowest in discussion 1 indicating that even though students are actively participating in the discussion, they are not responding to one another. On the other hand, the network has the highest transitivity at 22.6% making it less restrictive and controlled in comparison to the other networks. Generally, the transitivity is on the lower side, which implicates power and influence of the core nodes including the tutor – an outcome of the learning design. In discussion 2, the network is contained within one large component, as well with all 20 students active in the discussion. The degree of centralization drops to 28.2% as the tutor moves out to the periphery and the number of nodes in the core reduces to six. Even though the tutor is no longer active in the discussion, the CoP structure seen in discussion 1 remains intact. The core-periphery structure changes depicting LPP. Specifically, the tutor and student 1 and 7 move out of the core to the periphery, students 4, 8, and 15 join the core from the periphery while students 9 and 16 remain in the core. The number of cliques drops significantly indicating the loosening up of the structure as students reach out to other students as indicated by the high reciprocity. The low transitivity points to greater power and control of the students in the core. Both discussion 1 and 2 form a CoP with and without tutor or lecturer involvement, therefore it appears that the practice-based nature of the discussion achieves a similar outcome as the guided and facilitated discussion 1. In the free-flowing discussion 3, the number of ties and average degree drops further and the network centralization increases to 32.1%, the highest amongst the three networks. Again, we see evidence of LPP where the tutor remains at the periphery, student 1 re-joins the core, students 4 and 15 move out of the core to the periphery, student 14 joins the core from the periphery, and students 9 and 16 again maintain their positions in the core. The reciprocity is relatively high and the transitivity remains low indicating the control and influence of the students at the core. The overall structure of the network shows remnants of a CoP which has disintegrated presumably due to the lack of guidance and facilitation.

Finally, the aggregated network also depicts an overall CoP with a large spread out core (nine nodes) which explains the relatively low centralization (23.6%). The low but equal reciprocity (28.9%) and transitivity (28.6%) indicate the active participation, mutual exchange, control, and influence of the core nodes. Despite being on the periphery in discussions 2 and 3, the tutor appears in the core of the aggregated network, which indicates the integral role that guidance and facilitation played in the formation of a CoP. Furthermore, the tutor's position in the outer-boundary of the core nicely depicts the process of LPP whereby students push out the tutor by taking on central positions within the core. In summary, the learning design of discussion 1 and 2 leads to the formation of a CoP, which is not

sustained by the design of discussion 3. The guidance and facilitation provided by the tutor in discussion 1 was instrumental in the initial formation of the CoP, which was driven and sustained successfully by the students in the practice-based discussion 2. The lack of direction and tutor involvement in discussion 3 led to student disengagement and disintegration of the CoP. We now turn our attention to the final component of the IMF, i.e. qualitative analysis to support the SNA.

Findings From Qualitative Analysis

Using the IMF, we have identified the type of community formed based on the structural properties and dynamics of the networks. However, for a complete exploration we need to examine the nature of the interactions that bring students together into a CoP (Jan & Vlachopoulos, 2017). For this, we conducted qualitative analysis of the content of messages posted in the discussion activities. We used the illocutionary unit (Howell-Richardson & Miller, 1996), which focuses on the linguistic properties of the messages and the individual to whom the message is directed, as the unit of analysis. All messages were coded in terms of the type of interactions using the coding scheme given in Table 2.

Table 2

Interaction Coding Scheme

Type of interaction	**Code**	**Criteria**
Group proactive	GP	Student or tutor looks for a response from someone in the group - anyone
Group reactive	GR	Student or tutor responds to one of the above, or some other message, playing reply back to group
Individual proactive	IP	Student or tutor looks for a response from a specific contributor, or even asks for it
Individual reactive	IR	Student of tutor responds to one of the above, or some other message, from and then to a specific contributor
Quasi interactive	QI	Threaded (follow-up) message where tutor or student acknowledges previous message but continues with a new idea/concept.
Monologue	M	A new thread. No evidence of interaction with any other participant

Note. For detailed indicators of criteria refer to Vlachopoulos 2012).

Two researchers independently performed the coding and achieved a Cohen's (1960) Kappa interrater reliability of 72%. Figure 3 shows the types of interactions within each discussion. Of a total of 292 types of interactions, 91 occurred in discussion 1, 106 in discussion 2, and 95 in discussion 3. Discussion 1 had the highest number of GP and an equally high number of IR interactions, which indicates that while participants addressed the entire group, they also reached out to others. However, the low reciprocity found indicates that they were not responding or reacting to each other. Discussion 2 had the highest number of GP interactions followed by the highest number of QI messages indicating that while individuals posted to the group, they were not specifically responding to messages directed to them.

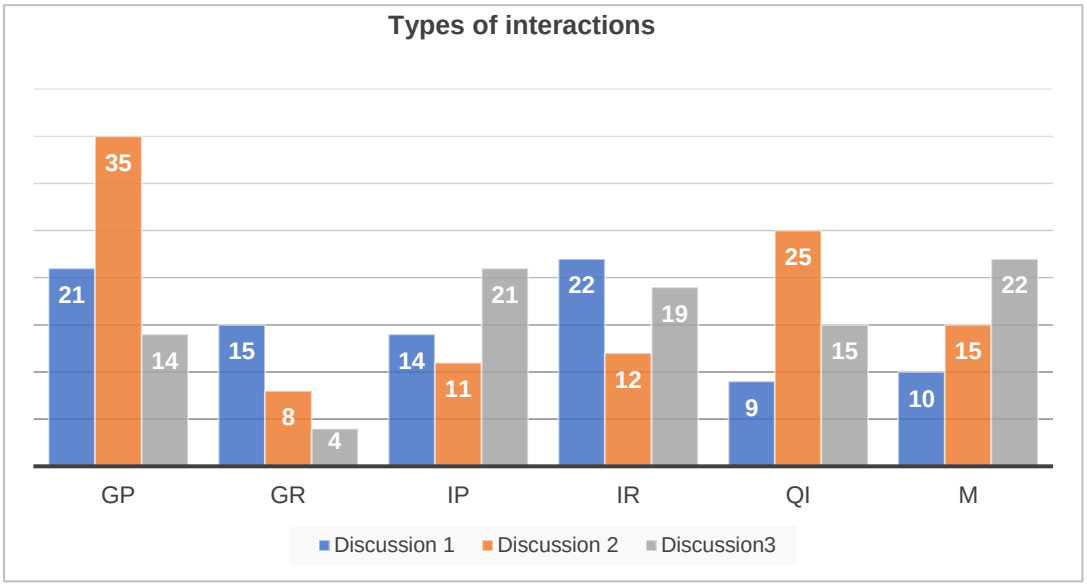

Figure 3. Types of interactions in discussions.

Again, this finding fits well with the low reciprocity found. Discussion 3 was dominated by M, IP, and IR interactions, which bodes well with findings from the SNA, i.e. there was a relatively high degree of mutual exchange (reciprocity), a few isolates, and a low level of group communication. The dominance of GP messages in discussions 1 and 2 lead us to conclude that messages directed to the entire group were a contributing factor in formation of the CoP.

Conclusion

In a CoP, individuals who share a *practice* come together as they *mutually exchange* ideas and negotiate meaning while creating a *shared repertoire* of conceptual and material artefacts (Wenger, 1998). As conceived by Wenger (1998) in its originality, a CoP is a natural occurrence and is formed whenever there is a practice, mutual engagement, and a shared repertoire. Learning, as signified by the process of LPP or identity formation, takes place within the CoP inevitably. In the context of online learning, if a CoP exists, we would expect similar patterns of engagement and learning to occur. However, in the online environment, a CoP may not form naturally and therefore needs to be artificially cultivated by design. As discussed earlier, a learning design does not have the capacity to orchestrate the learning experience or formation community but can create an environment conducive to its formation. Exploration of if and how this is achieved was the key objective of our research. In line with the research questions guiding our investigation, there are three key takeaways from our findings. Firstly, using CoP constructs from the IMF, we were successfully able to use SNA to structurally identify the type of community formed in each discussion activity by looking at the network diagrams and whole-network SNA measures. Secondly, we found that the guidance and facilitation in discussion 1 provided by the tutor was critical in setting the stage for the initial formation of the CoP. Replacing the tutors' guidance and facilitation with the practice-based design in discussion 2, maintained the structure of the community as the student-centered and student-directed discussion was able to sustain the CoP despite withdrawal of the tutor. In discussion 3, the absence of the tutor and the free-flowing, undirected design of the discussion, led to the disintegration of the CoP as student engagement lost its momentum and the nature of the interactions changed. As found by the qualitative analysis, another key influential

factor in the formation of the CoP was the type of interaction or message within the discussions. Discussions 1 and 2 were dominated by group proactive messages that addressed the entire group while discussion 3 was dominated by monologues.

In terms of practical implications for learning design and analytics in the online learning context, firstly, our findings validate the application and effectiveness of the IMF in identifying a CoP without having to conduct extensive qualitative analysis as has been the case previously (Jan, Vlachopoulos, & Parsell, in press). Secondly, the learning designs of the successive discussions 1 and 2 act as exemplars of the sort of design that could potentially bring students and/or tutors together to form a CoP should that be the intention of the designer. Thirdly, with respect to the role of the tutor, facilitation can be planned during a course of study by generating cross-sectional network diagrams, which indicate the orientation of the network in terms of the type of community being formed. Again, if the learning design intends to create a specific type of community, appropriate facilitation or intervention can be planned to alter the underlying structure of the community, i.e. the network. Last, but certainly not the least, group proactive messages or posts seem to illicit greater engagement and response. Therefore, tutors should try to address the entire group in their posts, at least at the beginning of an activity, such as in a discussion forum.

In terms of limitations of the study, we would like to point out that the study merely examines the formation of a community of learning in the online learning context. It does not claim that learning within one particular type of community is better than another, or even that community-based learning is more effective than otherwise. Furthermore, the study does not consider the critical influence of individual attributes on individual engagement. For a more holistic exploration, further research should look at student performance and attributional data to explore the relationships between engagement within a community, individual attributes like goal orientation and self-efficacy, and performance.

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