

WHO IS SPEAKING? WHO IS LISTENING?
A NETWORK APPROACH IN ANALYZING COMMUNICATION
STRUCTURES AND SOCIAL CONSTRUCTION OF KNOWLEDGE IN
ONLINE ASYNCHRONOUS DISCUSSION FORUMS

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January 2022

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ACCEPTANCE PAGE

This dissertation titled **“Who is Speaking? Who is Listening? A Network Approach in Analyzing Communication Structures and Social Construction of Knowledge in Online Discussion Forums”** is hereby accepted by the Faculty of Information and Communication Studies, University of the Philipines Open University (UPOU), in partial fulfillment of the requirements for the degree Doctor of Communication (DComm).

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BIOGRAPHICAL SKETCH

Myra Collado Almodiel is the eldest daughter of Sixto C. Collado and Ester T. Loresto-Collado from Guinayangan, Quezon. She is married to Roque V. Almodiel, Jr., and they have three kids - Ethan, Hamira, and Jesi.

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DEDICATION

To Him who gives freely without any reservations.

To Him who gave up His life to let me live.

To the Source and Creator of everything.

I dedicate this to You.

JESUS, thank you, for once again, walking me through.

Tuhan pasti sanggup.

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ABSTRACT

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Network plays a central role in the knowledge construction formed from the interactions and collaboration of online learners in asynchronous discussion forums. The very nature of networks to form connections, relationships, and links uncovers unique and wider opportunities for online learners to create higher levels of knowledge the more they interact and collaborate with each other. The opportunities to construct knowledge among online learners elevate as the connections and links formed from interacting with each other widen and enlarge reach.

This study employed multi-analysis methodologies, with Social Network Analysis as the primary research approach, in combination with Interaction Analysis Model (IAM) and Cluster Analysis to uncover and understand connections, links, patterns, and structures formed from online interactions (speaking and listening) that may influence the social construction of knowledge that occurred in the online discussion forums. This paper suggests that the network structures of online interactions (speaking and listening), both in terms of posts contributed and posts viewed, have potential influence on the knowledge construction of online learners based on the results of the study.

Keywords: network, Social Network Analysis (SNA), Interaction Analysis Model (IAM), online learning, asynchronous discussion forums (ADFs), data mining

Chapter One

INTRODUCTION

A. Background of the Study

Network comes from the basic structural idea that there are connections and relatively stable pathways of communication among individuals (Littlejohn & Foss, 2008). The use of networks in analyzing communication structures in a system is certainly not a recent development. As early as the 1930s, organizational scholars already began their research on the use of networks to present the communication structure of a system as a bigger picture of patterned flows of information exchange, moving the main concern of communication research to the dialogue, to the exchange of information as the central focus (Rogers & Kincaid, 1981).

Networks are social structures created by communication among individuals and groups, and as people communicate with others, links are created (Littlejohn & Foss, 2008). Network theory posits that the basic unit of relationship is not the person nor two individuals but interaction, and over time, the nature of relationships is formed or made through a series of interactions - responses to responses to responses (Littlejohn & Foss, 2008, p.197). From a network perspective, communication structures can be understood and analyzed in terms of the multiple networks of relationships and how interactions are patterned or who communicates with whom (Eccles & Nohria, 1992, Littlejohn & Foss, 2008).

The concept of network is prominent in the theory of connectivism which argues that learning is a process of building networks of information, contacts, and resources that apply to real problems (Anderson & Dron, 2011). Connectivism posits that the knowledge in the network arises from the interaction within a group of knowledge construction, presenting a model of learning that acknowledges the tectonic shifts in society where learning is no longer an internal, individualistic activity but where learners will be at the center of the learning experience, rather than the tutor and the institution, and where learners will be instrumental in determining the content of the learning, in addition to deciding the nature and levels of communication, and who can participate (Kop and Hill, 2008, Martinez & Frutos, 2018, Siemens, 2004).

Individual behavior is believed to be influenced through the relationships of the individual with others, as such, knowledge of an individual's network links allows interpretation of their social behavior and offers a basic explanation for the individual's behavior change (Rogers & Kincaid, 1981). Understanding how individual actors are positioned within a particular network can help us understand such questions as who is important to that network, who makes things 'happen' in the network or who holds the network together, as well as who faces fewer constraints and have more opportunities than others, who are in favorable structural positions to extract better bargains in exchanges, and who have greater influence, and maybe a focus for deference and attention from those in less favored positions (Hanneman & Riddle, 2011; Prell, 2012).

SNA has long been utilized in a wide variety of contexts to analyze network behaviors in various fields and recently among new generations of online learning practitioners and researchers. In an online learning environment where there is a

very limited or none at all face-to-face interaction among teachers and students, SNA provided avenues to explore connections on the conversational exchanges between individuals as to how often and who directs what conversation to whom as pictures of the social structure of the participants through data visualization (Haythornthwaite & Twidale, 2002). SNA offers both a visual and mathematical analysis of human relationships and visualizations of social networks which can show whether interactions are occurring between all members of a group or whether some group members are communicating more (or less) with other specific individuals (Erlin et al., 2009).

Social Network Analysis (SNA) is a perspective or a paradigm that takes as its starting point the premise that social life is created primarily and most importantly by relations and the patterns they form, looking beyond the specific attributes of individuals to consider relations and exchanges among social actors (Marin & Wellman, 2011; Garton et al., 1997). SNA is a popular approach for studying social relations and their structuring which involves concepts, methods, and analytical techniques to uncover the social relations that the individuals and groups together, the structure of those relations, and how relations and their structures influence (or are influenced by) social behavior, attitudes, beliefs, and knowledge (Prell, 2012).

SNA measures such as network centrality and density were used in recent studies to measure students' engagement and social level of interaction in online learning forums (Durairaj & Umar, 2015; Scott & Carrington, 2011). The most widely used approach to understanding the structural sources of individuals' advantage and disadvantage relative to their neighbors is that of network centrality where the core idea is very simple: actors who are more 'central' to social structures are more likely to be influential or powerful (but possibly also more constrained) (Hanneman &

Riddle, 2011, p. 363). People who occupy central positions in a network are said to be visible, tend to know many people, and many people know them (Prell, 2012). Measures of centrality have typically been used as indicators of power, influence, popularity, and prestige (Scott & Carrington, 2011). Density, on the other hand, provides a measure of the overall connections between the participants and indicates the level of engagement in the network or how active the participants are involved in the discourse (Erlin et al., 2009). The direction of interaction indicates to whom a participant's response is in a discussion forum and is shown through arrows in a network diagram (Durairaj & Umar, 2015).

Interaction has a long history of study and recognition as a critical component of the educational process and context, a defining component of the educational process that occurs when the student transforms the inert information passed to them from another and constructs it into knowledge with personal application and value, oftentimes seen as the primary criterion for selecting media for educational delivery (Anderson, 2003).

In a distance education context, Moore (1989) suggested three types of interaction: learner-content interaction, learner-instructor interaction, and learner-learner interaction, while Anderson and Garrison (1998) expanded these categories by including three more types of interaction namely teacher-teacher, teacher-content, and content-content interaction.

For the past decades, interest in research studies focusing on how interaction and learning take place in a student-centered online learning setting has elevated among online learning advocates and practitioners. Several research studies argued that the level of learners' interaction affects the quality of learning and the learning process itself, thus making it an important factor in the success of online learning

and teaching (Anderson & Garrison, 1998; Anderson & Kanuka, 1998; Aviv et al., 2010; Bento & Schuster, 2003; Corich et al., 2007; Durairaj & Umar, 2015; Garrison & Anderson, 2003; Power & St-Jacques, 2014). Research studies revealed that the level of students' interaction is found to be important in learning because the interaction affects the quality of learning and it will affect the learning process as well (Durairaj & Umar, 2015; Garrison & Anderson, 2003).

The advent of computer-mediated communication (CMC) and learning networks, introduces new perspectives on how social interaction and learning takes place in an online learning environment. Computer conferencing systems such as discussion forums have become a primary focus of educational research in recent years, as educators and psychologists examine learning environments that allow students to develop basic skills within authentic contexts and that also promote meaningful and collaborative learning (Pena-Shaff & Nicholls, 2004). Unlike didactic or teacher-centered models that view learners primarily as passive recipients of knowledge or information transmitted from an expert, network learning is premised upon a learner-centered model that treats the learner as an active participant, interacting with others in the group and actively constructing knowledge by formulating ideas built upon through reactions and responses of others to the formulation (Harasim et al., 1995).

A computer-mediated conference like asynchronous discussion forum (ADF) is seen as the "heart and soul" of online education and one of the most powerful tools for creating online learning communities because of its potential to support a learning environment where learners actively interact and construct knowledge (Corich et al., 2007; Jonassen, 1994; Harasim, 2000). In online classrooms that seek to facilitate knowledge construction, ADF is the most common space in which this

collaborative knowledge construction is demonstrated (Hall, 2010). Computer-mediated asynchronous communication tools offered new possibilities for a study that was not available in traditional learning models, making the process of collaboration more transparent by looking at the transcripts of ADFs which can be used to assess individual roles and contributions and the collaborative process itself (Aviv et al., 2010). ADFs seem a remarkable fit for constructivist and collaborative approaches to learning as it not only allows students and teachers to interact with each other, permitting both parties to shape the nature of the exchange, but also prompts students to review posted information and analyze their Toideas before responding because they are not constrained to respond immediately, and because most online communication is text-based, it has the potential to strengthen writing skills and encourage more deliberate articulation of ideas (Pena-Shaff & Nicholls, 2004). The opportunity for asynchronous interaction facilitates communication across time zones and increases control by the user over time and pace of participation, providing participants the opportunity to comment immediately or to reflect and compose a response thoughtfully. (Harasim et al., 1995).

In an online learning environment, ADFs provide potential convenience by allowing students to interact with each other and with the instructor when and where they want, and even to control the pacing of instruction, without the direct stimulation of real-time interaction (Bento & Schuster, 2003). The asynchronicity of online interaction allows participants time to reflect on a topic before commenting or carrying out outline tasks (Harasim et al., 1995). The distance-and-time-independent nature of online asynchronous discussion forums provides students more time to look into posts made by themselves and others and more opportunities to respond to others' messages at their own pace, if and how they choose to.

As we move from traditional to virtual classrooms, the challenge of understanding and nurturing student participation in class discussions is being considered not just something “nice to have,” but an essential part of the teaching and learning process in a student-centered and constructivist approach to education where control shifts from the teacher to the learner (Anderson & Garrison, 1998; Bento & Schuster, 2003; Corich et al., 2007).

The pedagogy supporting the use of asynchronous communication tools within learning communities has its roots in constructivism and social constructivism where interactions provide an opportunity for learners to create their own understanding by communicating with others and collaborate by sharing experiences and information in a way that promotes critical thinking and knowledge construction (Corich et al., 2007). Unlike the traditional classroom activity, in which the teachers direct the instruction, lead the lessons, prompt responses, and pace the class, online group learning is student-centered and requires a different role for the teacher, of facilitator rather than lecturer (Harasim et al., 1995).

The social construction of knowledge is a phenomenon defined by Gunawardena (1997) as a function of interaction, which is understood as a reciprocal influence among individuals that engage in dialogue (Gomez, 2018). Social constructivist pedagogy acknowledges the social nature of knowledge and its creation in the minds of individual learners, and each learner constructs means by which new knowledge is both created and integrated with existing knowledge (Anderson & Dron, 2011). According to constructivist learning theories, how we construct knowledge will depend on what is already known, and what we know depends on the kinds of experiences that we have had and how we have come to organize these into existing knowledge structures (Anderson & Kanuka, 1998).

Social constructivism is currently the most accepted epistemological position associated with online learning and in this view, the assumption is that knowledge is grounded in the relationship between the knower and the known and that knowledge is generated through social intercourse, and through this interaction, we gradually accumulate advances in our levels of knowing (Anderson & Kanuka, 1998). The value of another person's perspective, usually gained through interaction, is a key learning component in constructivist learning theories and in inducing mindfulness in learners' interaction has always been valued in distance education, even in its most traditional, independent study format (Jonassen, 1991; Anderson, 2004). Works on collaborative learning are said to illustrate potential gains in cognitive learning tasks, as well as increases in completion rates and the acquisition of critical social skills in education (Anderson, 2004).

Modern constructivist theorists stressed that the learner-to-learner interaction, an inter-learner interaction, between one learner and other learners, alone or in group settings, with or without the real-time presence of an instructor, is an essential and extremely valuable resource for learning and in investigating and developing multiple perspectives (Anderson, 2004; Moore, 1989).

For many years, the focus of research studies among online learning practitioners and researchers is how interaction and learning take place in an online learning setting. In a traditional bricks-and-mortar school, teachers can see who among the students are participating in a class discussion - who are speaking or participating, who are listening (or at least those who seem to be listening) and who are not. This can be quite difficult in an online learning setting since the social cues that teachers need to identify who is listening and those who are not, are not easily seen or visible inside the online classroom.

The type of interaction that usually happens when a participant communicates with other online participants through contributing posts and replying to other's posts in online discussion forums can be referred to as the speaking interaction pattern. These are the interactions that are more visible to the participants in the online classroom. On the other hand, the listening interaction pattern is the type of interaction between online participants when a participant accesses, reads, or views forum posts contributed by other participants. These interactions among participants are not easily visible or not visible at all to the students since these activities can only be seen by extracting records from the log records in the learning management system (LMS) and they are only accessible to the teachers or LMS administrators.

Although interactions are highlighted as an essential element in learning and knowledge construction, student participation is mostly associated only with the speaking interaction patterns (contributing and replying to posts). Listening interactions (viewing or reading posts) in online learning settings are not very popular and oftentimes less explored in research studies. Participation which is considered apparent only via the textual trace that a participant leaves by posting a message can typically serve as visual evidence, but is a limited indicator of student engagement since discussion itself requires a pattern of call and response, with turn-taking and listening being as important as contributing thoughts to the dialogue (Dennen, 2008; Lapadat, 2002). While much has been written regarding the learning behaviors of students participating in online courses, little research has been conducted to ascertain whether or not students are still engaged and actually learning when students are listening, not actively involved, or not actively seen in online discourse with other students (Beaudoin, 2002).

In a typical online learning management system, participants don't usually

see what posts other learners have opened, read, or accessed. Listening interaction patterns of students are commonly left tagged as non-participation and assumed to be of no contribution to learning. More frequently, these 'invisible' interactions where learners viewed or 'listened' to other learners' posts were not considered as another form of learner-to-learner interaction and were oftentimes left unrecognized as part of learners' participation and learning. In most cases, the non-existence of a learners' posts in ADFs are assumed as non-participation of learners and was assumed to lead to all sorts of negative feelings toward those students who are "missing" and apparently do not care about the course content or their peers, and an assumption that ultimately will result in no learning, a disastrous grade, or the student quitting the course (Bento & Schuster, 2003). What is not seen in asynchronous environments, literally and figuratively, is what else is going on that contributes to participants' learning, thus, it is easy to assume that unless learners in online formats are actively participating by posting frequent and relevant contributions, they may be benefiting relatively little from this more passive experience (Beaudoin, 2002).

Wise et al. (2013) emphasized that productive participation in online learning conversations requires more than just making posts - the students should read the existing messages in the forum before posting their messages to create quality interactive discussion. Moreover, other research studies suggested that a great deal of learning occurs even when learners are not posting (Dennen, 2008; Sutton, 2000; Wise et al., 2013). Several authors refer to these listening interaction patterns in different terms such as "listening behaviors" (Wise et al., 2013, Durairaj & Umar, 2015), "vicarious interactions" (Sutton, 2000), "lurking" (Beaudoin, 2002; Chen et al., 2006; Dennen, 2008), "witness learning" (Fritsch, 1997), or sometimes "silent

participation" (Nonnecke & Preece, 2003).

Research studies suggested that engaging with other's posts can support productive discussion not only as part of a direct sequence of events leading up to making a post, as participation in online discussions requires attention not only to learners' overt activity in making posts but also to the less public activity of interacting with the posts of others (Wise, et al., 2013). Previous research studies argued that students' action or task with existing posts in the online discussion is considered as their engagement in the forums or their listening behavior patterns (Durairaj & Umar, 2015; Wise, 2012).

Finding ways to capture these moments of "non-participation" and learning how they relate to active participation and, ultimately, to student learning and performance will help better explain how students might get the most out of their online course experiences (Dennen, 2008).

Thus, in order to have a deeper understanding of student participation in an online learning setting, one must be able to look both at instances when students speak (contribute posts) and also when they listen (access posts), as well as what the students are posting and what posts the students are reading, accessing, or viewing inside the discussion forums.

This study is an attempt to look into the advances of employing a network approach to uncover connections, patterns, and structures of students' online interactions (speaking and listening) and their level of the social construction of knowledge using social network analysis (SNA) as the primary research method, in combination with content analysis and cluster analysis.

Recent studies on the use of SNA measures, in combination with content analysis and cluster analysis, to analyze both the speaking and the listening interaction patterns, and knowledge construction in online discussion forums are relatively very scarce or not investigated at all. Results of this study will hopefully contribute to the studies on methodologies and approaches to explore online interactions focusing on both the speaking and listening patterns.

B. Research Objectives

The focus of this study is to explore the advances of employing social network analysis as the primary research method, in combination with content analysis and cluster analysis, in explaining the characteristics of communication network structures (speaking and listening) that may influence the occurrence of the social construction of knowledge in the online discussion forums.

Specifically, this study aims to:

1. Identify the level of knowledge construction that occurred in the discussion forums using content analysis (Interaction Analysis Model);
2. Describe and visualize the extent of students' interactions (speaking and listening) in the discussion forums using social network analysis and cluster analysis; and
3. Explain the characteristics of online interactions (speaking and listening) and the level of knowledge construction of students with central positions in the online discussion forums.

This study hopes to contribute to the thickening and advancing of literature on the application of three multi-analyses methodologies - SNA, Content Analysis, and Cluster Analysis, to explain network structures of online interactions (speaking and listening) and social construction of knowledge in asynchronous discussion forums. This study also hopes to be a part of the research studies that explore frameworks and approaches that can be used by online researchers, teachers, and practitioners to analyze online interactions.

C. Research Questions

This study attempted to answer the following research questions:

1. What level of the social construction of knowledge occurred in the online discussion forums in an online graduate class?
2. To what extent are students interacting (speaking and listening) in the online discussion forums?
 - a. What are the speaking patterns of the students in the online discussion forums?
 - b. What are the listening patterns of the students in the online discussion forums?
3. How does the network centrality of students' interactions influence the occurrence of the social construction of knowledge in online discussion forums?
 - a. What are the interaction patterns (speaking and listening) of students with central positions in the online discussion forums?

- b. What level of knowledge construction that students with central positions in the online discussion forums reached?

D. Ethical Considerations

To preserve the anonymity, privacy, and confidentiality of the participants in this study, names of participants were not revealed in the data collection, data analysis, and dissemination and reporting of the study findings. Necessary permission and requirements were obtained to secure a copy of the course site where the names of the participants were anonymized and the course name was replaced by a code. Moreover, the name of the university, course name, and academic year where the data was generated was not mentioned.

The results of the study will be shared with the participants and will be reported and disseminated through the thesis dissertation as part of the researcher's course requirements. In the future, the researcher plans to disseminate the results of the study through conference presentations and to publish this paper in the form of a journal article.

Chapter Two

REVIEW OF THE RELATED LITERATURE

Interactions in an Online Learning Environment

Interaction has long been defined as a critical component of the educational process designed to induce and promote learning through intellectual stimulation and the exchange of ideas (Anderson, 2003; Galikyan & Admiraal, 2019). Interaction serves to achieve common meanings among group members, and the meanings among group members and the meanings that individuals together assign to information provide the mechanism by which we come to some common understanding (Littlejohn & Foss, 2008).

For the past decades, interest in research studies focusing on how interaction and learning take place in a student-centered online learning setting has elevated among online learning advocates and practitioners. Previous studies revealed that the level of learners' interaction affects the quality of learning and the learning process itself, thus making it an important factor in the success of online learning and teaching (Anderson & Garrison, 1998; Anderson & Kanuka, 1998; Aviv et al., 2010; Bento & Schuster, 2003; Corich et al., 2007; Durairaj & Umar, 2015; Garrison & Anderson, 2003; Power & St-Jacques, 2014). Durairaj & Umar (2015) have argued that the quality of the interaction determines the success of online learning and that the teaching and instruction are more effective when it occurs in a dialogue form where students can interact with their peers or instructors who guide their learning.

There are several types of interactions such as learner-content interaction, learner-instructor interaction, learner-learner interaction, teacher-teacher interaction, teacher-content interaction, and content-content interaction (Moore, 1989, Anderson & Garrison,1998)

The learner-to-learner interaction which is the focus of this study is defined as an inter-learner interaction, between one learner and other learners, alone or in group settings, with or without the real-time presence of an instructor, is argued to have an essential and extremely valuable resource for learning and in investigating and developing multiple perspectives (Anderson, 2004; Moore, 1989). This study explores both the speaking and listening patterns among online learners in asynchronous discussion forums.

Speaking is the type of interaction that is typically visible and easily measured in an online classroom. This type of interaction usually happens when students communicate with other participants mostly through writing posts or replying to other students' posts in online discussion forums.

On the other hand, the kind of interactions between learners that are not very popular and oftentimes less explored are those interaction patterns of students when students access, read, or view discussion forums to view or read their forum posts or posts contributed by other students. This type of interaction is also called the "listening" interaction pattern. Compared to face-to-face conversations, in online discussions, learners have greater control of what comments they choose to attend to, when they chose to do so, and how long they spend "listening" to them (Wise et al., 2013).

While much has been written regarding the learning behaviors of students participating in online courses, little research has been conducted to ascertain

whether or not students are still engaged and actually learning when not actively involved in an online discourse with other students and faculty (Beaudoin, 2002). Theoretically, speaking and listening are intimately interrelated activities in the process of constructing knowledge through online discussions; however, such connections have not yet been examined empirically (Wise et al., 2014). The majority of research on collaboration in online discussions has focused on the “speaking” aspects of conversation – studying the messages learners contributed and how they interact to produce group meaning-making and much less attention has been paid to the interactions learners have with existing messages and the often extended sequences of listening behaviors they engage in during the processes leading up to contributing (e.g. how learners navigate the existing discussion; how many and which messages they choose to open; how they interact with this content once opened; how they compose their own contributions) (Wise et al., 2013). Moreover, studies looking at both the speaking and listening patterns at the same time, are very scarce or do not exist at all.

Wise, et al. (2013) emphasized that productive participation in online learning conversations requires more than just making posts - the students should read or view the existing messages in the forum before posting their messages to create quality interactive discussion. The permanence of print and the extended time frame allowed by the asynchronous medium permits students to look back, reflect, compose, and revise, and by devoting extra time to thinking, reading, and writing, and by holding higher expectations for the clarity and coherence of their contributions, students engage in higher-order thinking, and thus potentially can achieve deeper understandings (Lapadat, 2002). Importantly, in the specific context of a discussion (whether online or face-to-face), listening is not an isolated endeavor,

but an integral component of the larger activity of giving, receiving, negotiating, building on, and challenging others' ideas, making an important contribution to speaking by supporting subsequent comments that relate to those already made (Wise et al., 2014).

Related research studies suggested that a great deal of learning occurs even when learners are not posting (Dennen, 2008; Sutton, 2000; Wise et al., 2013). Some authors refer to these "listening" interaction patterns in different terms such as "listening behaviors", "invisible learners", "vicarious interactions", or "silent participation", while others use terms as "silent learners", "observers", "browsers", "read-only participants", "vicarious learners", "free-riders", "witness learners", or "legitimate peripheral participants" to refer to participants who never post or post infrequently (Beaudoin, 2002; Chen et al., 2006; Dennen, 2008; Durairaj & Umar, 2015; Honeychurch et al., 2017; Nonnecke & Preece, 2003; Sutton, 2000; Wise et al., 2013).

Sutton (2000) used the term "vicarious interactions" to refer to interactions when a student actively observes, absorbs, and processes the ongoing interactions between other students and between other students and their instructor. Dennen (2008) argued that while most often visible or active messages are assessed or measured and implicitly valued in online class discussion, the act of writing messages is not the only factor that contributes to student learning. Findings in her study revealed that both posting and reading messages contributed to the students' ability to learn and students who participated solely to meet course requirements and who focused on posting messages more than reading messages had less positive impressions of the discussion activity's impact on learning.

Beaudoin (2002), in his study on tracking the 'invisible' online students, found out that students spent a significant amount of time in learning-related tasks, including logging on, even when not visibly participating, and they feel they are still learning and benefiting from this low-profile approach to their online studies. Chen et al. (2006) argued that lurkers, who are said to engage in participation but in a limited way, need not necessarily be viewed as passive participation but, instead, as sets of tension and negotiation that are encountered by these less confident learners, and their seemingly silent participation conveys even deeper engagement than that of the non-lurkers. Nonnecke & Preece (2003) added that lurking is a strategic activity that involves more than just reading posts.

Wise, et al. (2013) conceptualized the term "online listening behaviors" as a pre-condition for productive interactivity and knowledge construction through engagement with the posts contributed by others. Wise, et al. (2013) further suggested that productive participation in online learning conversations requires more than just making posts - the students should read the existing messages in the forum before posting their messages to create quality interactive discussion. They also added that engaging with other's posts can also support productive discussion not only as part of a direct sequence of events leading up to making a post, as participation in online discussions requires attention not only to learners' overt activity in making posts but also to the less public activity of interacting with the posts of others. Students' action or task with existing posts in the online discussion is considered as their engagement in the forums or their listening behavior patterns (Durairaj & Umar, 2015; Wise, 2012).

Wise et al. (2014) suggested that listening behavior patterns can be calculated according to four dimensions, namely breadth, depth, temporal contiguity,

and revisitation. Listening breadth refers to the extensiveness of listening and can be considered both in terms of the total quantity of other's posts attended to (indicating the potential the diversity of ideas to which a learner is exposed) or their proportion out of the total number available (suggesting their ability to respond to the discussion as a whole). Listening depth refers to the degree to which learners consider others' ideas while listening revisitation refers to the extent to which a learner returns to posts made by themselves and others that they have attended to previously. Temporal contiguity is how a learner manages and divides their time within a discussion.

Asynchronous Discussion Forums (ADFs)

The advent of new communications technology such as computer-mediated communication (CMC) and learning networks has facilitated new ways of teaching and learning, opening up new perspectives on how interaction and learning take place in an online learning environment. The growth of online learning environments entails an understanding of how to promote collaborative knowledge construction processes and create learning environments that support meaningful student engagement and interactions (Galikyan & Admiraal, 2019). More than simply a common meeting place, an online learning community allows for mutual exploration of ideas, a safe place to reflect and develop those ideas, and a collaborative, supportive approach to academic work (Palooff & Pratt, 2007).

The exchange of messages among a group of participants using networked computers, to discuss a topic of mutual interest, is referred to as computer-mediated conferencing or computer conferencing (Gunawardena et al., 1997). Of all networking media available to educators in the 1980s and 1990s, conferencing

systems were the most amenable to instructional design and can be thought of as “spaces” that can be shaped to create an educational forum (Harasim, 2000). Contemporary educators who view learning as interactive, discursive, and situated have argued that well-designed online conferencing environments may be particularly suited to provide the socio-cognitive support for learning seen as fundamental to constructivist pedagogies (Lapadat, 2002). A computer-mediated conference like asynchronous discussion forum (ADF), which is also considered as the “heart and soul” of online education, is seen as one of the most powerful tools for creating online learning communities because of its potential to support a learning environment where learners actively interact and construct knowledge (Corich et al., 2007; Jonassen, 1994; Harasim, 2000). ADFs have become the main vehicle through which the teaching-learning process in online courses is facilitated (Gunawardena et al., 2016).

Online learning typically uses a learning management system (LMS) such as Moodle which serves as the online classroom where students and teachers meet and conduct classes. One of the most popular tools in LMS is the online asynchronous discussion forum (ADF) feature where the participants have the opportunity to exchange their experience through interaction in a forum, react to the course reading and even give comments on the viewpoints of their peers on the topics discussed in the course (Dooga, 2010, as cited by Roseli & Umar, 2015). In online classrooms that seek to facilitate knowledge construction, ADF is the most common space in which this collaborative knowledge and meaning are actively constructed, and the members of the community enhance the acquisition of knowledge and understanding and thereby satisfying learning needs (Hall, 2010; Rigou, 2004).

ADFs are intended to support knowledge construction and higher-order thinking is becoming even more appealing for their predictive relationship with learning (Galikyan & Admiraal, 2019). Online forums provide the potential for new forms of collaborative work, study, and community that reduce barriers of time and distance and their asynchronous qualities increase access and expand opportunities for discussion, interaction, and reflection (Anderson & Kanuka, 1998; Harasim, 2000). In discussion forums (DFs), critical thinking is evident when participants construct meaning while communicating with fellow participants, and when used appropriately, DFs can enable rapid dissemination of information and can encourage feedback and the refinement of ideas among participants (Corich et al., 2007).

Citing Lamy & Goodfellow (1999), Corich et al. (2007) mentioned that educational researchers have also reported positive outcomes using threaded discussions that encourage students to accept responsibility for building knowledge by reflecting on course materials and discussing content with fellow participants. Galikyan & Admiraal (2019) argued that learner interactions in computer-supported collaborative learning (CSCL) environments such as discussion forums promote learning through intellectual stimulation and the exchange of ideas.

The pedagogy supporting the use of asynchronous communication tools within learning communities has its roots in constructivism and social constructivism which suggest that the optimal learning environment is one in which there is a dynamic interaction between instructors and learners, and these tasks provide an opportunity for learners to create their own understanding by communicating with others and collaborate by sharing experiences and information in a way that promotes critical thinking and knowledge construction (Corich et al., 2007). Wang et al. (2009) suggested that group collaboration and class discussions contributed to

students' social knowledge construction. Moreover, online course activity based upon asynchronous communication is argued to yield an entirely new learning pattern that is highly active engagement (Harasim, 2000).

Contemporary educators who view learning as interactive, discursive, and situated have argued that well-designed online conferencing environments may be particularly suited to provide the socio-cognitive support for learning seen as fundamental to constructivist pedagogies (Lapadat, 2002). The characteristics of an asynchronous conference to store chronological compilation of written messages that course participants have composed, capacity to add incoming messages on a dynamic basis, and the flexible structuring and sequencing to enable users to sort, and, in some cases, also to search the messages in various ways, have been suggested to endow participants' textual contributions with interactivity and continuity that have the “feel” of conversation (Lapadat, 2002).

Social Construction of Knowledge

The social construction of knowledge is a phenomenon defined by Gunawardena et al. (1997) as a function of interaction, which is understood as a reciprocal influence among individuals that engage in dialogue (Gomez, 2018). According to constructivist learning theories, how we construct knowledge will depend on what is already known, and what we know depends on the kinds of experiences that we have had and how we have come to organize these into existing knowledge structures (Anderson & Kanuka, 1998).

Social constructivism is currently the most accepted epistemological position associated with online learning and in this view, the assumption is that knowledge is

grounded in the relationship between the knower and the known and that knowledge is generated through social intercourse, and through this interaction, we gradually accumulate advances in our levels of knowing (Anderson & Kanuka, 1998).

Social constructivism reminds us that learning is essentially a social activity and that meaning is constructed through communication, collaborative activity, and interactions with others as it highlights the role of social interactions in the making of meaning, especially the support of more knowledgeable others in knowledge construction (Swan, 2005).

Social constructivist pedagogy acknowledges the social nature of knowledge and its creation in the minds of individual learners, and each learner constructs means by which new knowledge is both created and integrated with existing knowledge (Anderson & Dron, 2011).

Social constructivism encourages us to consider the critical function of language as the vehicle of thought and hence of knowing and learning, and to understand how knowledge and knowing are culturally and historically determined and realized (Swan, 2005). The value of another person's perspective, usually gained through interaction, is a key learning component in constructivist learning theories and in inducing mindfulness in learners' interaction has always been valued in distance education, even in its most traditional, independent study format (Jonassen, 1991; Anderson, 2004). Work on collaborative learning is said to illustrate potential gains in cognitive learning tasks, as well as increases in completion rates and the acquisition of critical social skills in education (Anderson, 2004).

Constructivists believe that learning is affected by the context in which an idea is taught as well as by students' beliefs and attitudes, that is, learners will be constantly trying to derive their mental model of the real world from their perceptions

of that world, and as they perceive each new experience, learners will continually update their own mental models to reflect the new information, and will, therefore, construct their own interpretation of reality (Bada & Olusegun, 2015).

Connectivism

The theory of connectivism is one of the most prominent of the network learning theories that have been developed for e-learning environments which postulates that learning occurs through the creation of networks with people and information sources mediated and enhanced by technology, and overall understanding is reflected by the patterns that emerge as a result of the network (Goldie, 2016, Siemens, 2007).

Connectivism continues to play an important role in the development and emergence of new pedagogies, where control is shifting from the tutor to an increasingly more autonomous learner, where learners will be at the center of the learning experience, rather than the tutor and the institution, and where learners will be instrumental in determining the content of the learning, in addition to deciding the nature and levels of communication, and who can participate (Kop and Hill, 2008).

The theory of connectivism asserts that knowledge is distributive and consists of the network of connections formed from experience, conversation, and interaction, on sharing, creation, and participation, on learning not as a separate activity, but rather, as embedded in meaningful activities such as games or workflows (Downes, 2012). Learning, in other words, occurs in communities, and learning activity is, in essence, a conversation forming a rich tapestry of resources, dynamic and interconnected, created not only by experts but by all members of the community, including learners (Downes, 2010).

The theory of connectivism, which asserts that knowledge - and therefore the learning of knowledge - is distributive, that is, not located in any given place (and therefore not 'transferred' or 'transacted' per se) but rather consists of the network of connections formed from experience and interactions with a knowing community (Downes, 2010). Connectivity enhances the process of learning and knowledge building in the network society, thus, for connectivism, knowledge is in the interaction that occurs in the network (Martinez & Frutos, 2018).

Connectivism is a term coined by Goerge Siemens to describe the learning networks, and at its heart, is the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks (Downes, 2012).

Siemens (2004) introduced the following principles of connectivism:

- Learning and knowledge rest in a diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- The capacity to know more is more critical than what is currently known
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

Connectivism is one of the most prominent of the network learning theories that have been developed for e-learning environments (Goldie, 2016). In connectivism, the starting point for learning occurs when knowledge is actuated through the process of a learner participating, connecting to, and feeding information into a learning community (Kop & Hill, 2008, Goldie, 2016).

Connectivist learning is a process of immersion in an environment, discovery, and communication – a process of pattern recognition rather than hypothesis and theory-formation (Downes, 2012). Connectivism is driven by the understanding that decisions are based on rapidly altering foundations, and where new information is continually being acquired, the ability to draw distinctions between important and unimportant information, and the ability to recognize when new information alters the landscape based on decisions made yesterday is vital and critical (Siemens, 2004). Siemens (2004) added that the starting point of connectivism is the individual and that the cycle of knowledge development (personal knowledge to network to organization) allows learners to remain current in their field through the connections they have formed. Connectivism posits that learning occurs through the creation of networks (with people and information sources mediated and enhanced by technology), and overall understanding is reflected by the patterns that emerge as a result of the network (information is being considered, filtered, or discarded) (Siemens, 2007).

Connectivism presents a model of learning that acknowledges the tectonic shifts in society where learning is no longer an internal, individualistic activity (Siemens, 2004). Connectivism continues to play an important role in the development and emergence of new pedagogies, where control is shifting from the

tutor to an increasingly more autonomous learner, where learners will be at the center of the learning experience, rather than the tutor and the institution, and where learners will be instrumental in determining the content of the learning, in addition to deciding the nature and levels of communication, and who can participate (Kop and Hill, 2008).

Social Network Analysis (SNA)

Social Network Analysis (SNA) is a perspective or a paradigm that takes as its starting point the premise that social life is created primarily and most importantly by relations and the patterns they form, looking beyond the specific attributes of individuals to consider relations and exchanges among social actors (Marin & Wellman, 2011; Garton et al., 1997). Unlike a theory, SNA provides a way of looking at a problem but it does not predict what we will see nor provide a set of premises from which hypotheses or predictions can be derived (Marin & Wellman, 2011).

At the heart of SNA is the branch of mathematics called graph theory, in which individuals and other social actors, such as groups, organizations, and so on, are represented by the points and their social relations are represented by the lines (Scott & Carrington, 2011; Hanneman & Riddle, 2011). The three essential components of a social network are a set of nodes (or actors) and arcs (or links), a sociogram or graph (created with the nodes and arcs), and a sociomatrix (Willging, 2005). SNA used two kinds of tools from mathematics to represent information about patterns and ties among social actors: graphs and matrices (Hanneman & Riddle, 2011). A graph or digraph is a visual representation of a social network, where actors are represented as nodes or vertices and ties are represented as lines (also called edges or arcs), while a matrix is an array (or list) of data (usually named with a bold

letter) used to present information when there are many actors or many relations in a network (Prell, 2012).

The concept of network is prominent in the theory of connectivism which argues that learning is a process of building networks of information, contacts, and resources that apply to real problems (Anderson & Dron, 2011). The date at which researchers on the social structure began to explicitly use the idea of “social network” is difficult to determine with any precision, while structural thinking has deep roots in the sociological tradition (Scott & Carrington, 2011).

Network analysis is certainly not a recent development, although the main emphasis it has received from social scientists has occurred primarily in the past years (Rogers & Kincaid, 1981, p.90). SNA did not evolve via a neat, linear process, but it resulted from multiple interactions among academics; some of these interactions accumulated into their own unique research groups and sub-disciplines while some interactions spanned across disciplines, and some resulted in more formal, institutional frameworks that worked to promote and build the field in its own ‘discipline’ (Prell, 2012). German sociologist Georg Simmel was one of the first to recognize the theoretical significance of networks in understanding behavior change, based on Jacob L. Moreno’s efforts on the development of sociometry, which was widely considered as the precursor to Social Network Analysis (SNA) (Prell, 2012; Rogers & Kincaid, 1981). SNA emerged during the 1960s and 1970s at the Harvard sociology department where Harrison White led a group of young scholars focusing on social network concepts and analytical techniques (Prell, 2012). The social network perspective emphasizes multiple levels of analysis: differences among actors are traced to the constraints and opportunities that arise from how they are

embedded in networks: the structure and behavior of networks are grounded in and enacted by local interactions among actors (Hanneman & Riddle, 2011).

SNA is used as a tool for studying relations as it provides both a visual and mathematical analysis of human relationships (Erin et al., 2009). Some of the theoretical approaches and frameworks used in the social network community look at how pairs of actors are attracted to one another based on certain characteristics or behaviors they possess (Social Selection Network Theory), how actors influence one another's thoughts and behaviors (Social Influence Theory), and how negotiated bargaining scenarios between actors involving individual decisions to give (or not to give) are shaped by unequal power relationships between individuals and influenced by network structure in which actors are found (Network Exchange or Social Exchange Theory) (Prell, 2012). Individual behavior is believed to be influenced through the relationships of the individual with others, thus, knowledge of an individual's network links allows interpretation of their social behavior and offers a basic explanation for the individual's behavior change (Rogers & Kincaid, 1981).

In the most general terms, SNA is a structuralist paradigm: it conceptualizes social life in terms of structures of relationships among actors rather than terms of categories of actors (Scott & Carrington, 2011p.6). Network analysis is a method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by using some type of interpersonal relationships as the units of analysis (Rogers & Kincaid, 1981).

For a communication researcher, knowledge of an individual's network links allows interpretation of their social behavior (Rogers & Kincaid, 1981). A network consists of interconnected individuals who are linked by patterned communication flows and this network in which the individual is embedded offers a basic explanation

for the individual's behavior change (Rogers & Kincaid, 1981). It connects groups and enables them to exchange information, and groups cluster together according to common beliefs, values, and behaviors (Littlejohn, 1996).

Network analysis is the method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by using some type of interpersonal relationships as the units of analysis (Rogers & Kincaid, 1981). Network analysis describes the linkages created by the sharing of information, and their interrelationships, in the interpersonal communication structure (Rogers & Kincaid, 1981). This analytical approach is beneficial to organization and communication researchers because it allows them to "trace specific message flows in a system, and then compare this communication structure with the social structure of the system in order to determine how this social structure is interrelated with the communication network" (Rogers & Kincaid, 1981, p.82).

In recent years, the popularity of the use of network analysis to analyze interaction patterns and knowledge construction of students in online learning communities has become evident in various research studies among online learning advocates and practitioners.

SNA and Online Interactions

The basic unit of relationship is not the person nor two individuals but interaction - behaviors responding to other behaviors, and such, over time the nature of relationships is formed or made, through a series of interactions - responses to responses to responses (Littlejohn & Foss, 2008). To understand how learners interact in an online learning setting, it is important to look at how students

participate and engage with other participants - who are speaking and who are listening. In a traditional bricks-and-mortar school, teachers can easily see who among the students are participating in a class discussion - who is speaking, who is listening, and who is not. This can be quite difficult in an online learning setting since the social cues that teachers need to identify who is listening are not easily seen or visible in online classrooms. In linear bulletin boards threads, the dynamics of conversations and social groupings that may emerge around conversational topics are hidden in the lines of online postings, and is hard to determine who are not engaged in the conversations or having a peripheral activity (Willging, 2005).

Social network analysis (SNA) has proven to be extremely powerful at describing and analyzing network behaviors in various fields. SNA techniques paired with recent developments in software for visualization could help provide a clearer picture of what is happening in the online environment, creating the visual objects that represent the online interactions (Willging, 2005). Research studies show the use of network analysis as a primary research method for investigating interaction and structural patterns to understand relationships, direction and strength of interactions, group dynamics, and network connectedness and centralization in computer-mediated environments and online learning communities (Cela et al., 2015; De Laat et al., 2007; Jan 2018; Scott et al., 2005; Thormann et al., 2013; Willging, 2005).

De Laat et al. (2007) argued that SNA can help in identifying patterns of relationship between people who are part of a social network by illuminating the 'flow' of information and/or other resources that are exchanged among participants. Their study also suggested that SNA can provide a useful window for teachers and students to see how the students are engaged in the project as it provides

information about the overall group's functioning and the strength and direction of their interactions.

Cela et al. (2015) who did a preliminary systematic review on the potentials of SNA to understand and improve e-learning systems have strongly suggested that SNA, particularly when combined with content analysis, can provide a detailed understanding of the nature and type of interactions between members of the network, allowing for optimization of course design, the composition of learner groups and identification of learners in danger of dropping out.

Jan et al. (2019) argued that the intricate relationship between networks and communities, structural parallels between the two, and access to retrospective and real-time big data from LMS, make SNA the ideal technique for structurally investigating learning communities.

Willging (2005) used SNA techniques and visualizations to examine interactions in an online asynchronous forum. His study revealed that SNA provided useful information about virtual interactions in asynchronous spaces and SNA metrics and three-dimensional representations were able to reveal structural characteristics of the group, identifying central members, bridges, and isolates in the class.

Another study concluded that SNA provides more meaningful students' interactions analysis in terms of information of communication structures, level of participation, identifying who is the central participant, identifying who is involved in the discussion, bridge and isolate (able to determine who are not engaged in the discussion) (Erin et al., 2009). Their study further suggested that SNA can be a useful research tool for revealing network structures of online discussion in asynchronous form and SNA techniques can be used by instructors and teachers to

evaluate and monitor interaction among students, making them aware of social interaction developed in online asynchronous.

Some of the social network metrics that can be used in network analysis to measure students' engagement and social level of interaction in asynchronous discussion forums include centrality, density, the strength of ties, and direction of interactions (Durairaj & Umar, 2015; Scott & Carrington, 2011).

SNA and Social Construction of Knowledge

Recent research studies used SNA measures to ascertain a possible relationship between students' online interactions and critical thinking (Thormann et al., 2013), and as an analytic tool for interaction patterns in primary care practices to construct a visual representation of the networks, illustrating the web of decision-making consultations in each entire network (Scott et al., 2005).

Lumanta, et al. (2018) did an exploratory study that assessed student interaction in an online graduate colloquium class using centrality and density measures, and results indicated that the pedagogical approach maximizes interaction among learners in an online learning community positively contributes to knowledge construction. Using network analysis, the study was able to map interactions in the online colloquium to show network density implying that there is a strong connection among the students to actively share and exchange information among themselves leading to knowledge construction.

In Aviv et al. (2010)'s study, the quality of the knowledge construction process is evaluated through Content Analysis and the network structures are analyzed

using Social Network Analysis among participants during online discussions. Their research study concluded that a well-designed asynchronous learning network develops significant, distinct cohesion, and role and power structures lead the knowledge construction process to high phases of critical thinking.

Gomez (2018), on the other hand, used mixed methods on a research project to identify interaction patterns among graduate students by analyzing discussion forum posts, measuring student centrality, and generating social network diagrams to explain the characteristics of posts and social networks that may contribute to the social construction of knowledge. The researcher noted that evidence was found that suggests a possible relationship between the centrality measure in-degree and high levels of the social construction of knowledge.

Durairaj & Umar (2015), proposed a collaborative approach combining multi-analysis techniques which include content analysis, cluster analysis, and social network analysis to measure students' social interaction and knowledge construction in an asynchronous online forum. They suggested that SNA can provide visual information such as strong or weak ties in the network as well as information about potential high achievers or low-performing students in the class.

Meanwhile, Heo, et al. (2010) employed SNA and content analysis to investigate how online interaction in project-based learning influences successful learning performances. Their study suggested that the visualized information on interaction patterns and individual prominence in relations with others through network analysis can provide both teachers and students with opportunities to reflect on participation and interaction in collaborative work.

Tirado et al. (2015) used SNA and content analysis to study the effects of centrality and cohesion on the social construction of knowledge in discussion forums.

The results of their study showed a positive correlation between cohesion and centralization, and the positive influence of the cohesion index and the centralization index on social presence and cognitive presence in knowledge building.

In 2010, Buraphadeja's study asserted that centrality measures in SNA and mean level of knowledge construction are related based on the notion that individuals construct knowledge by interacting with others, and thus more interactions would result in higher levels of knowledge construction.

Gunawardena et al. (2016), on the other hand, suggested combining interaction analysis with learning analytics and Social Network Analysis to conceptualize the process by which knowledge construction takes place in online platforms. They further concluded that the study of the relationship between the social construction of knowledge and student centrality helps researchers gain a better grasp of the characteristics of discussion postings and the degree of student centrality associated with potential paths to higher levels of knowledge construction.

Social Network Analysis (SNA) Measures

Centrality

The most widely used approach to understanding the structural sources of individuals' advantage and disadvantage relative to their neighbors is that of centrality where the core idea is very simple: actors who are more 'central' to social structures are more likely to be influential or powerful (but possibly also more constrained) (Hanneman & Riddle, 2011, p. 363).

Centrality measures have typically been used as indicators of power, influence, popularity, and prestige (Scott & Carrington, 2011). Network analysts often describe the way that an actor is embedded in a relational network, and actors that

face fewer constraints, and have more opportunities than others, are in favorable structural positions which means that an actor may extract better bargains in exchanges, have greater influence, and maybe a focus for deference and attention from those in less favored positions (Hanneman & Riddle, 2011).

With regards to social relations in online discussion forums, the question of who writes to who has important implications for information flow, so it is relevant to analyze interaction patterns of both independent relations and the totality of interconnected relations (Gunawardena et al., 2016). Student centrality is a concept that accounts for the social aspect of knowledge construction in that it serves as an indicator of student influence on other students (Gunawerdena et al., 2016, p.14).

a. Degree Centrality

Degree centrality is a method of evaluating centrality based on a student's direct linkage to other students, presented by in-degree centrality and out-degree centrality to represent popularity and activity (or expansiveness) (Erin et al., 2009). Degree centrality measures an individual's involvement in the network - indegree centrality reveals "popular" actors and outdegree centrality focuses on the expansion of a focal actor's network (Prell, 2016).

Degree centrality is the number of a student's connections (links) with the other participants. If an actor receives many ties, they are often said to be prominent or have high prestige, that is many other actors seek direct ties to them, and this may indicate their importance (Hanneman & Riddle, 2011). Being connected to others that are not well connected makes one powerful because these other actors are dependent on you, whereas well-connected actors are not (Hanneman & Riddle, 2011, p. 365).

In-degree Centrality

In an online setting, the in-degree measure counts inbound posts (a reply to a post made by a student) with other students and an indicator of network "prestige" which results from the number of replies directed to a student's post and represents the degree to which other students seek out that student for interaction, thus students with high in-degree are notable because their information may be considered more important than others in the discussion forum (Gomez, 2018). Students with high in-degree centrality have more interactive activities and thereby receive more information or comments from others which can indicate that his or her ideas may be influential in the discourse, and the participant has more prestige in the network (Erin et al., 2009).

Out-degree Centrality

Out-degree counts outbound posts (an initial post or reply sent by a student) and an indicator of "influence", thus students with high influence are in contact with many other students, as evidenced by the large number of discussion posts that they send to others, while students with low influence post fewer messages and do not contribute to the information flow as much as other students (Gomez, 2018).

Out-degree also describes the extent to which students learn actively. Actors who have unusually high out-degrees are actors who can exchange with many others or make many others aware of their views while actors who display high out-degree centrality are often said to be influential actors (Hanneman & Riddle, 2011, p.364).

b. Betweenness centrality

Betweenness centrality measures how each participant is connected to all other participants, and whether and how participants have formed connections among themselves.

In communication networks, betweenness centrality measures how much potential control an actor has over the flow of information (Prell, 2012). Moreover, betweenness centrality draws attention to who is critical for the network's information flow, i.e. who connects different segments of the network together and is an important intermediary or broker (Prell, 2012, p.113). If an actor rests between many other actors in the network, then this actor can greatly influence the network by choosing to withhold or distort information she or he receives (Prell, 2012, p. 104).

Betweenness centrality allows one to quantify how highly connected an individual may be to others in the network, whether through direct or indirect interaction (Doran et al., 2011). Betweenness centrality views an actor as being in a favored position, that is, the more people depend on an individual to make connections with other people, the more power that person has. Another way to think about betweenness is to ask which relations are most central, rather than which actors. (Hanneman & Riddle, 2011, p. 366). Erin et al. (2009) argued that if information flows among students are often indirect and via a given student, the student has a high betweenness.

c. Closeness centrality

Closeness centrality is considered a more global measure of centrality, as it takes into consideration the entire network of ties when calculating the centrality of an individual actor, emphasizing an actor's independence (Prell, 2012). The actor

who is close to many other actors is a very independent actor and an actor with high closeness centrality would also be seen as someone who could more easily mobilize a network, as he or she can more easily reach out to everyone in the network (Prell, 2012, p. 106).

Closeness centrality is a measure of the distance between each participant and all other participants and could provide an indicator of the overall closeness or connectedness of the group and the relative connectedness of various members within the group (Doran et al., 2011).

Density

Density refers to the proportion of ties in a network that are actually present and looks at the extent to which all the individual actors in a network are linked together (Prell, 2012). Density provides a measure of the overall 'connections' between the participants and indicates the level of engagement in the network or how active the participants are involved in the discourse (Erin et al., 2009).

Density is used to show student involvement in the network as a whole, which means that the density value becomes 100 if all students communicate with one another whereas, if the density is 0, means the network does not have any communication or contact among participants (Durairaj & Umar, 2015). The density of a network may give us insights into such phenomena as the speed at which information diffuses among the nodes and the extent to which actors have high levels of social capital and/or social constraint (Hanneman & Riddle, 2005).

Direction of Interaction

The direction of interaction indicates to whom a participant's response in a discussion forum and is shown through arrows in a network diagram (Durairaj &

Umar, 2015). There are two types of interaction direction: unidirectional or asymmetric and reciprocal or mutual interaction (Durairaj & Umar, 2015; Prell, 2012). Edges are depicted with arrows showing the direction of information flow (Gomez, 2018). The direction of the arrows reflects the direction of interaction between the two participants, and the thickness of the lines usually reflects the strength of the interaction (Tirado et al., 2015). Relations with individuals also differ according to the strength of the tie and the direction of the tie (Prell, 2012).

Network Visualization

A graph or digraph is a visual representation of a social network, where actors are represented as nodes or vertices, and ties are represented as lines (also called edges or arcs), while a matrix is an array (or list) of data used to present information when there are many actors or many relations in a network (Prell, 2012). Applications such as UCINET Netdraw are used to generate the network diagrams. The increase in software applications that have been developed to support SNA reflects the growing interest in the field, and the desire of software developers to explore different aspects of the field (Prell, 2012, p. 226).

Content Analysis

Content Analysis is a systematic coding and categorizing approach to explore large amounts of existing textual information in order to ascertain the trends and patterns of words used, their frequency, their relationships, and the structures, contexts, and discourses of communication (Grbich, 2013).

Content analysis, using the five-phase Interaction Analysis Model (IAM) by Gunawardena et al. (1997) was used in this study to identify the level of knowledge

construction that occurred in the online discussion forums using the transcripts that were extracted from the learning management system.

Interaction Analysis Model (IAM)

The Interaction Analysis Model (IAM) of Gunawardena, Lowe, & Anderson (1997) is an established method used for the content analysis of online course transcripts which consists of five phases of the social construction of knowledge. Gunawardena, Lowe, and Anderson (1997) proposed the Interaction Analysis Model (IAM) to assist in examining the negotiation of meaning and co-construction of knowledge in collaborative learning environments. The IAM is one of the most frequently used instruments in the study of knowledge construction and the extent of its use makes it one of the most coherent and empirically validated instruments in the research field (Lucas, et al., 2014). The IAM is focused on examining the relationship between interactions and it was developed by Gunawardena, Lowe, and Anderson (1997) to qualitatively examine the interactions (or discussions) during the phases of knowledge construction (Gunawardena et al., 2016). IAM is a constructivist model of content analysis used to analyze the construction of knowledge in computer conferencing transcripts in an online forum and has been used globally on examining the relationship between interactions to determine occurrences of the social construction of knowledge in online discussions (Gunawardena et al., 2016).

Gunawardena, Lowe, and Anderson (1997) theorized that the active construction of knowledge moves through five phases (see Fig.1):

- ***Phase I. Sharing/comparing of information.*** In everyday transactions, this might take the form of ordinary observations, statements of problems, or

questions. This phase may include an observation, opinion, agreement, corroborating example, clarification, and/or identification of a problem.

- ***Phase II. Discovery and exploration of dissonance or inconsistency among the ideas, concepts, or statements advanced by different participants.*** This is defined as an inconsistency between a new observation and the learner's existing framework of knowledge and thinking skills. Operations, which may occur in this phase, might include the identification of differences in understanding of terms, concepts, schemas, and/or questions to clarify the extent of disagreement.
- ***Phase III. Negotiation of meaning and/or co-construction of knowledge.*** This phase includes negotiation or clarification of the meaning of terms, identification of areas of agreement, and proposal of a compromise or co-construction.
- ***Phase IV. Testing and modification of proposed synthesis or co-construction.*** Events that occur in this phase include testing against an existing cognitive schema, personal experience, formal data experimentation, or contradictory information from the literature.
- ***Phase V. Phrasing of agreement, statement(s), and applications of the newly constructed meaning.*** This phase encompasses summarizing agreement(s) and metacognitive statements that illustrate new knowledge construction and application.

Figure 1. Interaction Analysis Model (IAM) (Gunawardena et al., 1997)

PHASE I: SHARING/COMPARING OF INFORMATION. Stage one operations include:	
A. A statement of observation or opinion	[PhI/A]
B. A statement of agreement from one or more other participants	[PhI/B]
C. Corroborating examples provided by one or more participants	[PhI/C]
D. Asking and answering questions to clarify details of statements	[PhI/D]
E. Definition, description, or identification of a problem	[PhI/E]
PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS. (This is the operation at the group level of what Festinger [20] calls cognitive dissonance, defined as an inconsistency between a new observation and the learner's existing framework of knowledge and thinking skills.) Operations which occur at this stage include:	
A. Identifying and stating areas of disagreement	[PhII/A]
B. Asking and answering questions to clarify the source and extent of disagreement	[PhII/B]
C. Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view	[PhII/C]
PHASE III: NEGOTIATION OF MEANING/CO-CONSTRUCTION OF KNOWLEDGE	
A. Negotiation or clarification of the meaning of terms	[PhIII/A]
B. Negotiation of the relative weight to be assigned to types of argument	[PhIII/B]
C. Identification of areas of agreement or overlap among conflicting concepts	[PhIII/C]
D. Proposal and negotiation of new statements embodying compromise, co-construction	[PhIII/D]
E. Proposal of integrating or accommodating metaphors or analogies	[PhIII/E]
PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR CO-CONSTRUCTION	
A. Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture	[PhIV/A]
B. Testing against existing cognitive schema	[PhIV/B]
C. Testing against personal experience	[PhIV/C]
D. Testing against formal data collected	[PhIV/D]
E. Testing against contradictory testimony in the literature	[PhIV/E]
PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY-CONSTRUCTED MEANING	
A. Summarization of agreement(s)	[PhV/A]
B. Applications of new knowledge	[PhV/B]
C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction	[PhV/C]

Cluster Analysis

Clustering is an unsupervised method for grouping and it groups the data into sets of related observations or clusters (Myatt, 2007). Cluster analysis is applied to determine the patterns of online listening behavior and to suggest clusters with several patterns of listening behaviors among the participants in the online forum (Durairaj et al., 2015).

Wise (2013) suggested that listening behavior patterns can be calculated according to four dimensions, namely breadth, depth, temporal contiguity, and revisitation. This study adapted Wise's taxonomy using the breadth, revisitation, and temporal contiguity dimensions using 7 variables to describe and classify the characteristics of the listening patterns of the students. Variables were identified and revised according to the availability of data in the learning management system (see Table 1). These variables were utilized using K-means clustering to come up with the speaking and listening patterns using IBM SPSS Statistics version 27, a software package used for statistical analysis.

Chapter Three

METHODOLOGY

A. Research Design

This is an exploratory study using Social Network Analysis (SNA) as the primary research method, in combination with two other approaches - Content Analysis and Cluster Analysis, which aims to uncover patterns and structures of online interactions (speaking and listening) of nine graduate students that may influence the level of knowledge construction in the discussion forums of an online class.

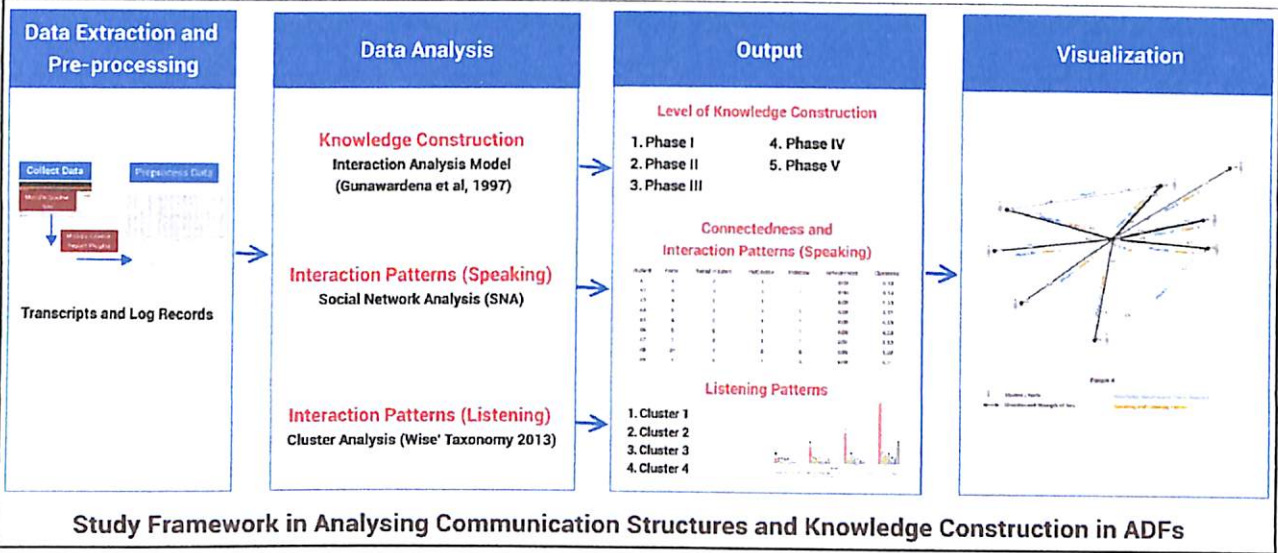
Content analysis, using the five-phase Interaction Analysis Model (IAM) (Gunawardena et al., 1997) was used to identify the level of knowledge construction that occurred in the discussion forums. IAM is a widely-used approach to analyzing the social construction of knowledge and is premised on social constructivism.

Cluster analysis was used to categorize the interaction patterns (listening) of the online learners in the discussion forums using Wise's Taxonomy (2012) involving the listening breadth, revisitation, and temporal contiguity dimensions using seven variables.

SNA was used to measure centrality and density, as well as the strength and direction of ties of the interaction patterns (speaking) of the online learners in the discussion forums. Social network diagrams were generated to visualize the structures of online interactions in relation to the occurrence of the social construction of knowledge in online discussion forums. Figure 2A shows the study

framework used in this research based on the conceptual framework of this study (Figure 2B).

Figure 2A. Study Framework in Analyzing Communication Structures and Knowledge Construction in Online ADFs

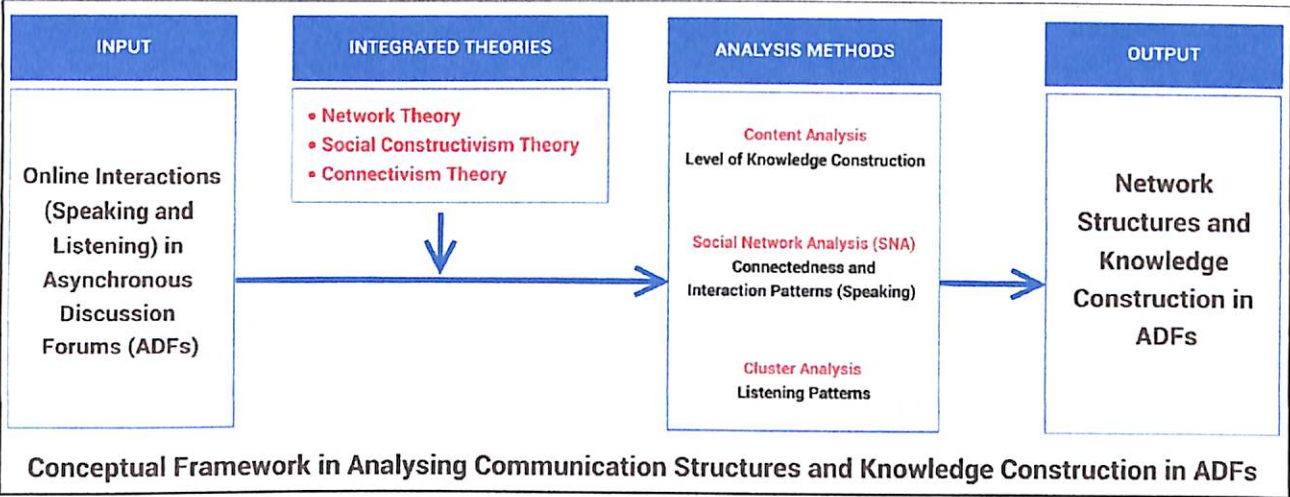


B. Conceptual Framework

The conceptual framework used in this study is grounded on Network Theory where the basic structural idea is that there are connections and relatively stable pathways of communication among individuals (Littlejohn & Foss, 2008); on Vygotsky’s Social Constructivist Learning Theory which posits that knowledge is generated through social intercourse, and that interaction provides an opportunity for learners to create their own understanding by communicating with others and collaborate by sharing experiences and information in a way that promotes critical thinking and knowledge construction (Anderson & Kanuka, 1998, Corich et al., 2007); and on Siemen’s Theory of Connectivism which asserts that learning occurs through the creation of networks in computer-mediated communication and that

knowledge is distributed across a network of connections formed from experience, conversation and interaction, on sharing, creation and participation, on learning not as a separate activity, with learners at the center of the learning experience (Downes, 2012, Kop and Hill, 2008, Siemens, 2004) (Figure 2B).

Figure 2B. Conceptual Framework in Analyzing Communication Structures and Knowledge Construction in ADFs



C. Unit of Analysis

This study utilized the transcripts and log records of nine graduate students who participated in the discussion forums of an online class as part of their class requirements in a graduate program. The data was extracted from an anonymized copy of GradCourse01, an online graduate class using Moodle (Modular Object-Oriented Dynamic Learning Environment), an open-source learning management system (LMS) upon obtaining consent from the course faculty-in-charge and students who were enrolled in the class. GradCourse01 contains discussion forums that are learner-managed. In this course, each student is assigned a colloquium block where he or she will select a specific seminar topic that focuses on research tools, research methods, research approaches, research issues, and practices that are of relevance to and use in researching communication phenomena. Each student is required to present, manage, and moderate a colloquium for one week. Non-presenters, on the other hand, are encouraged and expected to actively participate in all colloquium sessions. The transcripts that were extracted from GradCourse01 contained a total of 732 posts from nine (9) discussion forums. Log records of students' activities including forum posts, views, and session log-ins were also extracted to determine the listening patterns. Log records showed that students accessed the LMS 8,525 times and viewed the discussion forums a total of 3,179 times (Table 6).

To preserve the anonymity, privacy, and confidentiality of the participants in this study, names of participants and course name were anonymized and replaced with codes (ex. A1 for Student 1, GradCourse01 for the course name) in the data collection, data analysis, and dissemination and reporting of the study findings. Informed consent from the faculty-in-charge and the students to analyze the data

from the course forums for this research were obtained through online communication.

D. Data Collection

Data mining process for data collection

This study adapted the process in data mining by Romero, et al. (2007) (see Fig.3) as a tool for data collection. Transcripts of messages and log records of students' activities including forum posts, views, and session log-ins were extracted from nine asynchronous discussion forums in an online graduate course. The online course is a student-managed/driven course that focuses on research tools, methods, approaches, issues, and practices. Data were generated using selected standard report plugins for Moodle and were cleaned and preprocessed using Microsoft Excel and Google Sheets (see Fig. 4). Extracted data used in this study includes transcripts from nine discussion forums containing posts contributed and log records of students' activities including forum posts, views, and session log-ins.

Figure 3. Data Mining Process in Moodle Course Site Using Standard Report Plugins in Moodle (Adapted from Romero et al., 2007)

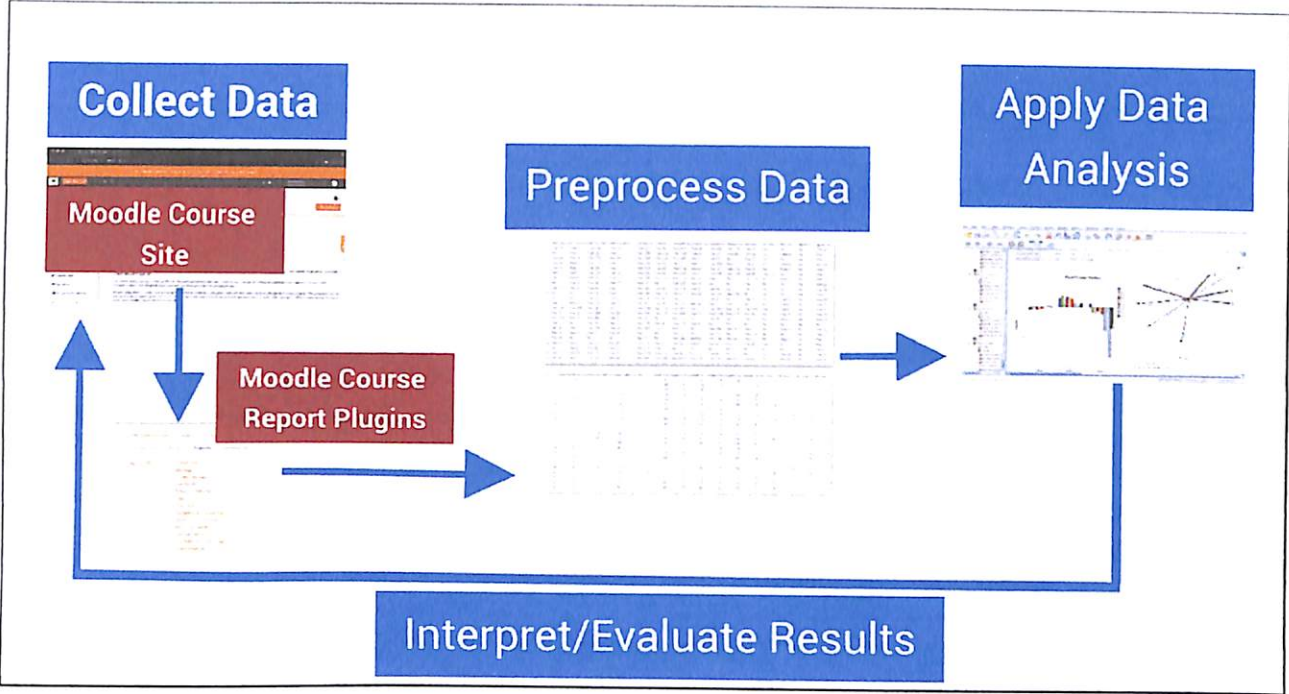
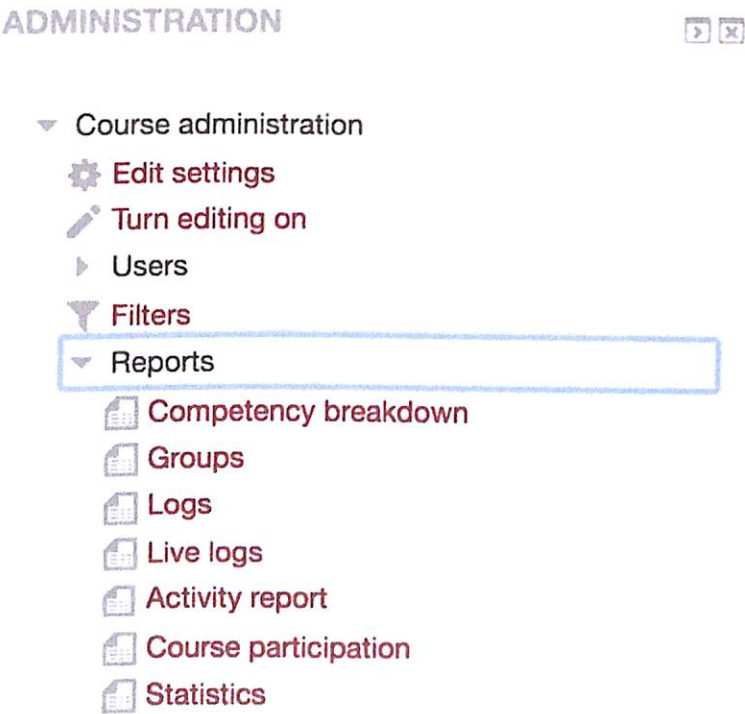


Figure 4. Screenshot of the standard report plugin in the Moodle course site



E. Data Analysis

This study utilized a mixed-method approach using SNA, Content Analysis, and Cluster Analysis to explain characteristics of the communication network structures (speaking and listening) and the level of knowledge construction of learners in the online discussion forums of an online graduate class, GradCourse01. Table 1 summarizes the data analysis procedures that were employed in this study.

Table 1. Data analysis procedures

Research Questions	Procedure and Instrument
1. What level of the social construction of knowledge occurred in the online discussion forums in an online graduate class?	Content Analysis using Interaction Analysis Model (IAM)
2. To what extent are students interacting (speaking and listening) in the online discussion forums?	Cluster Analysis, SNA, and Network Visualization (UCINET NETDRAW)
3. How does the network centrality of students' interactions influence the occurrence of the social construction of knowledge in online discussion forums?	SNA, Cluster Analysis, and Content Analysis

Content Analysis to identify the level of knowledge construction using Interaction Analysis Model (IAM)

Content analysis, using the five-phase Interaction Analysis Model (IAM) by Gunawardena et al. (1997) (*Phase I. Sharing/comparing of information, Phase II. Discovery and exploration of dissonance or inconsistency among the ideas, concepts, or statements advanced by different participants, Phase III. Negotiation of meaning and/or co-construction of knowledge, Phase IV. Testing and modification of proposed synthesis or co-construction and Phase V. Phrasing of agreement, statement(s), and applications of the newly constructed meaning*) was used in this study to identify the level of knowledge construction that occurred in the online discussion forums using the transcripts that were extracted from the learning management system.

Extracted transcripts were processed and saved as code sheets using Excel and Google Sheet. Created code sheets for the posts contributed (speaking) includes information such as username, message, date created, forum number, and IAM phase number (see Fig.5). Each message/post contributed was chosen as the unit of analysis for the coding and evaluation of the level of knowledge construction. Messages in the code sheets were analyzed using Interaction Analysis Model (IAM) (Gunawardena et al., 1997) to identify the level of knowledge construction that occurred in the online discussion forums.

Figure 5. Screenshot of Forum Transcripts Code Sheet

Forum Number

Username/StudentCode

Message

IAM Phase Number

Date Created

Forum Nun ID	Student Code	Message	Level IAM	Forum ID	Date	subject
B1	30 anonfirstname4-m anonlastname4	How do you deal with unreliable results in survey research? How do you increase confidence in the survey process when unreliability haunts?				
B1	31 anonfirstname6-f anonlastname6	It is a researcher's responsibility to produce reliable survey results. To comply with this expectation, if one realizes that at the end of the research, results are inaccurate, then he/she must re-test. He/she should not publish said results unless reliability is met.	1	12	29 Septemr	Re: Your questic
B1	32 anonfirstname3-f anonlastname3	Since we discussed the importance of sample size for validity, should all survey researches use statistically significant sample size? My answer to this question depends on the purpose of the survey. For example, statistically significant sample size do not matter in customer feedback surveys. What are some	3	12	1 October	Re: Your questic
B1	33 anonfirstname5-f anonlastname6	Ideally, survey research should follow the statistically significant sample size for validity purposes. When doing so, research results are accepted with less doubt. Thus for me, statistically significant sample size matters in any form of survey research.	2	12	1 October	Re: Your questic

Cluster analysis to identify listening patterns

This study adapted Wise’s taxonomy using seven variables to describe and classify the characteristics of the listening patterns of the students and revised based on the availability of data in the learning management system (see Table 2).

To analyze the listening patterns of students, extracted data of activities from the learning management system including forum posts, views and log-ins were processed and organized using Excel and Google Sheets. Exported log records saved in Excel/Google Sheet format were processed and saved as worksheets (Fig.6). Worksheets per forum were created for the posts viewed (listening) which includes information such as username, message, date created, forum number. Seven variables were adapted from Wise Taxonomy (2014) including the average number of views per discussion, average number of posts viewed per discussion,

number of times the student logged in the discussion, the total number of sessions in which the student viewed the discussion, the total number of sessions in which the student made a post, the total number of times the student contributed posts discussion forums, and average # of posts per discussion. Variables were measured using K-means clustering using IBM SPSS Statistics version 27, a software package used for statistical analysis to come up with the listening patterns.

Table 2. Summary of listening variables (Adapted from Wise Taxonomy (2014))

Dimension	Variables	Definition
Breadth	Average # of Views per Discussion	Number of times the student viewed the forum divided by the total number of threads
	# of Discussion Views	Number of times the student viewed the discussion forum
Temporal Contiguity	# of Sessions	Number of times the student logged in to the discussion forum
	# of Sessions with Views	Number of sessions in which the student viewed the discussion forum
	# of Sessions with Posts	Number of sessions in which the student made a post
	Average # of posts per discussion	Number of times the student contributed a post divided by the number of threads
	# of Posts	Number of times the student contributed a post

Figure 6. Screenshot of Forum Log Record Sheet

Date Created

Username/StudentCode

Forum Number

Event Name/Activity

Log Records

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Date	User full name	Affected	Event context	Component	Event name	Description	Origin
23/10/20, 20:0	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	23, The user with id '9' h2	
23/10/20, 20:0	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	23, The user with id '9' h2	
10/10/20, 21:1	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	10, The user with id '9' h2	
8/10/20, 18:16	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	8, The user with id '9' h2	
4/10/20, 00:29	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	4, The user with id '9' h2	
4/10/20, 00:29	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	4, The user with id '9' h2	
8/10/20, 18:17	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	8, The user with id '9' h2	
8/10/20, 16:30	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	8, The user with id '9' h2	
30/09/20, 11:3	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	30, The user with id '9' h2	
30/09/20, 02:2	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	30, The user with id '9' h2	
30/09/20, 02:2	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	30, The user with id '9' h2	
27/09/20, 18:3	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	27, The user with id '9' h2	
27/09/20, 18:3	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	27, The user with id '9' h2	
27/09/20, 16:2	anonfirstname2-f anonlas -		Forum: Colloquium Block 1	Forum	Discussion viewed	27, The user with id '9' h2	

SNA to identify patterns and network structures of the interactions

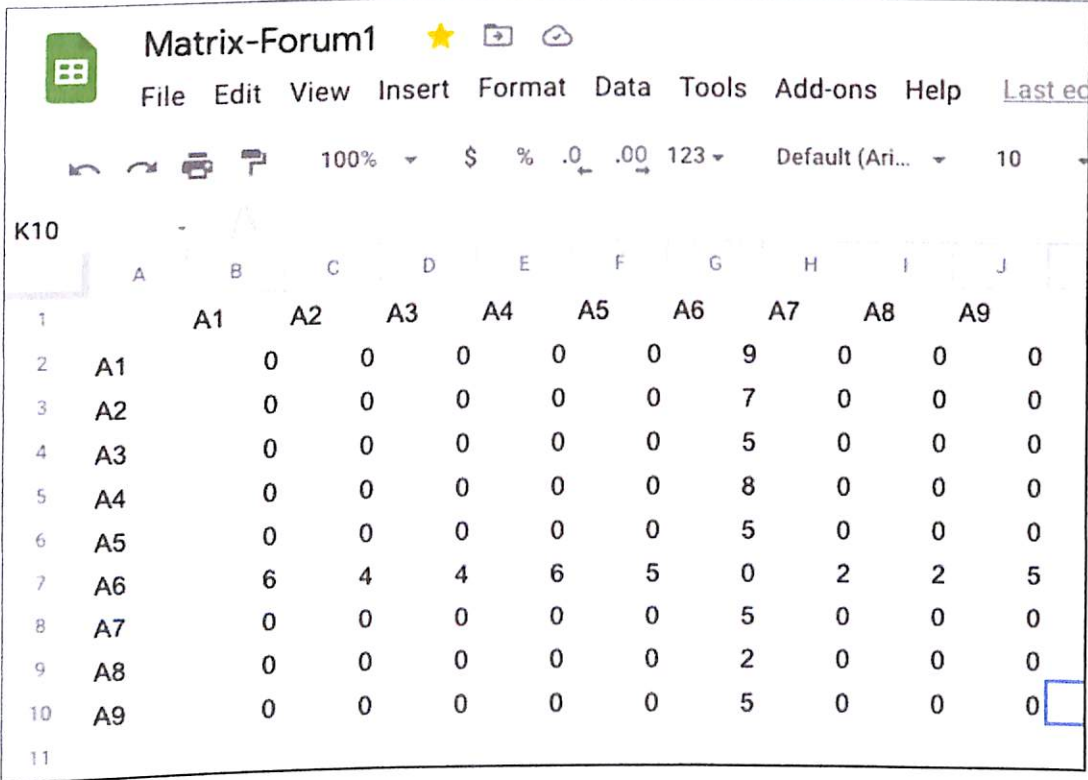
This study used UCINET, a software that supports SNA to analyze interactions of nine students in the online discussion forums of an online graduate course. Several network measures such as betweenness centrality, closeness centrality, degree centrality, and density, as well as tie strength and direction of ties, were measured to describe the online interactions of nine students in the online discussion forums. Network diagrams were generated to visualize the extent of the students' participation and their level of knowledge construction during the discussions in the online forums using the UCINET Netdraw application.

To analyze the network centrality and density of the online interactions, a whole network data with a complete set of actors or participants is required. Thus,

this study used the nominalist approach to identify the network boundary of the study where only the class with consent from all members was chosen.

To identify the patterns and network structures of the interactions in the forums, matrices of the interactions in the forums were created (Fig.7). The name of the sender (name of the student who sent the message) and receiver (to whom the message was sent or replied to (receiver) were identified for each message per forum. The frequency of the message exchanges was also counted. These data were then organized and structured into matrices using Excel/Google Sheet. To analyze the centrality and density, as well as to determine the tie strength and direction of ties of the online interactions, UCINET, a software for analyzing social network data, and UCINET Netdraw were used to generate the network diagrams.

Figure 7. Sample matrix of interactions in the discussion forums



	A1	A2	A3	A4	A5	A6	A7	A8	A9
A1	0	0	0	0	0	0	9	0	0
A2	0	0	0	0	0	0	7	0	0
A3	0	0	0	0	0	0	5	0	0
A4	0	0	0	0	0	0	8	0	0
A5	0	0	0	0	0	0	5	0	0
A6	6	4	4	6	5	0	2	2	5
A7	0	0	0	0	0	5	0	0	0
A8	0	0	0	0	0	2	0	0	0
A9	0	0	0	0	0	5	0	0	0

Chapter Four

RESULTS AND DISCUSSIONS

A. Level of Social Construction of Knowledge that occurred in the DFs

To identify the level of knowledge construction that occurred in the online discussion forums, content analysis, using the five-phase Interaction Analysis Model (IAM) by Gunawardena et al. (1997) was used in this study.

A total of 732 messages from nine discussion forums were extracted for this study and results showed that 78.96% of the messages were coded in Phase I of the social construction of knowledge, while less than one percent (0.27%) were coded under Phase II, and some messages (20.77%) were coded under Phase III (see Table 3). All of the messages in the discussion Forum 2 and Forum 7 are coded in Phase I of the social construction of knowledge(see Table 4). More than half of the messages in Forum 1 (68.18%), Forum 4 (56.7%), and Forum 6 (59.46%) were coded under Phase I of the social construction of knowledge (see Table 4). Most of the messages in Forum 3 (82.72%), Forum 5 (74.14%), Forum 8 (93.42%), and Forum 9 (93.06%) were also in Phase I of the social construction of knowledge (see Table 4). This implies that the students' interactions in the forums are mostly statements on sharing and comparing information.

The messages in the discussion forums that were coded under Phase I of the social construction of knowledge vary from statements of observation or opinion or statement of agreement from one or more participants ("I agree with your idea that...", "I think", "In my opinion...", "I believe that...", "You are right..."), while some are definitions, descriptions, or identification of a problem. Some statements in the discussion forums were to ask or answer questions to clarify details of statements ("Please enlighten me about how you plan to use...", "I wonder how you will

approach...?", "Do you plan on using Context Analysis...?", "Please let me clarify..."). While some statements are corroborating examples provided by other participants ("I would like to base this post on my experience...").

Some factors that might be attributed to why the messages in the discussion forums of this online course were mostly coded on Phase I of the social construction of knowledge include how the forums were designed, the intention of the moderator, and the discussion points made by the moderators. Discussion forums that were created in this online course were designed as learner-managed colloquium on communication research where students were expected to share a specific seminar topic that he/she plans to implement as his/her dissertation. Moderators of the discussion forums intended to share their research plans and how they are going to implement them, while other students were expected to give their opinions and share ideas that they think can help in the implementation of the research. Discussion points such as "What do you think is the importance of...", "What are your recommendations...", "I would like you to share...", "You can comment..." might lead other participants to comment or share their opinions and personal experiences regarding the topic, thus limiting students' interactions to statements of observation, opinion or agreement on the discussion topics. This result supports the findings of Wang et al (2009) that the nature of discussion topics greatly influenced the depth of online discussions and knowledge construction and that topics selected for online discussions should be meaningful and relevant to participants, and challenging and controversial enough to trigger different opinions.

While most of the messages are coded in Phase I of the social construction of knowledge, only less than one percent of the messages are recorded in Phase II, the discussions on discovery and exploration of dissonance or inconsistency among

ideas, concepts, or statements (Table 3). This suggests that most of the students in this class were not keen on identifying or stating areas of disagreement on other students' statements. Out of nine discussion forums, only Forum 1 contains messages that identify and state areas of disagreement or dissonance. Statements such as "However, I see a loophole because, as researchers, we actually cannot identify..." and "Thank you for pointing out other factors that may affecthowever, what we wanted to establish in the discussion thread is....". This could also be because discussion forums did not specifically call for participants to post diverse or opposing views on the topic which was also noted by Gunawardena, et al. (2014) in their study. Another aspect that can be considered why there is a very small number of interactions under Phase II of the social construction of knowledge can be considered based on the idea suggested by Gunawardena, et al. (2014) as observed by some researchers that discussion of dissonance or opposing ideas online may not be culturally appropriate- that non-native speakers, particularly students from Asian countries, consider it far less appropriate to challenge and criticize the ideas of others.

Despite the very small percentage of discussions on Phase II, it is quite interesting to note that the occurrence of discussions coded on negotiations of meaning or co-construction of knowledge (Phase III of the social construction of knowledge) were still observed in Forum 1 (29.55%), Forum 3 (17.28%), Forum 5 (25.86), Forum 8 (6.58%), and Forum 9 (6.94%), and almost half of the messages in two discussion forums Forum 4 (43.30%), Forum 6 (40.54%).

The absence of messages under Phase IV and V of the social construction of knowledge were observed in all discussion forums. This suggests that students in this class were not able to reach the level where they test and modify the proposed

synthesis or to agree and apply newly constructed meaning. This might be explained by the fact that at this stage, students are still in the planning stage of their research and they were given a limited time (only one week per discussion forum) to continuously interact with each other until they reach a higher level of knowledge construction. Another factor that can be considered is the level of the student's motivation to engage. As suggested by Gunawardena et al. (2014), the personal relevance of discussion topics may influence participants' motivation and engagement; motivated and engaged participants are more likely to employ deep, reflective strategies, to weigh and compare ideas or arguments and change their cognitive schema. The discussion points provided by the moderators can also be attributed to the level of engagement and motivations to construct knowledge among the participants.

Table 3. Level of Knowledge Construction in GradCourse01

Phase/Level	Frequency	Percentage
I	578	78.96%
II	2	0.27%
III	152	20.77%
IV	0	0.00%
V	0	0.00%
Total	732	100.00%

Table 4. Level of Knowledge Construction per Discussion Forum

PHASE/ LEVEL	FORUM 1 (n=88)	FORUM 2 (n=48)	FORUM 3 (n=81)	FORUM 4 (n=97)	FORUM 5 (n=116)	FORUM 6 (n=74)	FORUM 7 (n=80)	FORUM 8 (n=76)	FORUM 9 (n=72)
I	68.18%	100.00%	82.72%	56.70%	74.14%	59.46%	100.00%	93.42%	93.06%
II	2.27%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
III	29.55%	0.00%	17.28%	43.30%	25.86%	40.54%	0.00%	6.58%	6.94%
IV	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
V	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

B. The extent of students’ interactions (speaking and listening) in the online discussion forums

The extent of students’ interactions (speaking and listening) in the online discussion forums can be described through the patterns and structures of the students’ participation and engagement in the online course, both on the extent that students contributed posts and the extent they view or access the posts in the discussion forums. The data extracted from the course learning management system (LMS), including transcripts and log records of students’ activities (forum posts, views, and session log-ins) were used to analyze the extent of interactions in the online discussion forums among nine students of an online graduate course, GradCourse01. The online course is composed of nine discussion forums and each forum was analyzed to determine the speaking and listening patterns of the students.

B.1. Online Interaction Patterns (Speaking)

The online interactions in terms of posts contributed by the students (speaking) in the discussion forums were analyzed using SNA. To determine the level of engagements and connections between the students as well as their involvement in the discussion forums, the network centrality, and density, as well as the direction and strength of ties for each discussion forum, were measured in this study. Network measures such as centrality and density were conducted using UCINET and network diagrams were generated using Netdraw to visualize the network structures and speaking patterns in the discussion forums. Matrices created from the students' interactions in the nine discussion forums were analyzed using SNA to determine who speaks to whom or who among the students were speaking/contributing posts in the discussion forums and to what extent.

The degree centrality was used to measure the number of students' connections or links, and their level of engagement in terms of the posts they contributed or received in the discussion forums. The value of the outdegree centrality refers to the number of ties or outbound connections given by the actor/student to other students in the class or the number of participants that the student speaks with within the discussion forums. Indegree centrality value, on the other hand, refers to the number of ties or inbound posts or replies that the students received from other students, or the number of participants that speak or replied to the actor/student in the discussion forums.

Betweenness centrality values imply how much potential control the student has over the flow of information in the discussion forums, while closeness centrality values indicate the student's closeness to the group and his/her level of independence in terms of reaching other participants in the class for information.

Forum 1

Figure 8 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 1. Results showed that all students except A6 have a degree centrality value of 1, implying that eight out of nine students interacted with only one person in the forum. The graph in Fig. 8 showed that all students interacted with A6, who is the moderator and speaker of Forum 1.

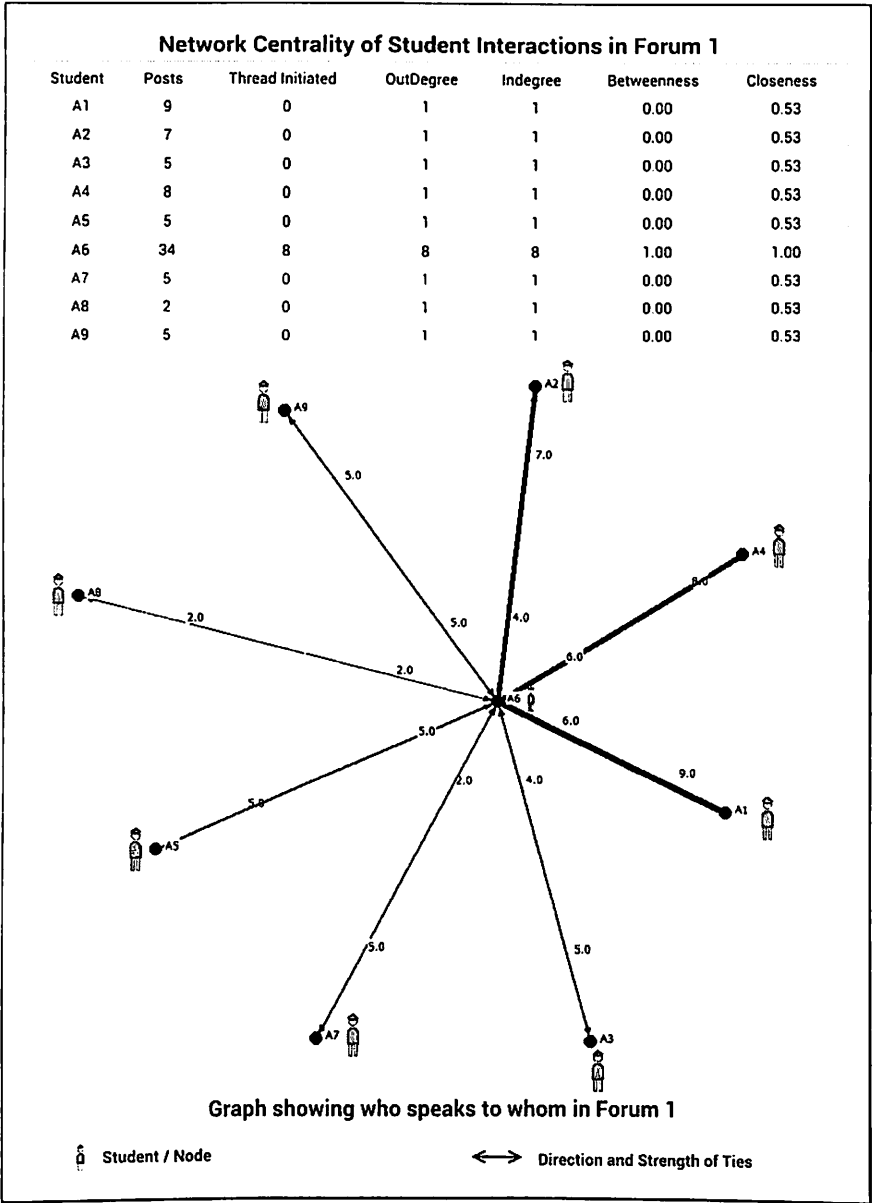
The closeness centrality value of all students except A6 is 53 percent. Student A6, on the other hand, contributed the most number of posts (34) and the number of threads initiated (8) and has the highest degree centrality value of 8, which implies that A6 speaks with all the other students and all students replied to him/her in the discussion forum.

Student A6 has a betweenness centrality value of 100 percent, which implies that A6 is connected to all other eight students and has the biggest potential to control the flow of the information and influence in terms of choosing what information to give or what to withhold from the information he/she received in Forum 1. Having a closeness centrality value of 100 percent also indicates that A6 is connected to all the participants in the discussion forum and is in a position where he/she can easily access information as he/she is very independent to reach other students.

A star graph was generated from the matrices of interactions in discussion Forum 1 to visualize the online interaction patterns of the students, and determine who they speak with, as well as the direction and strength of their ties or interactions (Fig. 8).

Considering the design of this discussion forum where the moderator is assigned to interact with other participants, the expected structure where the moderator occupies the central position in the flow of information can be observed in this forum. This pattern where the moderator/speaker of the forum has the most number of posts contributed and the number of threads initiated and has the highest centrality values can also be observed in all other discussion forums.

Figure 8. Network Centrality of Student Interactions in Forum 1



Forum 2

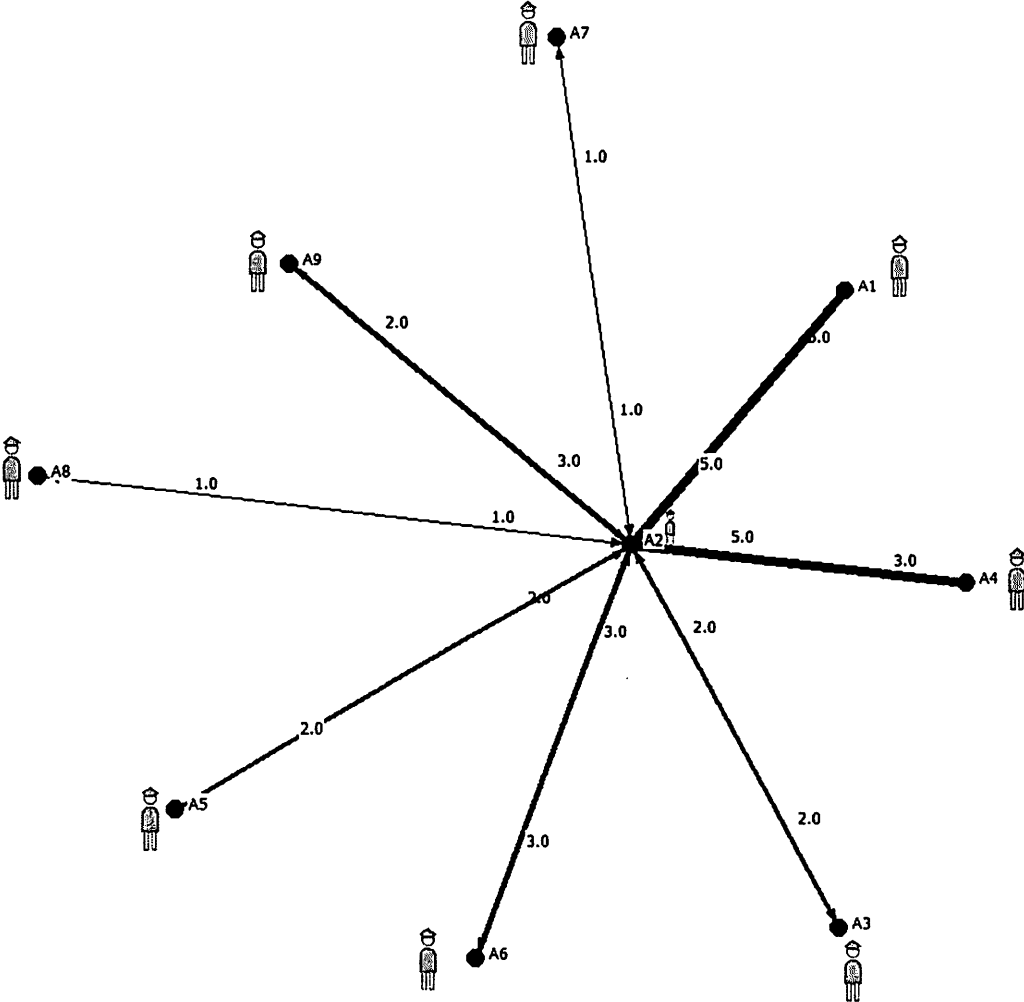
Figure 9 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 2. Student A2, who is the moderator/speaker, occupies the central position in Forum 2 with a degree centrality value of 8 and betweenness and closeness centrality value of 100 percent. This implies that A2 interacted with all students in the forum. All other eight students have a degree centrality value of 1 and a closeness centrality value of 53 percent. This implies that all eight students interacted only with the moderator/speaker of the discussion forum. Visual representation of who speaks to whom in Forum 2 is shown in Fig. 9, including the direction and strength of ties in the discussion forum.

Considering the design of this discussion forum where the moderator is assigned to interact with other participants, the expected structure where the moderator occupies the central position in the flow of information can be observed in this forum.

Figure 9. Network Centrality of Student Interactions in Forum 2

Network Centrality of Student Interactions in Forum 2

Student	Posts	Thread Initiated	OutDegree	Indegree	Betweenness	Closeness
A1	5	0	1	1	0.00	0.53
A2	27	1	8	8	1.00	1.00
A3	2	0	1	1	0.00	0.53
A4	4	0	1	1	0.00	0.53
A5	2	0	1	1	0.00	0.53
A6	3	0	1	1	0.00	0.53
A7	1	0	1	1	0.00	0.53
A8	1	0	1	1	0.00	0.53
A9	2	0	1	1	0.00	0.53



Graph showing who speaks to whom in Forum 2

Student / Node Direction and Strength of Ties

Forum 3

Figure 10 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 3. In this forum, student A3, who is the moderator/speaker, occupies the central position with a degree centrality value of 8, a betweenness centrality value of 96 percent, and a closeness centrality value of 100 percent. All other students have a degree centrality value of 1 and closeness centrality value of 53 percent except A8 and A9 who have a degree centrality value of 2 and a closeness centrality value of 57 percent. This implies that all students interacted with the moderator/speaker of the discussion forum, except the 2 students (A8 and A9) who also interacted with each other.

Visual representation of who speaks to whom in Forum 3 is shown in Fig. 10, including the direction and strength of ties in the discussion forum. The graph shows everyone interacted with A3 who is at the center of the network, while A8 and A9 also interacted with each other.

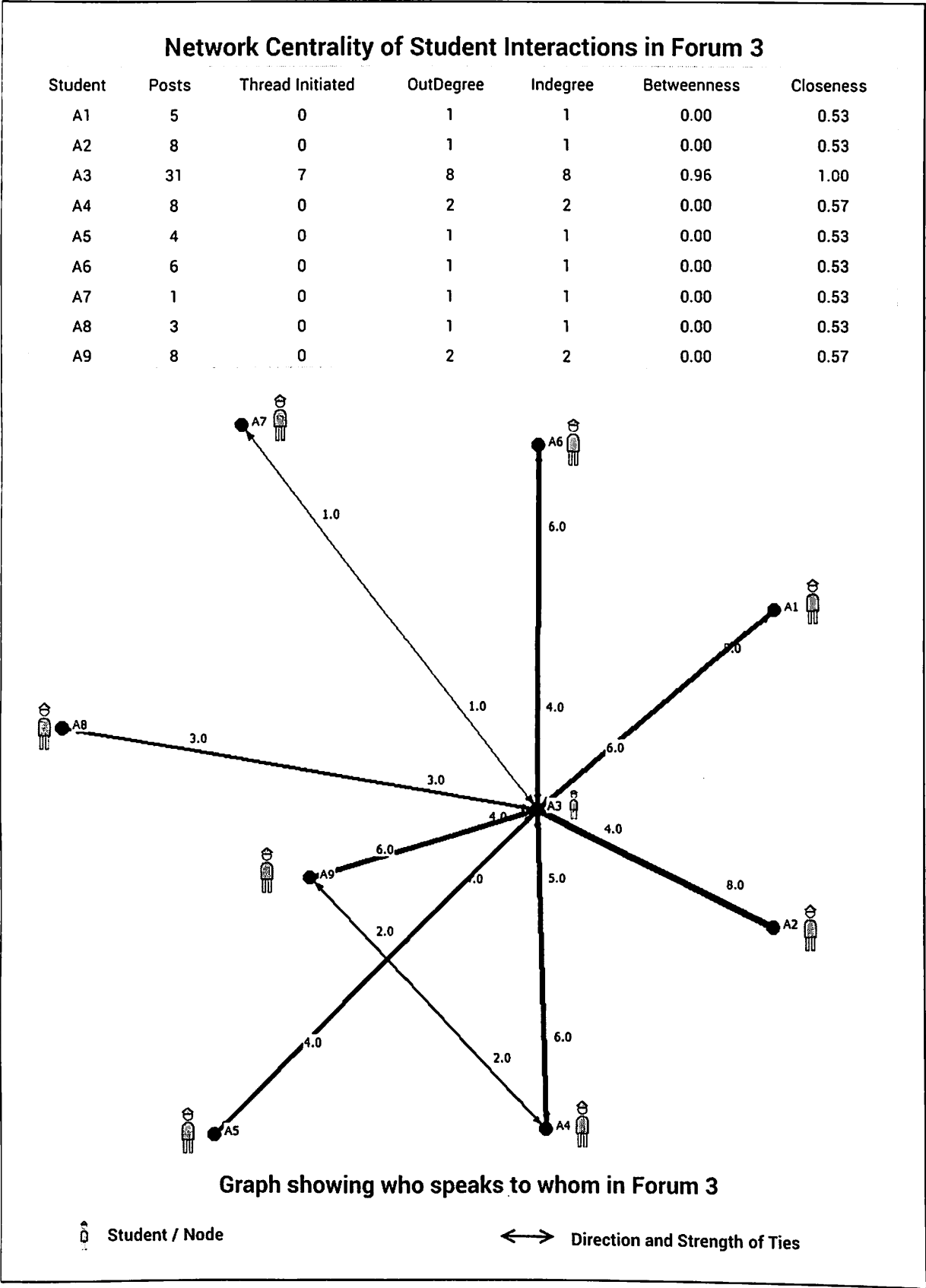
While it is expected that the moderator occupies the central position in the flow of information considering the design of this discussion forum where the moderator is assigned to interact with other participants, it is also interesting to note that two students (A4 and A9) also interacted with each other in this forum.

Based on the transcripts extracted from their communication exchanges, these are the noted reasons why two students (A4 and A9) interacted with each other, aside from interacting with the moderator.

1. To clarify and/or ask questions related to the information posted by the other student ("May I ask something on the theory-building approach...", "Would that approach follow a Grounded Theory Methodology considering...?")

2. To confirm and acknowledge the relevance of shared information, and/or agree with the other students' posted message ("It's interesting that you mentioned.. Indeed, observing culture...", "Yes, it's true..", "Thank you very much, ####, for mentioning the Institutional Review Board...".)
3. To provide additional information and share own experiences related to the other student's posted message ("Another compounding issue in extracting any type of data is..." "In my university, we are not allowed to conduct...",")
4. To answer an inquiry/question from other students ("It is not always voluntary participation, ####. It depends on the researchers on how they involve their participants in their research. In my uni, when you apply for an IRB research approval, ...").

Figure 10. Network Centrality of Student Interactions in Forum 3



Forum 4

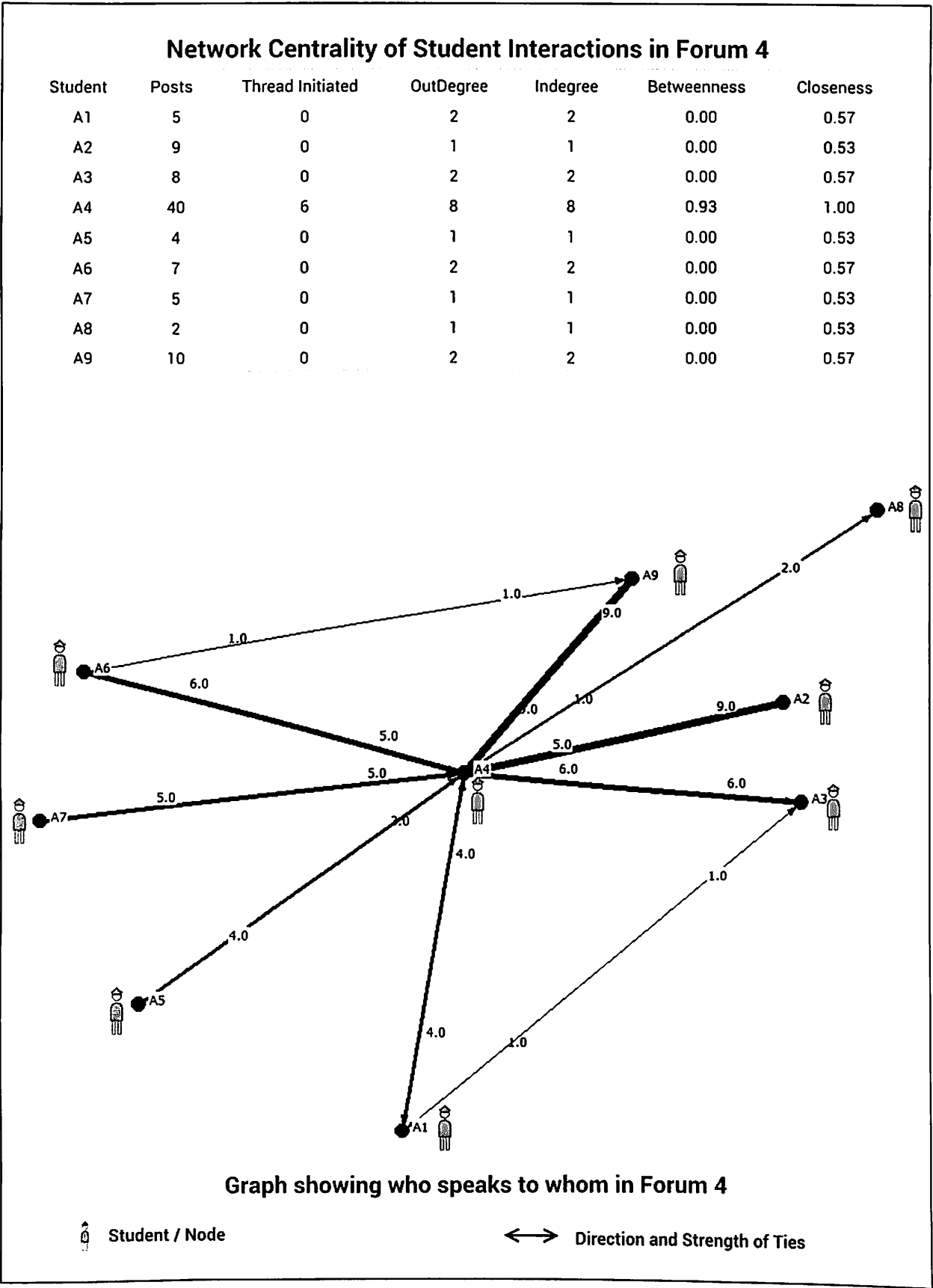
Figure 11 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 4. Student A4, who is the moderator/speaker of Forum 4, occupies the central position with a degree centrality value of 8, a betweenness centrality value of 93 percent, and a closeness centrality value of 100 percent. Almost half of the students (44%), A1, A3, A6, A9 have a degree centrality value of 2 and closeness centrality value of 57 percent while four students, A2, A5, A7, and A8 have a degree centrality value of 1 and closeness centrality value of 53 percent. This implies that all students interacted with the moderator/speaker of the discussion forum, while except four students (A1, A3, A6, A9) interacted with each other. Visual representation of who speaks to whom in Forum 4 is shown in Fig. 11, including the direction and strength of ties in the discussion forum. The graph shows everyone interacted with A4 who is at the center of the network, while A1 and A3, and A6 and A9 also interacted with each other.

While it is expected that the moderator will occupy the central position at the flow of information considering the design of this discussion forum where the moderator is assigned to interact with other participants, it is also interesting to note that four students (A1, A3, A6, and A9) also interacted with other students in this forum. Based on the transcripts extracted from their communication exchanges, these are the observed reasons why A1 and A3, and A6 and A9 interacted with each other, aside from interacting with the moderator.

1. To clarify and ask questions related to the information posted by the other student ("Can you send me a link to a sample research article?", "If a researcher is going to do an interview and observation..?").

2. To confirm and acknowledge the relevance of shared information, and/or agree with the other students' posted message ("I also share the same dilemma of whether to do an ethnography or an autoethnography...", "Thank you for this question, ###...", "Thank you #### for the clarification...").
3. To provide additional information and share their own experiences related to the other student's posted message ("Regarding validity, the quantitative study requires..., Most of the research articles I've read that employed autoethnography are focused on...").
4. To answer an inquiry/question from another student ("Hi! Perhaps this link can add to our understanding.").

Figure 11. Network Centrality of Student Interactions in Forum 4



Forum 5

Figure 12 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 5. Results showed that Student A1 contributed the most number of posts (34) and the number of threads initiated (8), and has the highest degree centrality value of 8, which implies that this student speaks with all the other students and all students replied to him/her in the discussion forum. Closeness centrality value of all other students is 53 percent except A1 who has a betweenness centrality value of 100 percent, which implies that A1 is connected to all other eight students and has the biggest potential to control the flow of the information and influence in terms of choosing what information to give or what to withhold from the information he/she received in Forum 5. Having a closeness centrality value of 100 percent also indicates that A1 is connected to all the participants in the discussion forum and is in a position where he/she can easily access information as he/she is very independent to reach other students.

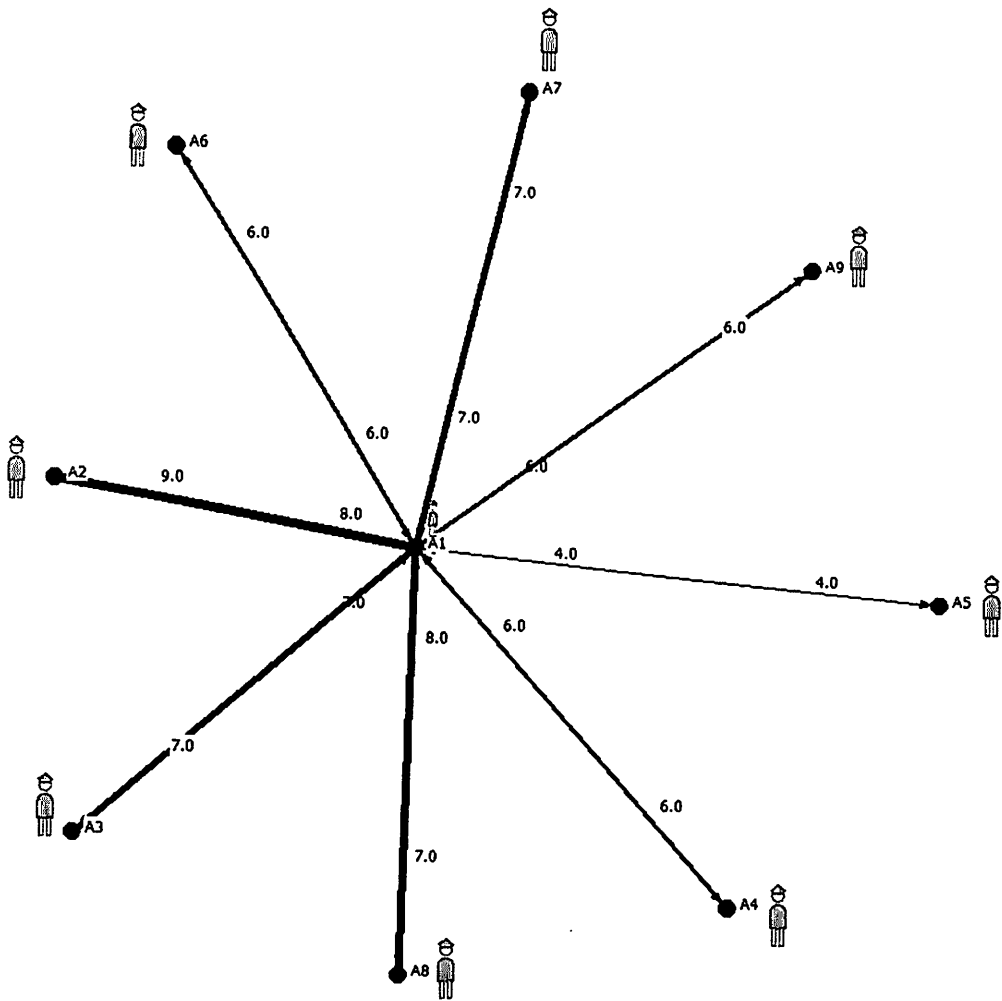
A star graph was generated from the matrices of interactions in discussion Forum 5 to visualize the online interaction patterns of the students, and determine who they speak with, as well as the direction and strength of their ties or interactions (Fig. 12).

Considering the design of this discussion forum where the moderator is assigned to interact with other participants, the expected structure where the moderator occupies the central position in the flow of information can be observed in this forum.

Figure 12. Network Centrality of Student Interactions in Forum 5

Network Centrality of Student Interactions in Forum 5

Student	Posts	Thread Initiated	OutDegree	Indegree	Betweenness	Closeness
A1	55	9	8	8	1.00	1.00
A2	9	0	1	1	0.00	0.53
A3	7	0	1	1	0.00	0.53
A4	6	0	1	1	0.00	0.53
A5	4	0	1	1	0.00	0.53
A6	6	0	1	1	0.00	0.53
A7	7	0	1	1	0.00	0.53
A8	7	0	1	1	0.00	0.53
A9	6	0	1	1	0.00	0.53



Graph showing who speaks to whom in Forum 5

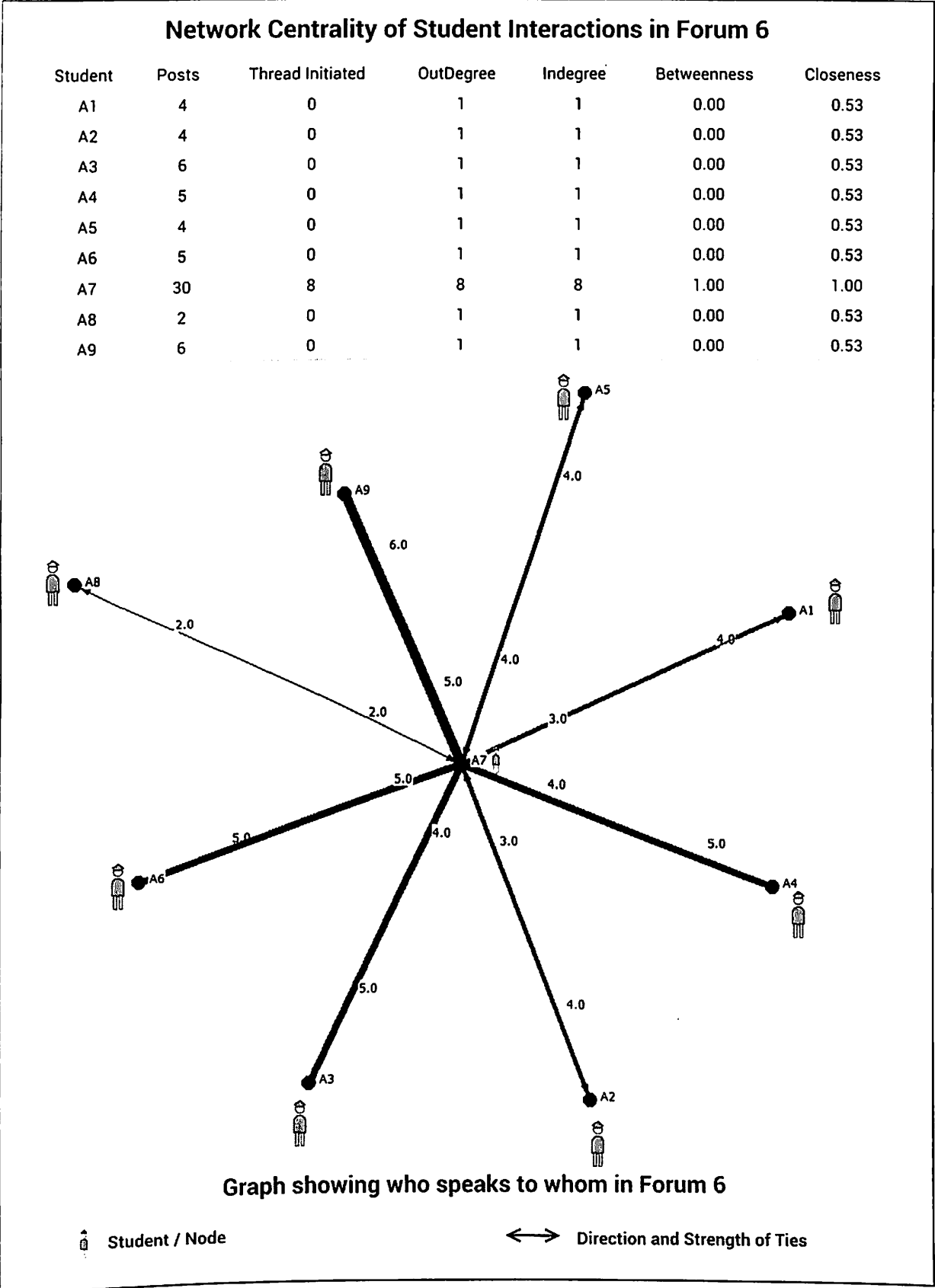
 Student / Node  Direction and Strength of Ties

Forum 6

Figure 13 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 6. Student A7, who is the moderator/speaker, occupies the central position in Forum 6 with a degree centrality value of 8 and betweenness and closeness centrality value of 100 percent. All other eight students have a degree centrality value of 1 and a closeness centrality value of 53 percent. This implies that all eight students interacted only with the moderator/speaker of the discussion forum. Closeness centrality value of all other students is 53 percent except A1 who has a betweenness centrality value of 100 percent, which implies that A1 is connected to all other eight students and has the biggest potential to control the flow of the information and influence in terms of choosing what information to give or what to withhold from the information he/she received in Forum 5. Having a closeness centrality value of 100 percent also indicates that A7 is connected to all the participants in the discussion forum and is in a position where he/she can easily access information as he/she is very independent to reach other students. Visual representation of who speaks to whom in Forum 6 is shown in Figure 13, including the direction and strength of ties in the discussion forum.

Considering the design of this discussion forum where the moderator is assigned to interact with other participants, the expected structure where the moderator occupies the central position in the flow of information can be observed in this forum.

Figure 13. Network Centrality of Student Interactions in Forum 6

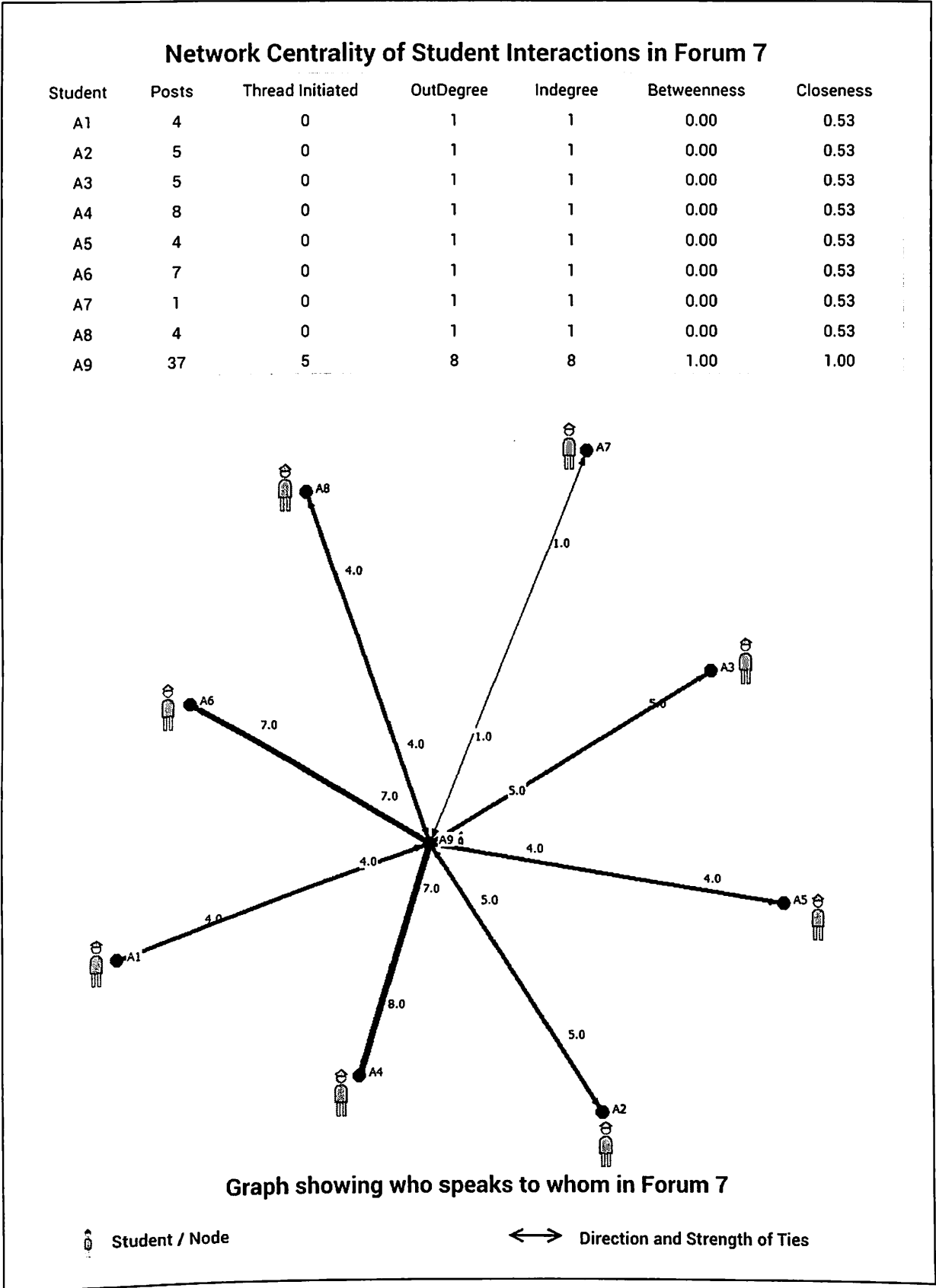


Forum 7

Figure 14 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 7. Student A9, who is the moderator/speaker, occupies the central position in Forum 7 with a degree centrality value of 8 and a betweenness and closeness centrality value of 100 percent. All other students have a degree centrality value of 1 and a closeness centrality value of 53 percent. This implies that all eight students interacted only with the moderator/speaker of the discussion forum. This also implies that A9, who is at the center of the network, is connected to all the participants in the discussion forum and is in a position where he/she can easily access information as he/she is very independent to reach other students. Visual representation of who speaks to whom in Forum 7 is shown in Fig. 14, including the direction and strength of ties in the discussion forum.

Considering the design of this discussion forum where the moderator is assigned to interact with other participants, the expected structure where the moderator occupies the central position in the flow of information can be observed in this forum.

Figure 14. Network Centrality of Student Interactions in Forum 7



Forum 8

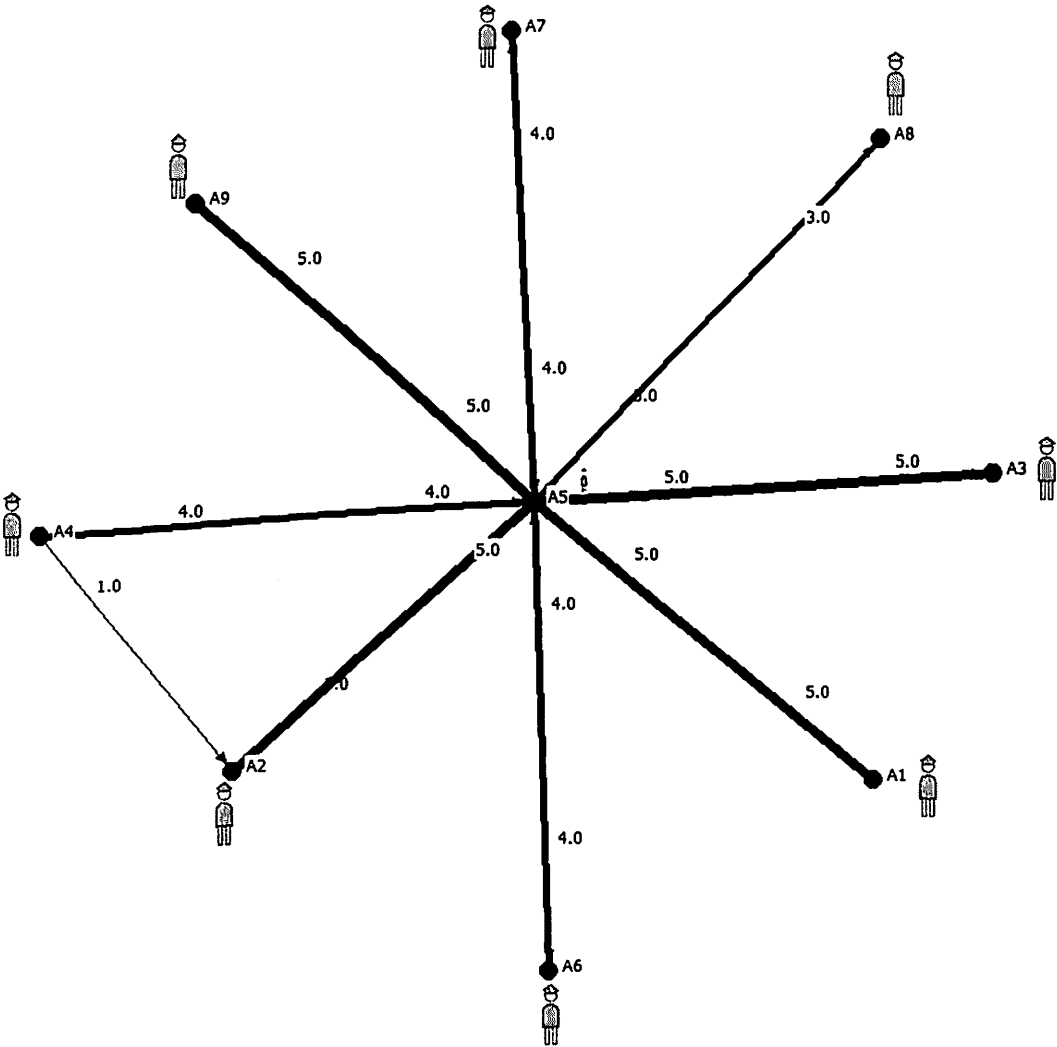
Figure 15 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 8. In this forum, student A5, who is the moderator/speaker, occupies the central position with a degree centrality value of 8, a betweenness centrality value of 98 percent, and a closeness centrality value of 100 percent. All other students have a degree centrality value of 1 and closeness centrality value of 53 percent except A2 who has an in-degree centrality of 2 and A4 who has an outdegree centrality value of 2. A2 and A4 have a closeness centrality value of 57 percent. This implies that all students interacted with the moderator/speaker of the discussion forum, and A2 received messages from A5 and A4, while A4 sent messages to A5 and A2. Visual representation of who speaks to whom in Forum 8 is shown in Fig. 15, including the direction and strength of ties in the discussion forum. The graph shows that everyone interacted with the moderator (A5) who is at the center of the network, while A4 also attempted to interact with A2 by sending a message to him/her.

While it is expected that the moderator will be the most central actor who will occupy the central position in the flow of information considering the design of this discussion forum where the moderator is assigned to interact with other participants, it is also interesting to note that one student (A4) also interacted with another student (A2) in this forum. Based on the transcripts extracted from their communication exchanges, A4 interacted with A2 to acknowledge the relevance of the shared information and provide additional information related to the other student's posted message ("It is interesting that ### mentioned survey method in quantitative communication research. The advantage of the survey result is...").

Figure 15. Network Centrality of Student Interactions in Forum 8

Network Centrality of Student Interactions in Forum 8

Student	Posts	Thread Initiated	OutDegree	Indegree	Betweenness	Closeness
A1	5	0	1	1	0.00	0.53
A2	5	0	1	2	0.00	0.57
A3	5	0	1	1	0.00	0.53
A4	5	0	2	1	0.00	0.57
A5	35	5	8	8	0.98	1.00
A6	4	0	1	1	0.00	0.53
A7	4	0	1	1	0.00	0.53
A8	3	0	1	1	0.00	0.53
A9	5	0	1	1	0.00	0.53



Graph showing who speaks to whom in Forum 8

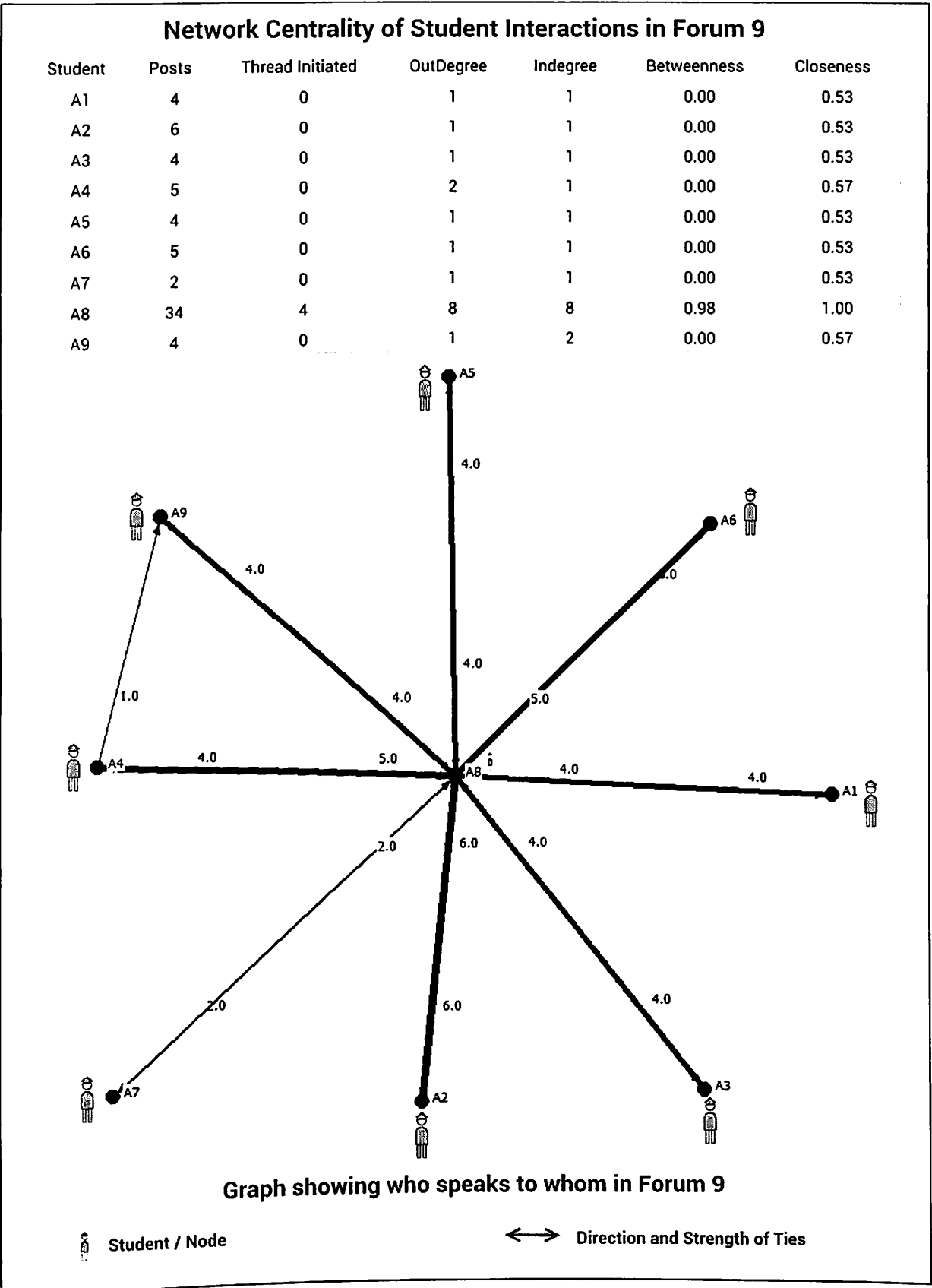
Student / Node ↔ Direction and Strength of Ties

Forum 9

Figure 16 shows the number of posts contributed, the number of threads initiated, as well as the network centrality of the nine participants in Forum 9. Results showed that, in this forum, student A8, who is the moderator/speaker, occupies the central position with a degree centrality value of 8, a betweenness centrality value of 98 percent, and a closeness centrality value of 100 percent. All other students have a degree centrality value of 1 and closeness centrality value of 53 percent except A9 who has an in-degree centrality of 2 and A4 who has an outdegree centrality value of 2. A4 and A9 have a closeness centrality value of 57 percent. This implies that all students interacted with the moderator/speaker of the discussion forum, and A9 received messages from A4 and A8, while A4 sent messages to A2 and A9. Visual representation of who speaks to whom in Forum 9 is shown in Fig. 16, including the direction and strength of ties in the discussion forum. The graph shows that everyone interacted with the moderator (A8) who is at the center of the network, while A4 also attempted to interact with A9 by sending a message to him/her.

While it is expected that the moderator will be the most central actor who will occupy the central position in the information flow considering the design of this discussion forum where the moderator is assigned to interact with other participants, it is also interesting to note that one student (A4) also interacted with another student (A9) in this forum. Based on the transcripts extracted from their communication exchanges, A4 interacted with A9 to provide additional information related to the other student's posted message ("Systematic reviews are an increasingly common research method employed to collect...").

Figure 16. Network Centrality of Student Interactions in Forum 9



Connectedness (Network Density) of the Online Class

The extent to which the students are linked or connected to each other is also measured by looking at the network density of the discussion forums, and the class, as a whole. Results showed that as a whole class, the online course has a network density of one hundred percent (100%), which suggests that, overall, all participants were able to connect and engage with each other (Table 5) in the discussion forums. However, it is very important to note that the network density values measured for each discussion forum are low. Results showed low-density values of 22% for Forums 1, 2, 5, 6, and 7, 25% for Forums 3,8 and 9, and 28% for Forum 4, which suggests that for each discussion forum, students did not speak with all the participants and just engaged with one or two students other than the moderator. This coincides with the above observation on network centrality that in most cases, students were only speaking with the moderator, or with at most two other students in some cases such as in Forums 3, 4, 8, and 9.

Table 5. Network Density in Discussion Forums of GradCourse01

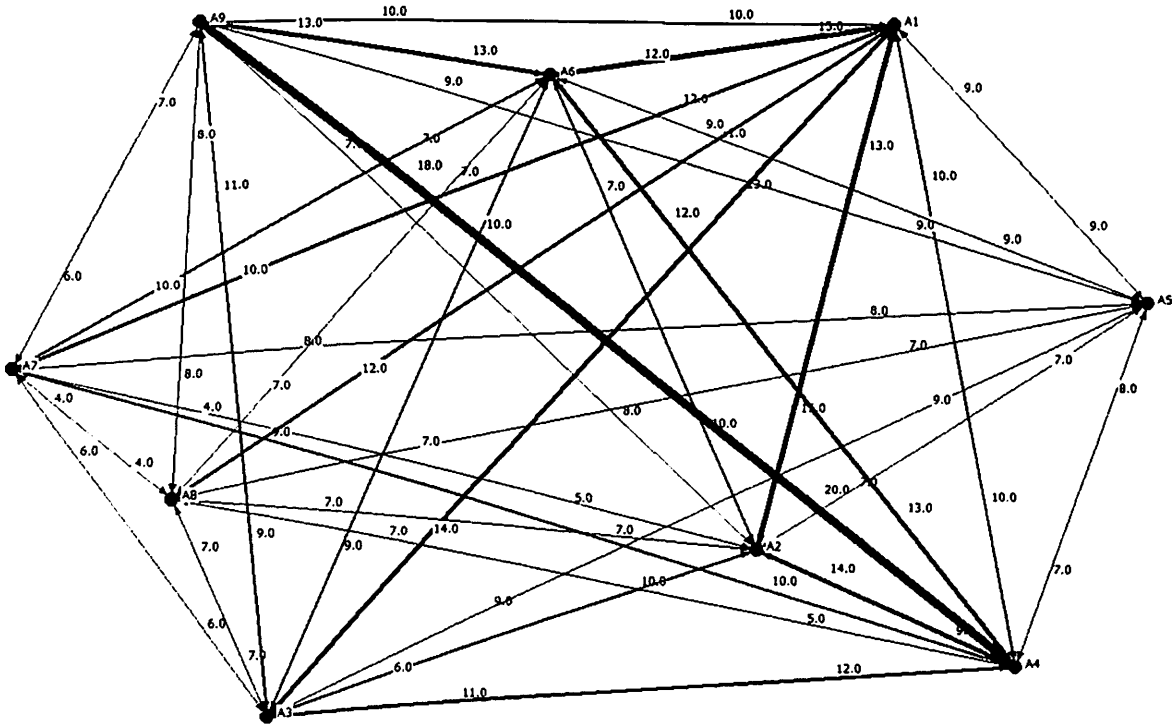
Forum	Nodes	Density
Forum 1	9	0.22
Forum 2	9	0.22
Forum 3	9	0.25
Forum 4	9	0.28
Forum 5	9	0.22
Forum 6	9	0.22
Forum 7	9	0.22
Forum 8	9	0.25
Forum 9	9	0.25
Whole	9	1.00

Direction and Strength of Ties in the Online Class

To visualize who speaks to whom in the online class as a whole, a graph generated from the valued matrix of the students' interactions is shown in Figure 17. The direction of interaction indicates the direction of information flow and the direction to whom the student is speaking through a network diagram. The values in the valued matrix in Fig.17 indicate the strength of the interaction or the tie strength which determine the overall frequency of the number of posts contributed by the students or replies made to other students. The thickness of the lines also reflects the strength of ties (Fig 17). The valued matrix in Fig. 17 shows that overall, A1(93), A4(86), A9(83), and A6(77) have the highest number of posts contributed, while A1(92), A4(89), A6(86), and A9(83) have the highest number of posts received. The graph in Fig. 17 also indicates that all students interacted with each other.

Figure 17. Valued matrix and graph of students' interactions - Who speaks to whom?

Student	A1	A2	A3	A4	A5	A6	A7	A8	A9
A1	-	13	13	10	9	15	12	11	10
A2	15	-	10	14	7	10	5	7	8
A3	14	6	-	11	9	9	6	7	9
A4	10	9	12	-	7	13	10	5	20
A5	9	7	9	8	-	9	8	7	9
A6	12	7	10	12	9	-	7	7	13
A7	10	4	6	9	8	10	-	4	6
A8	12	7	7	7	7	7	4	-	8
A9	10	7	11	18	9	13	7	8	-



Visualization of who speaks to whom?

B.2. Online Interaction Patterns (Listening)

Online interaction patterns in terms of posts viewed or accessed by the students (listening) in the discussion forums were analyzed using Cluster Analysis. This study adapted Wise's listening patterns taxonomy using the listening breadth, revisitation, and temporal contiguity dimensions and seven variables based on the availability of data in the learning management system to describe and classify the characteristics of the listening patterns of the students (see Table 2). Interaction patterns of students in terms of listening or viewing of posts in the discussion forums were evaluated using three dimensions - the listening breadth to determine the extensiveness of the listening, the revisitation to determine the extent to which a learner returns to posts made by themselves and others that they have attended to previously, and the temporal contiguity to describe how a learner manages and divides their time within a discussion, in this case, on nine discussion forums. Variables evaluated under the listening breadth, revisitation, and temporal contiguity includes the number of times the student viewed or accessed the posts in the discussion forums, the number of times the student log-in in the discussion forums, the number of sessions that the student viewed posts, the number of sessions that the student contributed a post, and the number of posts that the student contributed in the discussion forums.

A total of 8,525 views were recorded in the online course GradCourse01 based on the data extracted from the LMS (Table 6). The number of sessions (536), discussion views (3179), and posts contributed (732) were also extracted to evaluate the listening patterns of the students in nine discussion forums in the online class (Table 6).

Table 6. Number of Sessions, Views, and Posts of Students in GradCourse01

FORUM	LMS			# of DF Sessions	% of DF Sessions with Posts	% of DF Sessions with Views
	Views	# of Views	# of Posts			
Forum 1	1240	474	88	83	28.92%	63.86%
Forum 2	575	204	48	69	27.54%	62.32%
Forum 3	1248	510	81	68	42.65%	75.00%
Forum 4	1138	461	97	67	38.81%	77.61%
Forum 5	1399	478	116	54	46.30%	85.19%
Forum 6	862	360	74	58	34.48%	72.41%
Forum 7	715	241	80	52	44.23%	75.00%
Forum 8	688	239	76	39	38.46%	74.36%
Forum 9	660	212	72	46	36.96%	65.22%
TOTAL	8525	3179	732	536	36.94%	71.83%

Forum 1

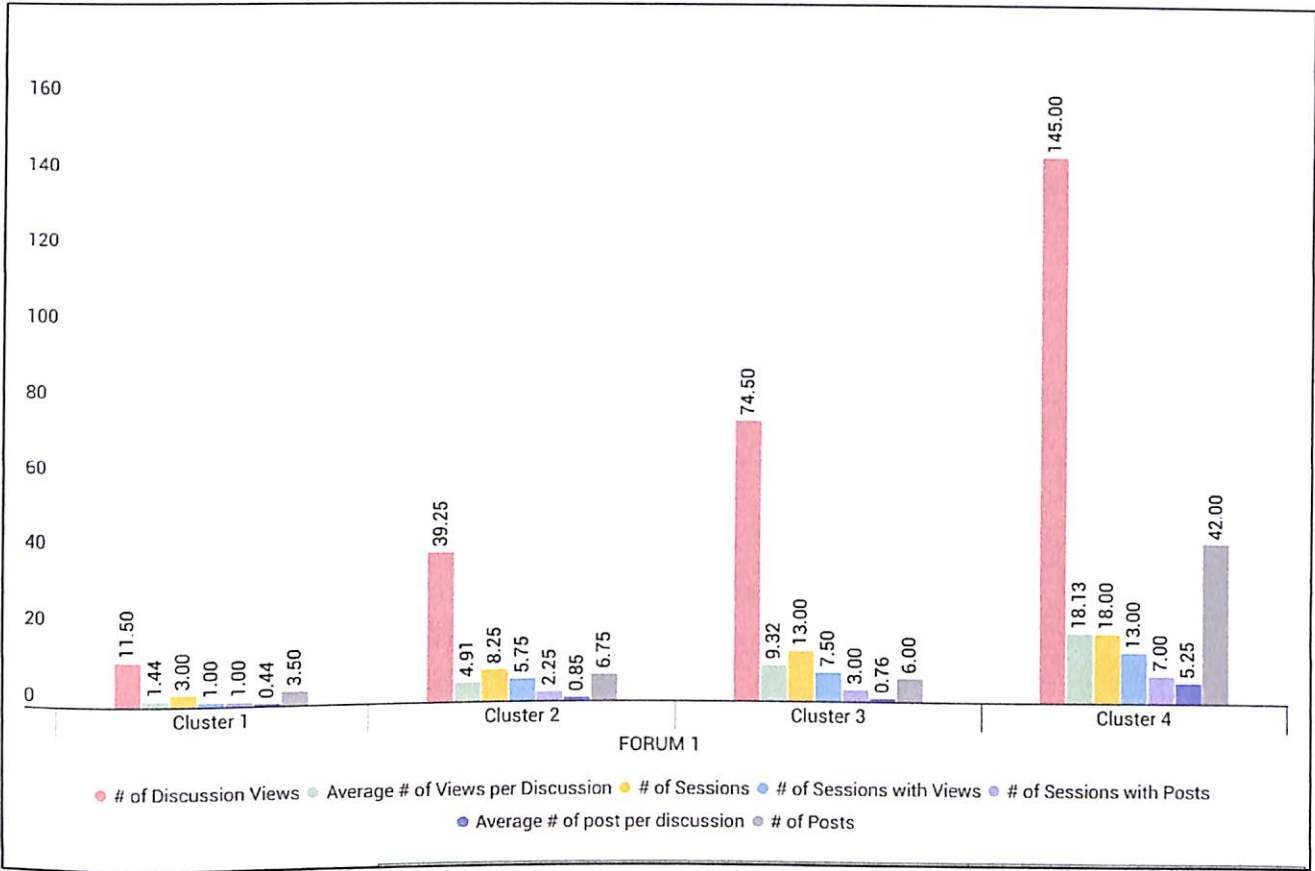
Table 7 shows the listening patterns of the nine participants in Forum 1 based on the characteristics of the clusters. Results showed that in Forum 1, there is 22.22 percent of students belonging to Cluster 1 which is characterized as the group of students who rarely viewed and contributed posts in the discussion forums. Students belonging to this group also logged in and accessed the discussion forums very seldomly. Almost half (44.44%) of the students were in Cluster 2 which is characterized as moderate listeners with a moderate number of views and posts, frequently log-in to DFs, and contributed posts seldomly. Two students who belong to Cluster 3 are frequent listeners and logged in to the discussion forums on an average of 13 times in Forum 1. One student belongs to Cluster 4, who has a high

level of listening breadth, revisitation, and temporal contiguity which implies that he/she has an extensive level of listening and was able to divide and manage their time in the discussion forums very well. Table 7 also recorded that students in Forum 1 logged in to the discussion forum very frequently. It is also interesting to note that in all clusters in Forum 1, it can be observed that the more the students log-in in the discussion forums, the higher the number of times that the student listens (view posts) and speaks (contribute posts) in the discussion forums (see Fig.18).

Table 7. Listening Patterns of Students in Forum 1

CLUSTER	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A5,A8	22.22%
2	Moderate Listener, Infrequent Speaker, High number of log-ins to DFs, Moderate number of sessions with views, Moderate number of sessions with posts.	A1,A4,A7,A9	44.44%
3	Frequent Listener, Infrequent Speaker, Very high number of log-ins to DFs, High number of sessions with views, Moderate number of sessions with posts.	A2,A3	22.22%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A6	11.11%

Figure 18. Listening Variables by Cluster - Forum 1



Forum 2

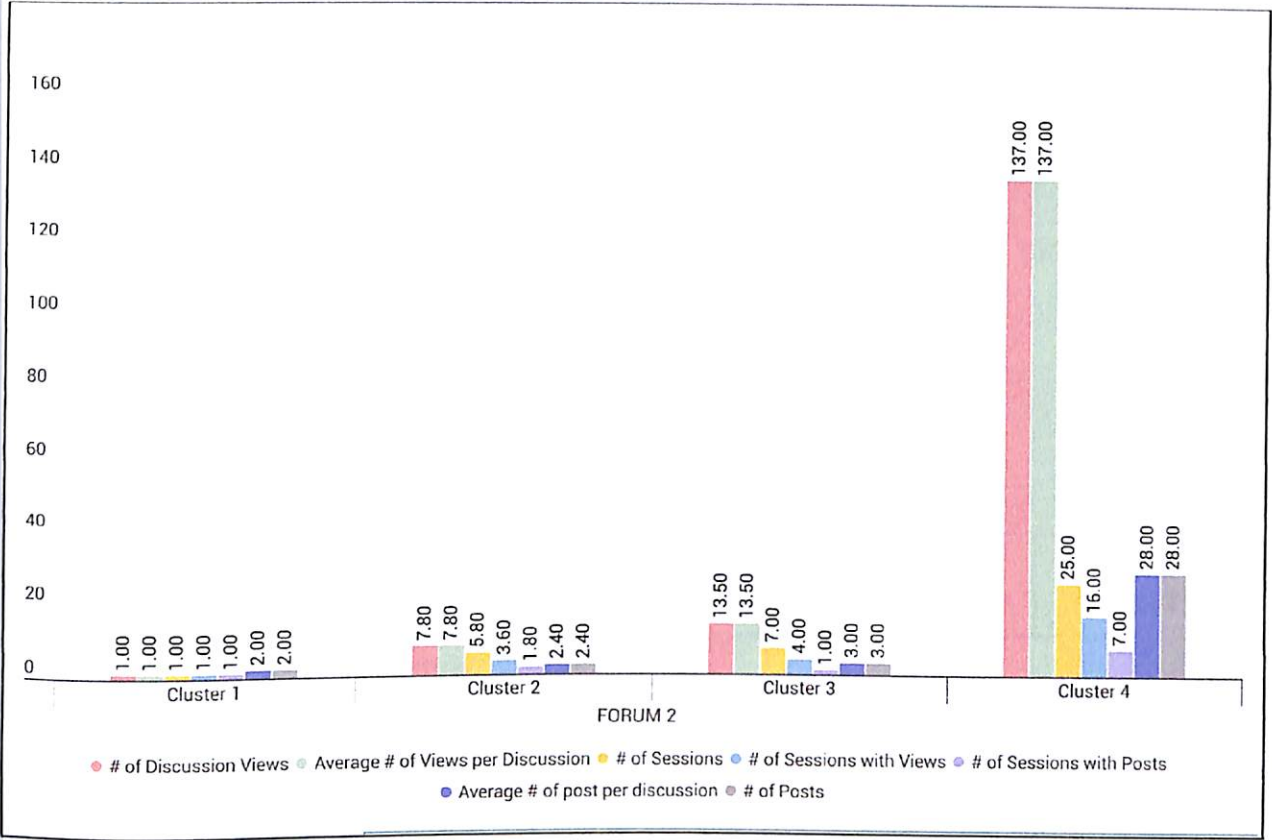
Table 8 shows the listening patterns of the nine participants in Forum 2 based on the characteristics of the clusters. Results showed that in Forum 2, more than half of the students (77.78%) who are in Clusters 2 and 3 are infrequent listeners and speakers and moderately logged in the discussion forums. One student who belongs to Cluster 1 is an infrequent listener and speaker and seldomly logged in the discussion forums. Only one student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions, the student belonging to Cluster 4 has the highest level of listening breadth and temporal contiguity (see Fig.17). It is also interesting to note that in all

clusters in Forum 2, it can be observed that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 19). Forum 2 recorded the lowest total number of discussion forum views (204) and posts (48) among the nine discussion forums (see Table 8).

Table 8. Listening Patterns of Students in Forum 2

CLUSTER	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A5	11.11%
2	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Moderate number of sessions with views, Low number of sessions with posts.	A1,A6,A7,A8, A9	55.56%
3	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Moderate number of sessions with views, Moderate number of sessions with posts.	A3, A4	22.22%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A2	11.11%

Figure 19. Listening Variables by Cluster - Forum 2



Forum 3

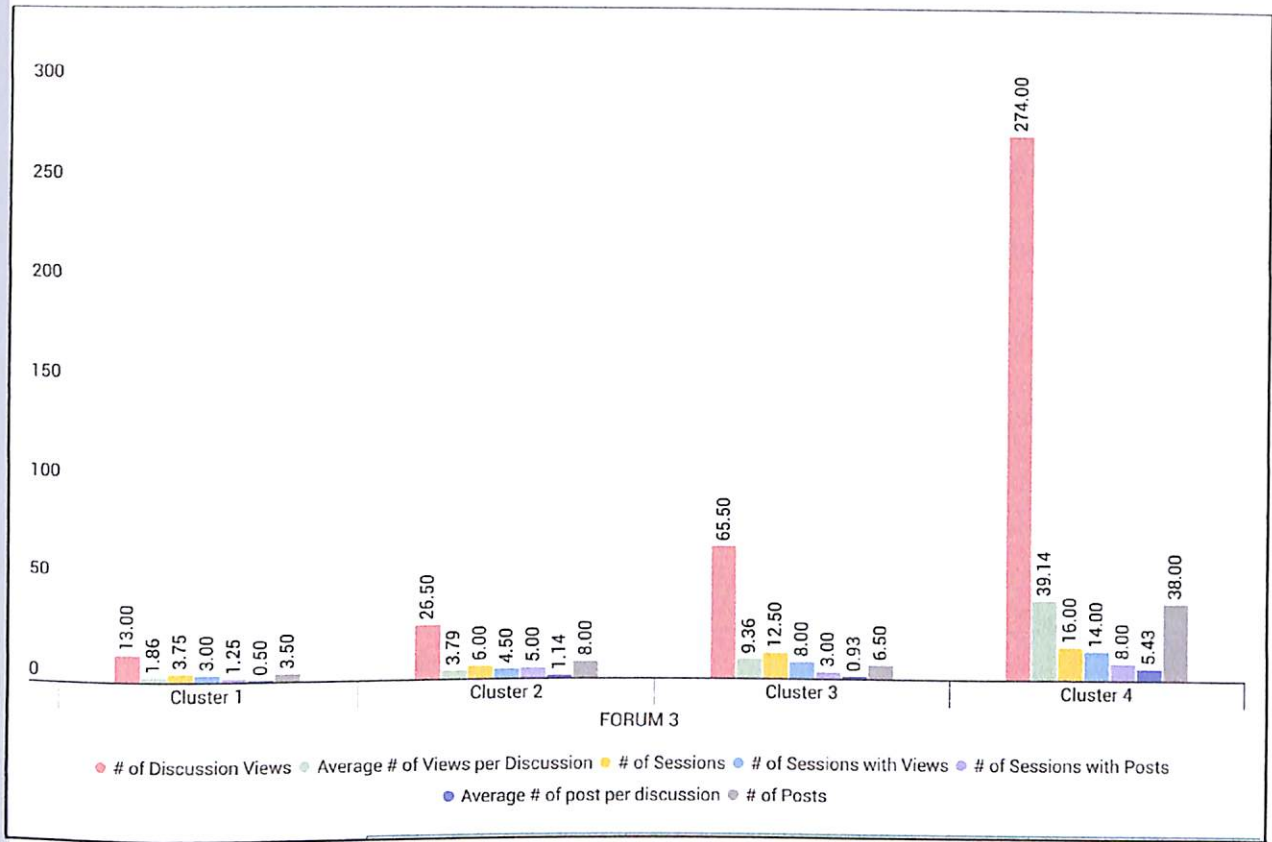
Table 9 shows the listening patterns of the nine participants in Forum 3 based on the characteristics of the clusters. Results showed that in Forum 3, almost half of the students (44.44%) who are in Cluster 1 are infrequent listeners and speakers and logged in to the discussion forums very seldomly. Two students who belong to Cluster 2 are infrequent listeners and speakers and moderately logged in the discussion forums. Two students who belong to Cluster 3 are moderate listeners, infrequent speakers, and logged in to the discussion forums very frequently. Only one student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions, the student

belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.20). It can also be observed that in Forum 3, the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 20). Forum 3 recorded the highest number of discussion forum views (510) among the nine discussion forums (see Table 9).

Table 9. Listening Patterns of Students in Forum 3

CLUSTER	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A5,A6,A7,A8	44.44%
2	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Moderate number of sessions with views, High number of sessions with posts.	A4,A9	22.22%
3	Moderate Listener, Infrequent Speaker, Very high number of log-ins to DFs, High number of sessions with views, Moderate number of sessions with posts.	A1,A2	22.22%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A3	11.11%

Figure 20. Listening Variables by Cluster - Forum 3



Forum 4

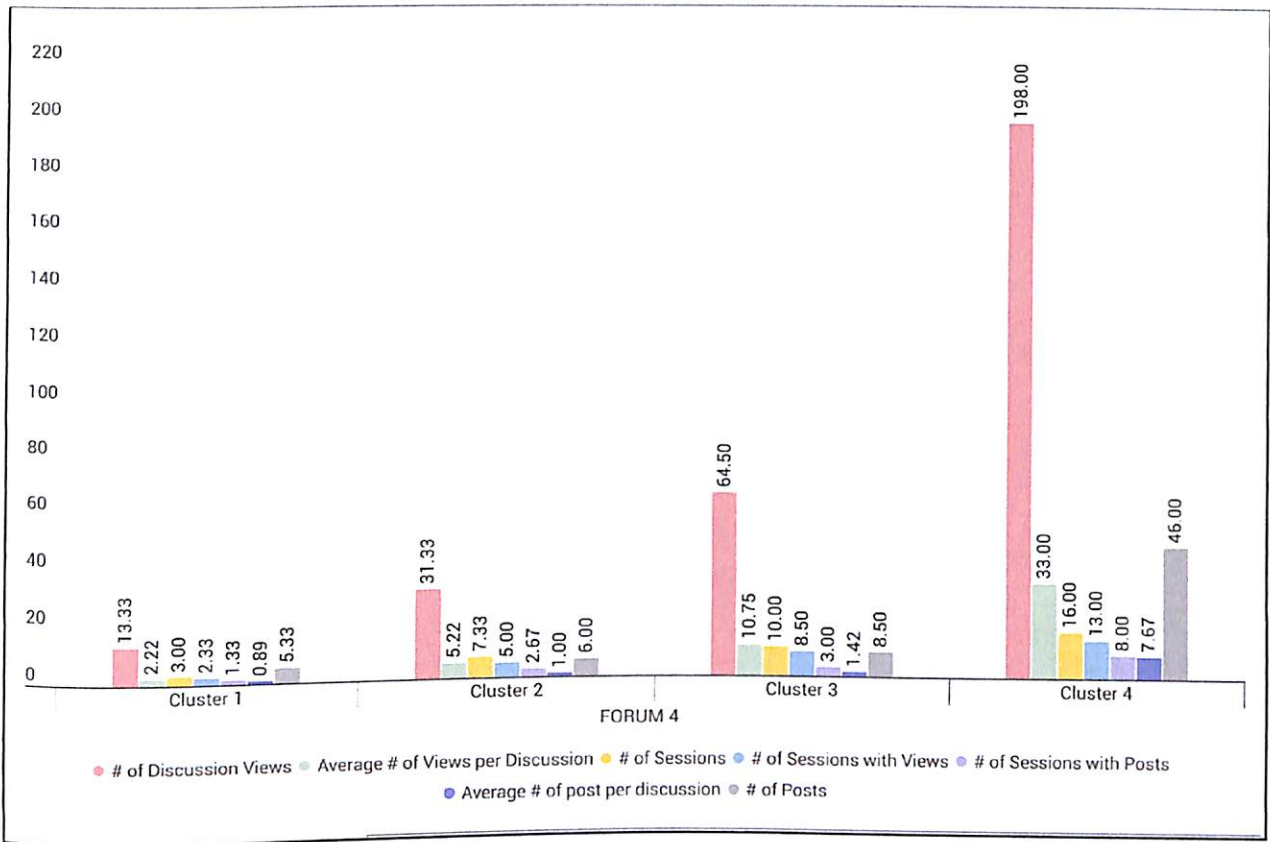
Table 10 shows the listening patterns of the nine participants in Forum 4 based on the characteristics of the clusters. Results showed that in Forum 4, one-third of the students (33.33%) who are in Cluster 1 are infrequent listeners and speakers and logged in to the discussion forums very seldomly. Thirty-three percent of the students who belong to Cluster 2 are infrequent listeners and speakers and moderately logged in the discussion forums. Two students who belong to Cluster 3 are moderate listeners, and speakers, and logged in the discussion forums moderately. Only one student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening

dimensions, the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.21). It can also be observed in Forum 4 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 21). Forum 4 recorded a high number of discussion forum views (461) and posts (97) (see Table 10).

Table 10. Listening Patterns of Students in Forum 4

CLUSTER	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A5,A6,A7	33.33%
2	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Moderate number of sessions with views, High number of sessions with posts.	A1,A8,A9	33.33%
3	Moderate Listener, Moderate Speaker, Very high number of log-ins to DFs, High number of sessions with views, Moderate number of sessions with posts.	A2,A3	22.22%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A4	11.11%

Figure 21. Listening Variables by Cluster - Forum 4



Forum 5

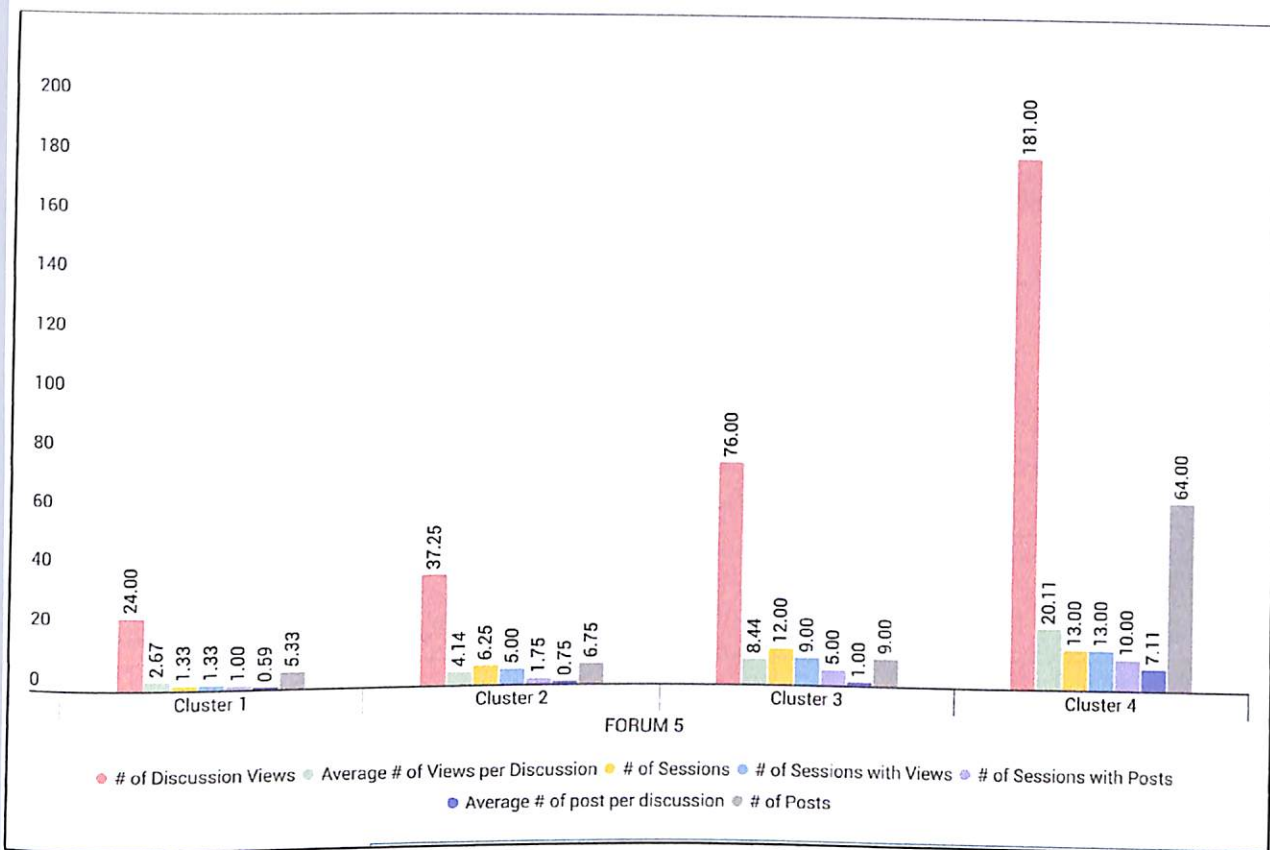
Table 11 shows the listening patterns of the nine participants in Forum 5 based on the characteristics of the clusters. Results showed that in Forum 5, three students who are in Cluster 1 are infrequent listeners and speakers and logged in the discussion forums very seldomly. Almost half of the students (44.44%) who belong to Cluster 2 are infrequent listeners and speakers and moderately logged in the discussion forums. One student who belongs to Cluster 3 is a moderate listener, infrequent speaker, and logged in to the discussion forums very frequently. One student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High

number of sessions with posts). In terms of listening dimensions, the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.22). It can also be observed in Forum 5 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 22). Forum 5 recorded the highest number of contributed posts (116), and the highest number of sessions with posts (46.30%) and views (85.19%) among the nine discussion forums (see Table 11).

Table 11. Listening Patterns of Students in Forum 5

CLUSTER	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A4,A5,A6	33.33%
2	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A3,A7,A8,A9	44.44%
3	Moderate Listener, Infrequent Speaker, Very high number of log-ins to DFs, Moderate number of sessions with views, Low number of sessions with posts.	A2	11.11%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A1	11.11%

Figure 22. Listening Variables by Cluster - Forum 5



Forum 6

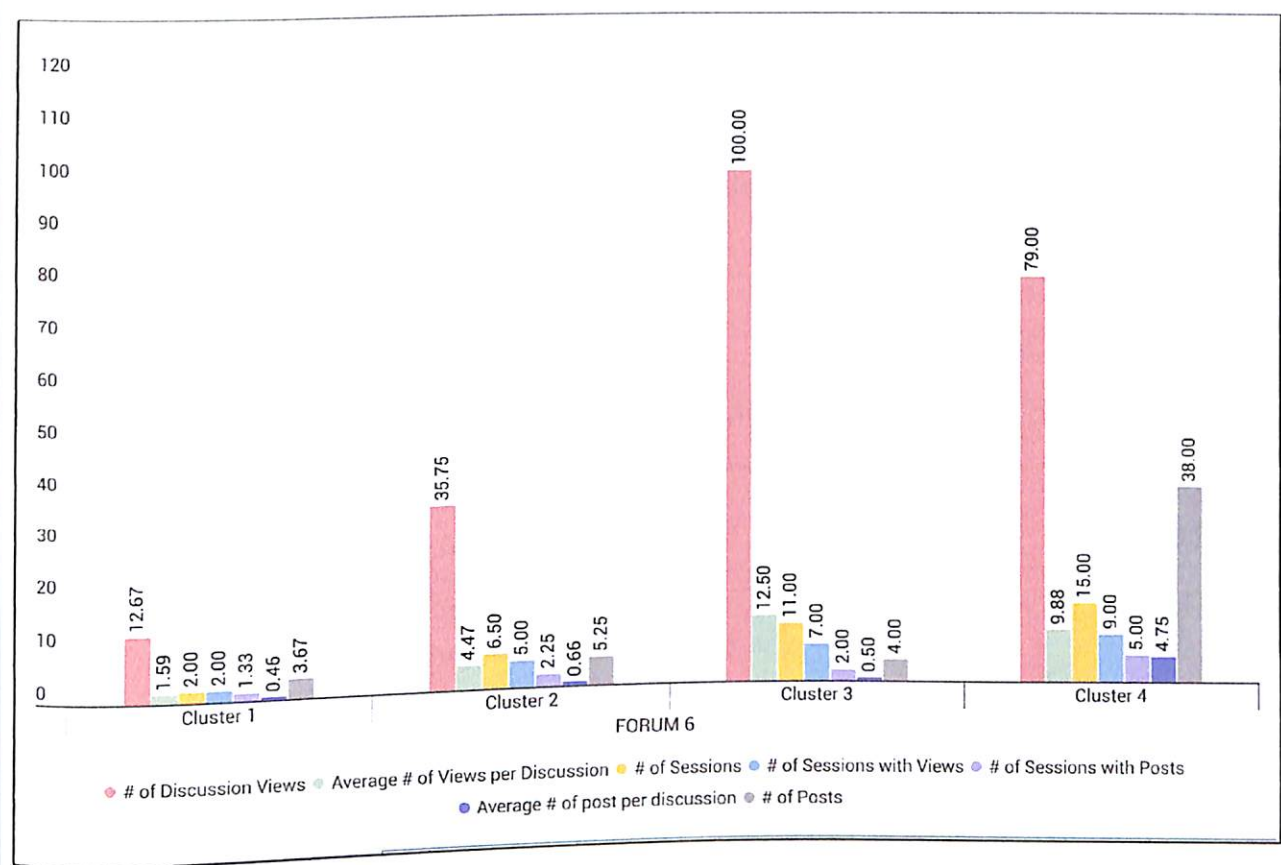
Table 12 shows the listening patterns of the nine participants in Forum 6 based on the characteristics of the clusters. Results showed that in Forum 6, three students who are in Cluster 1 are infrequent listeners and speakers and logged in the discussion forums very seldomly. Almost half of the students (44.44%) who belong to Cluster 2 are infrequent listeners and speakers and moderately logged in the discussion forums. One student who belongs to Cluster 3 is a very frequent listener, an infrequent speaker, and logged in to the discussion forums very frequently. One student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions,

the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.23). It can also be observed in Forum 6 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 23). Out of the 58 sessions made by nine students in Forum 6, 72.41% are sessions with views and 34.48% are with posts (see Table 12).

Table 12. Listening Patterns of Students in Forum 6

FORUM 6	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Moderate number of sessions with views, Low number of sessions with posts.	A4,A5,A8	33.33%
2	Moderate Listener, Infrequent Speaker, Moderate number of log-ins to DFs, High number of sessions with views, High number of sessions with posts.	A1,A3,A6,A9	44.44%
3	Very frequent Listener, Infrequent Speaker, High number of log-ins to DFs, Very high number of sessions with views, High number of sessions with posts.	A2	11.11%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A7	11.11%

Figure 23. Listening Variables by Cluster - Forum 6



Forum 7

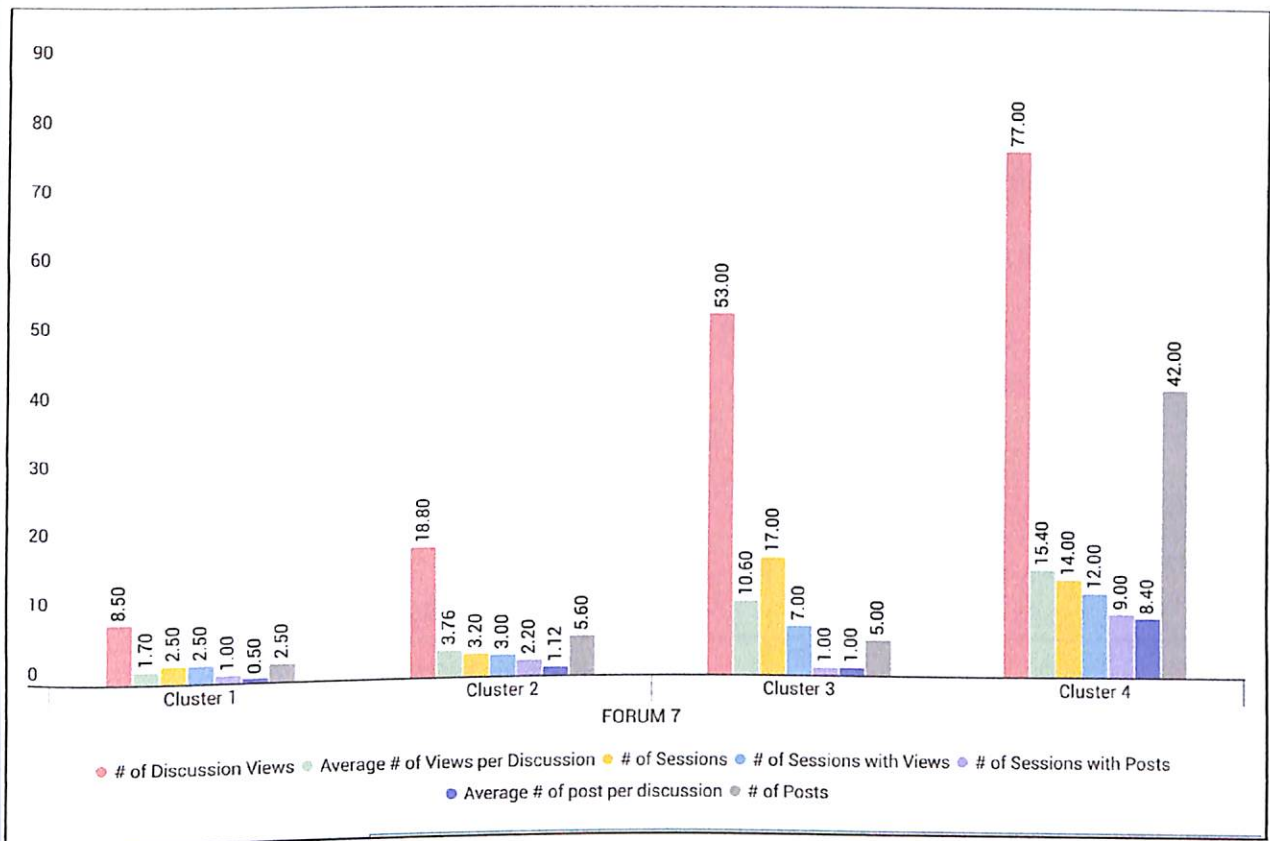
Table 13 shows the listening patterns of the nine participants in Forum 7 based on the characteristics of the clusters. Results showed that in Forum 7, most of the students (77.79) who are in Clusters 1 and 2 are infrequent listeners and speakers and logged in the discussion forums very seldomly. One student who belongs to Cluster 3 is a very frequent listener, an infrequent speaker, and logged in to the discussion forums very frequently. One student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions, the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.24). It can

also be observed in Forum 7 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 24). Out of the 52 sessions made by nine students in Forum 7, 75% are sessions with views and 44.23% are with posts (see Table 13).

Table 13. Listening Patterns of Students in Forum 7

FORUM 7	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Low number of log-ins to DFs, Low number of sessions with views, Low number of sessions with posts.	A5,A7	22.22%
2	Moderate Listener, Infrequent Speaker, Low number of log-ins to DFs, Moderate number of sessions with views, Moderate number of sessions with posts.	A1,A3,A4,A6,A8	55.56%
3	Frequent Listener, Infrequent Speaker, Very high number of log-ins to DFs, High number of sessions with views, Low number of sessions with posts.	A2	11.11%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A9	11.11%

Figure 24. Listening Variables by Cluster - Forum 7



Forum 8

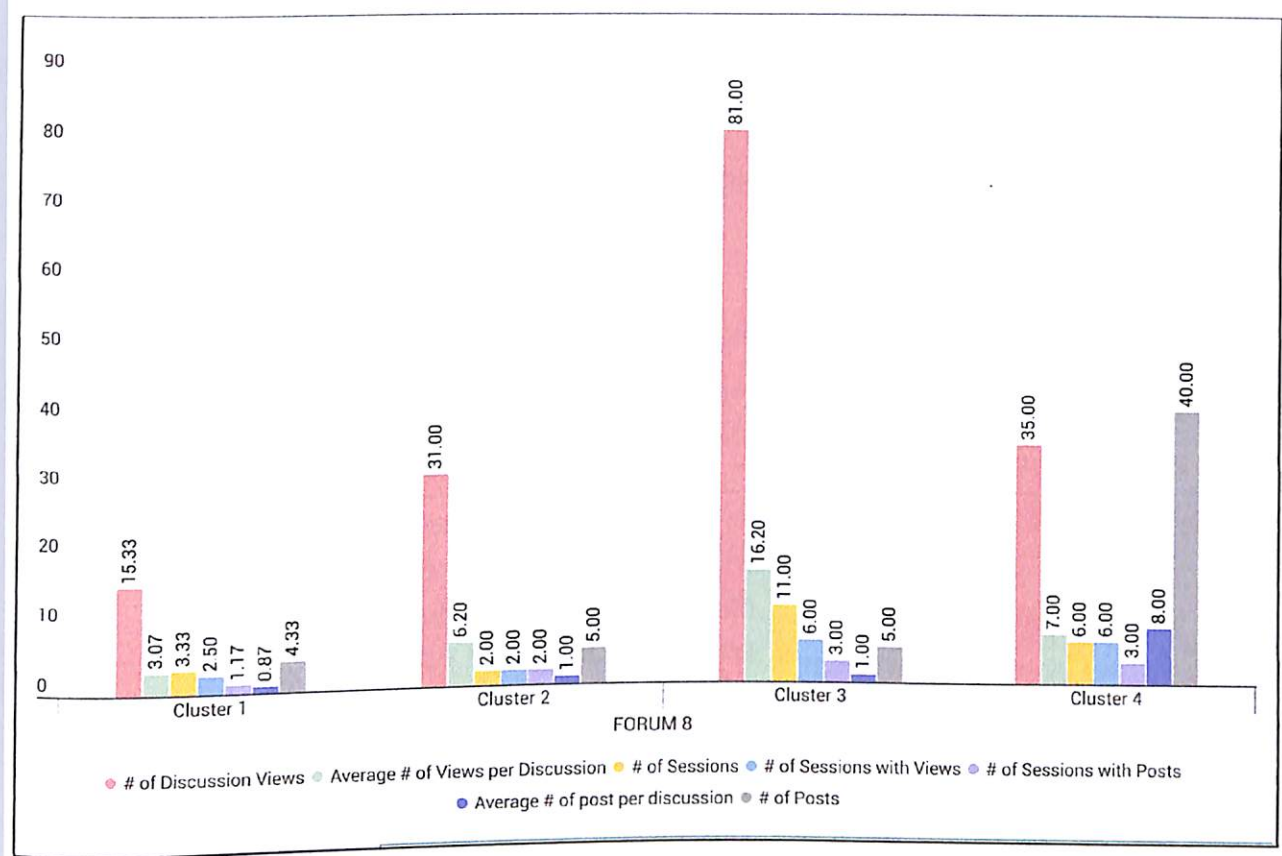
Table 14 shows the listening patterns of the nine participants in Forum 8 based on the characteristics of the clusters. Results showed that in Forum 8, many students (66.67%) who are in Cluster 1 are infrequent listeners and speakers and logged in to the discussion forums moderately. One student (11.11%) who belongs to Cluster 2 is a moderate listener and an infrequent speaker who moderately logged in in the discussion forums. One student who belongs to Cluster 3 is a very frequent listener, an infrequent speaker, and logged in to the discussion forums very frequently. One student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions,

the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.25). It can also be observed in Forum 8 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 25). Out of the 39 sessions made by nine students in Forum 8, 74.36% are sessions with views and 38.46% are with posts (see Table 14).

Table 14. Listening Patterns of Students in Forum 8

FORUM 8	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, High number of sessions with views, Moderate number of sessions with posts.	A1,A4,A6,A7,A8,A9	66.67%
2	Moderate Listener, Infrequent Speaker, Moderate number of log-ins to DFs, High number of sessions with views, High number of sessions with posts.	A3	11.11%
3	Very frequent Listener, Infrequent Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A2	11.11%
4	Frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A5	11.11%

Figure 25. Listening Variables by Cluster - Forum 8



Forum 9

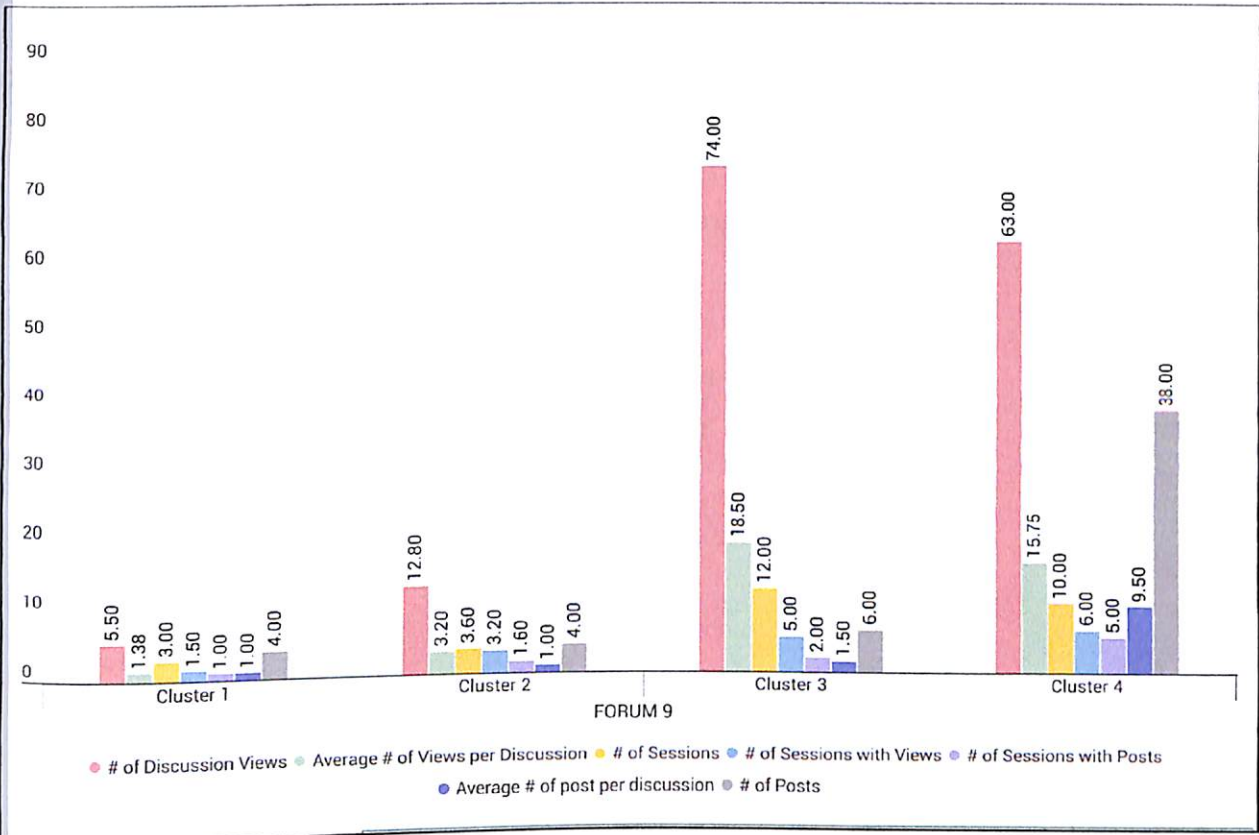
Table 15 shows the listening patterns of the nine participants in Forum 9 based on the characteristics of the clusters. Results showed that in Forum 9, most of the students (77.79%) who are in Clusters 1 and 2 are infrequent listeners and speakers and logged in the discussion forums moderately. One student who belongs to Cluster 3 is a very frequent listener, an infrequent speaker, and logged in to the discussion forums very frequently. One student belongs to Cluster 4 (Very Frequent Listener, Very Active Speaker, Very High number of log-ins to DFs, Very High number of sessions with views, Very High number of sessions with posts). In terms of listening dimensions, the student belonging to Cluster 4 has the highest level of listening breadth, revisitation, and temporal contiguity (see Fig.26). It can also be

observed in Forum 9 that the more frequent the students log in to the discussion forums, the higher the number of times they viewed posts and contributed posts in the discussion forums (see Fig. 26). Out of the 46 sessions made by nine students in Forum 9, 65.22% are sessions with views and 36.96% are with posts (see Table 14).

Table 15. Listening Patterns of Students in Forum 9

FORUM 9	CHARACTERISTICS	STUDENT	CASE PER CLUSTER
1	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Low number of sessions with views, Moderate number of sessions with posts.	A5,A9	22.22%
2	Infrequent Listener, Infrequent Speaker, Moderate number of log-ins to DFs, Moderate number of sessions with views, Moderate number of sessions with posts.	A1,A3,A4,A6,A7	55.56%
3	Very frequent Listener, Infrequent Speaker, Very high number of log-ins to DFs, High number of sessions with views, High number of sessions with posts.	A2	11.11%
4	Very frequent Listener, Very active Speaker, Very high number of log-ins to DFs, Very high number of sessions with views, Very high number of sessions with posts.	A8	11.11%

Figure 26. Listening Variables by Cluster - Forum 9



C. Interaction Patterns and Level of Knowledge Construction of Students With High Centrality

The characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 1 are illustrated through a graph in Fig. 27. In Forum 1, one student, A6, who is at the center of the star graph has the highest centrality values (degree (8), betweenness (1.0), and closeness (1.0)) (Fig.8). A6, who belongs to listening pattern cluster 4 was able to reach knowledge construction level/phase I, II, and III. A6 who logged in to the discussion forums very frequently is also a very frequent listener who viewed the discussion forums 145 times, and a very active speaker who contributed a total of 34

posts and 8 threads in the discussion Forum 1. The graph in Fig. 27 also shows that in most cases, those students who continued interacting/exchanging messages with other students in Forum 1 were able to reach a higher level/phase of knowledge construction.

Figure 27. Visualization of online interactions between students in Forum 1

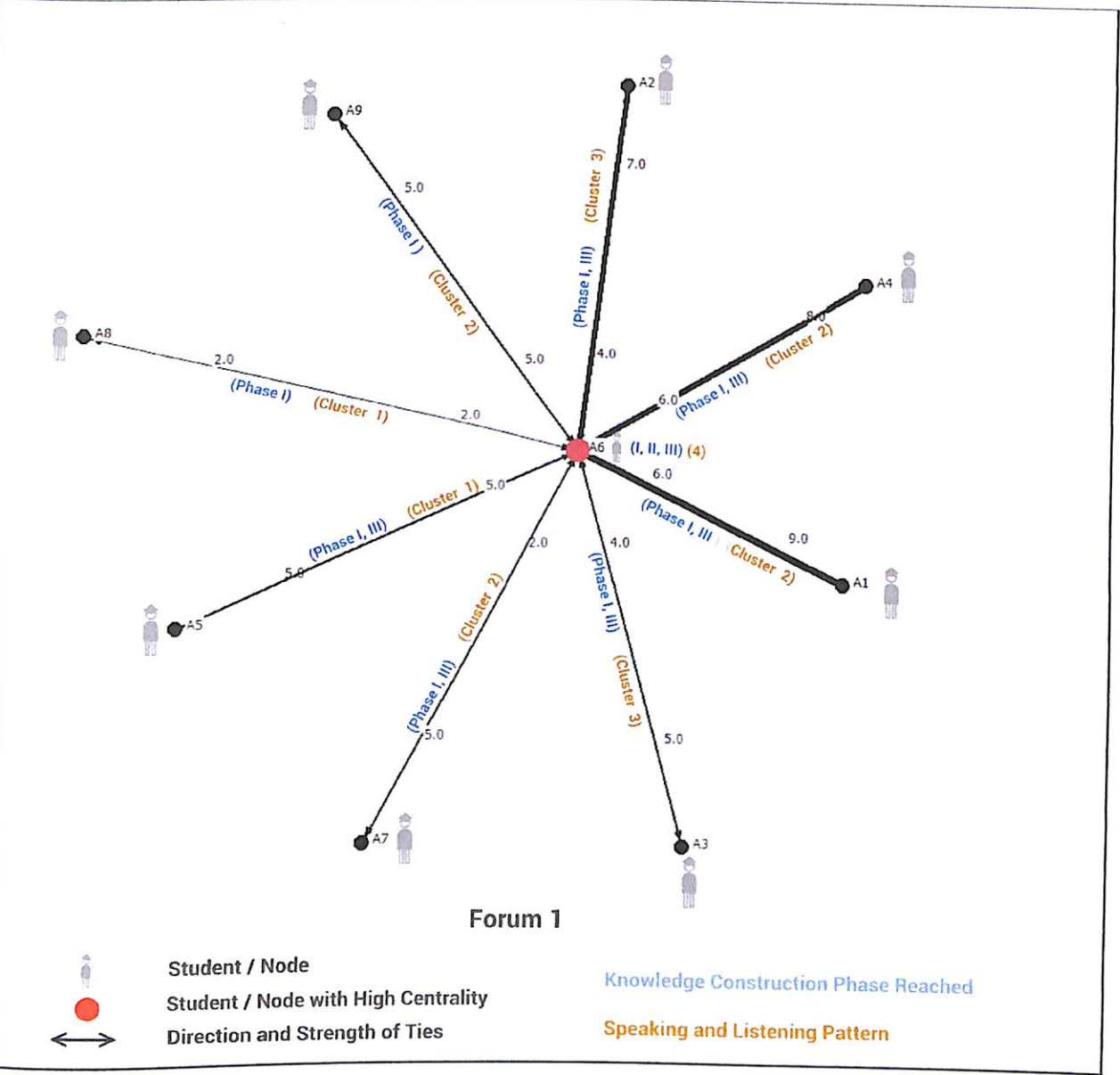


Figure 28 illustrates the characteristics of the interaction patterns (speaking and listening) of the students and the level of knowledge construction reached in Forum 2. In Forum 2, one student, A2, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.9). A2, who belongs to listening pattern cluster 4 also reached knowledge construction level I. A2 who logged in to the discussion forums very frequently is also a very frequent listener who viewed the discussion forums 137 times, and a very active speaker who contributed a total of 27 posts and one thread in the discussion Forum 2.

Figure 28. Visualization of online interactions between students in Forum 2

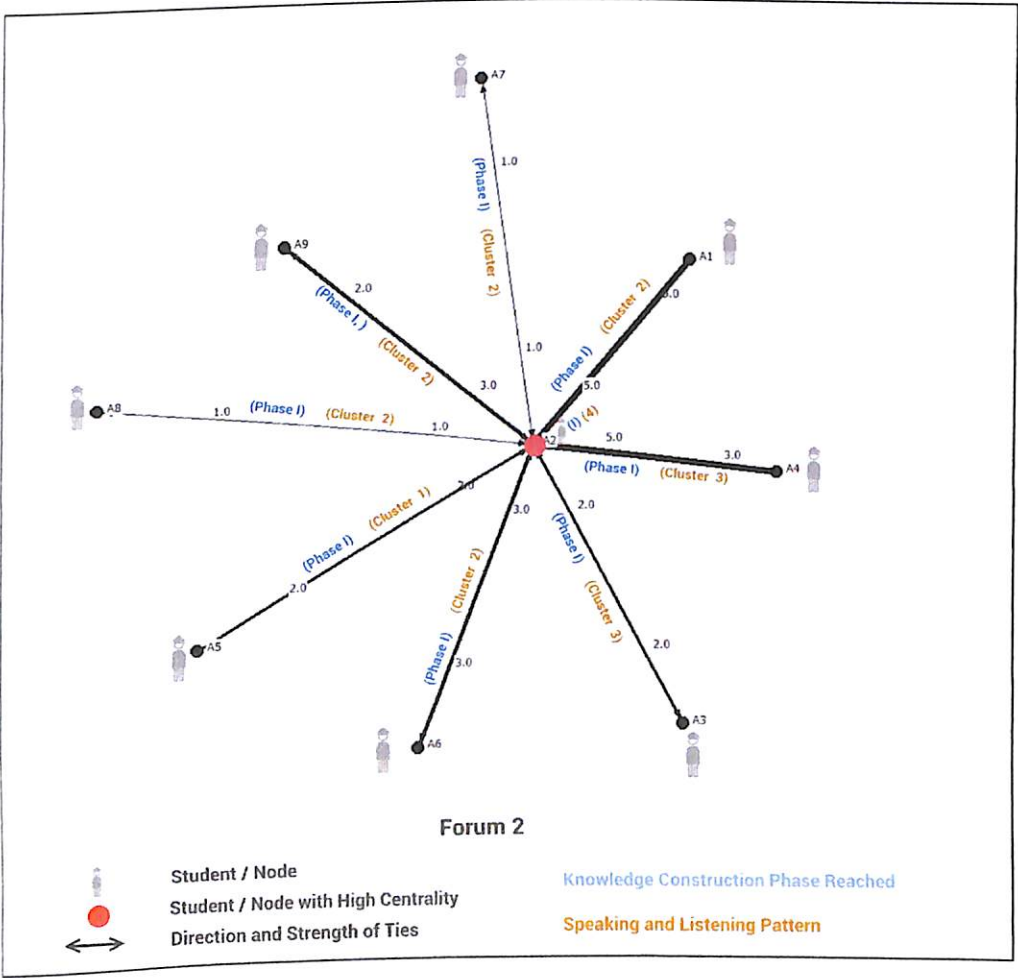


Figure 29 illustrates the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 3. In Forum 3, three students, A3, A4, and A9, have high centrality values. A3, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.10). All three students reached knowledge construction levels I and III. A3 belongs to Cluster 4, while A4 and A9 belong to Cluster 2. A2 and A4 are infrequent listeners and speakers who logged in to discussion forums moderately. A3, who logged in to the discussion forums very frequently, is also a very frequent listener who viewed the discussion forums 274 times, and a very active speaker who contributed a total of 31 posts and 7 threads in the discussion Forum 3.

Figure 29. Visualization of online interactions between students in Forum 3

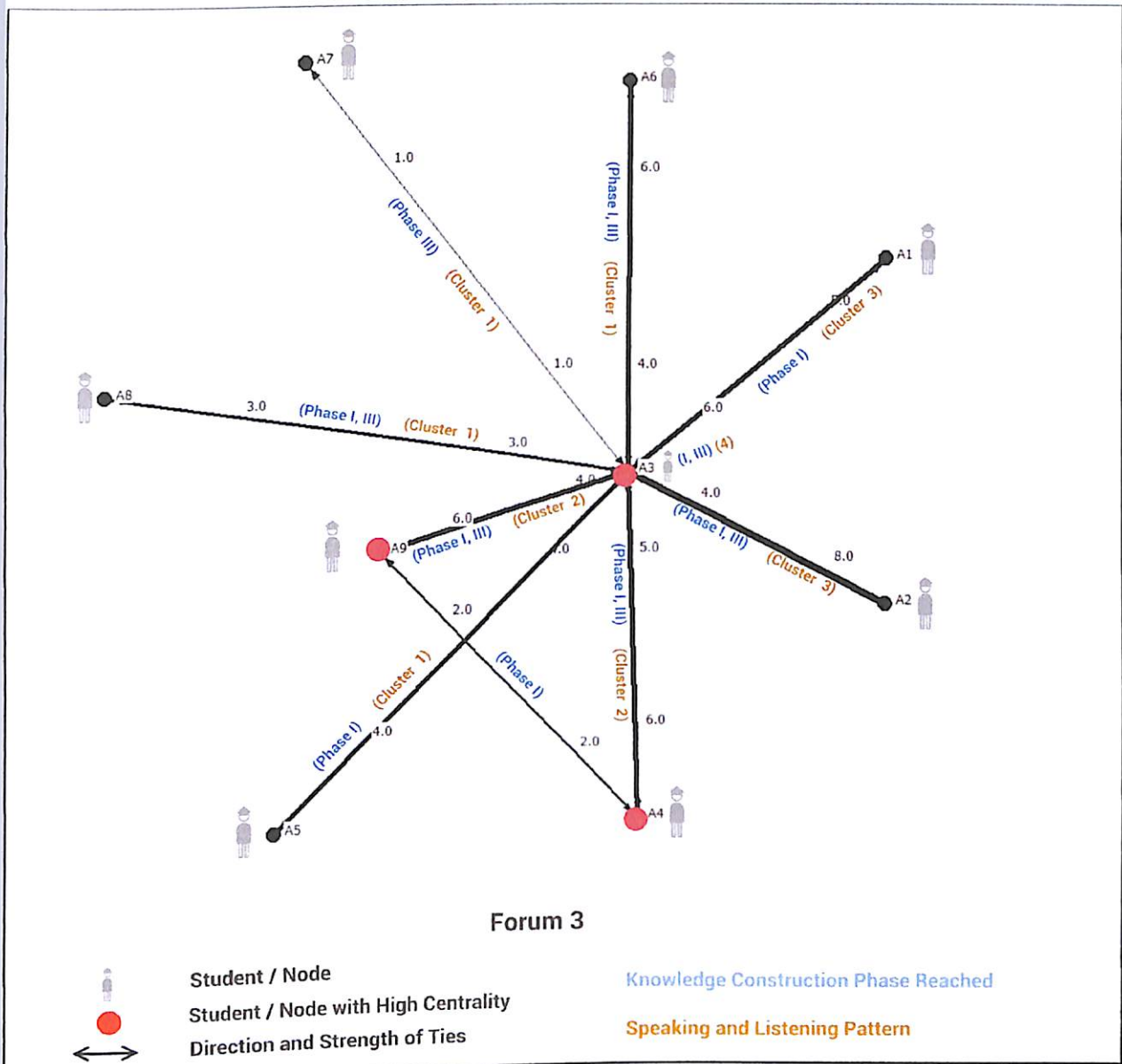
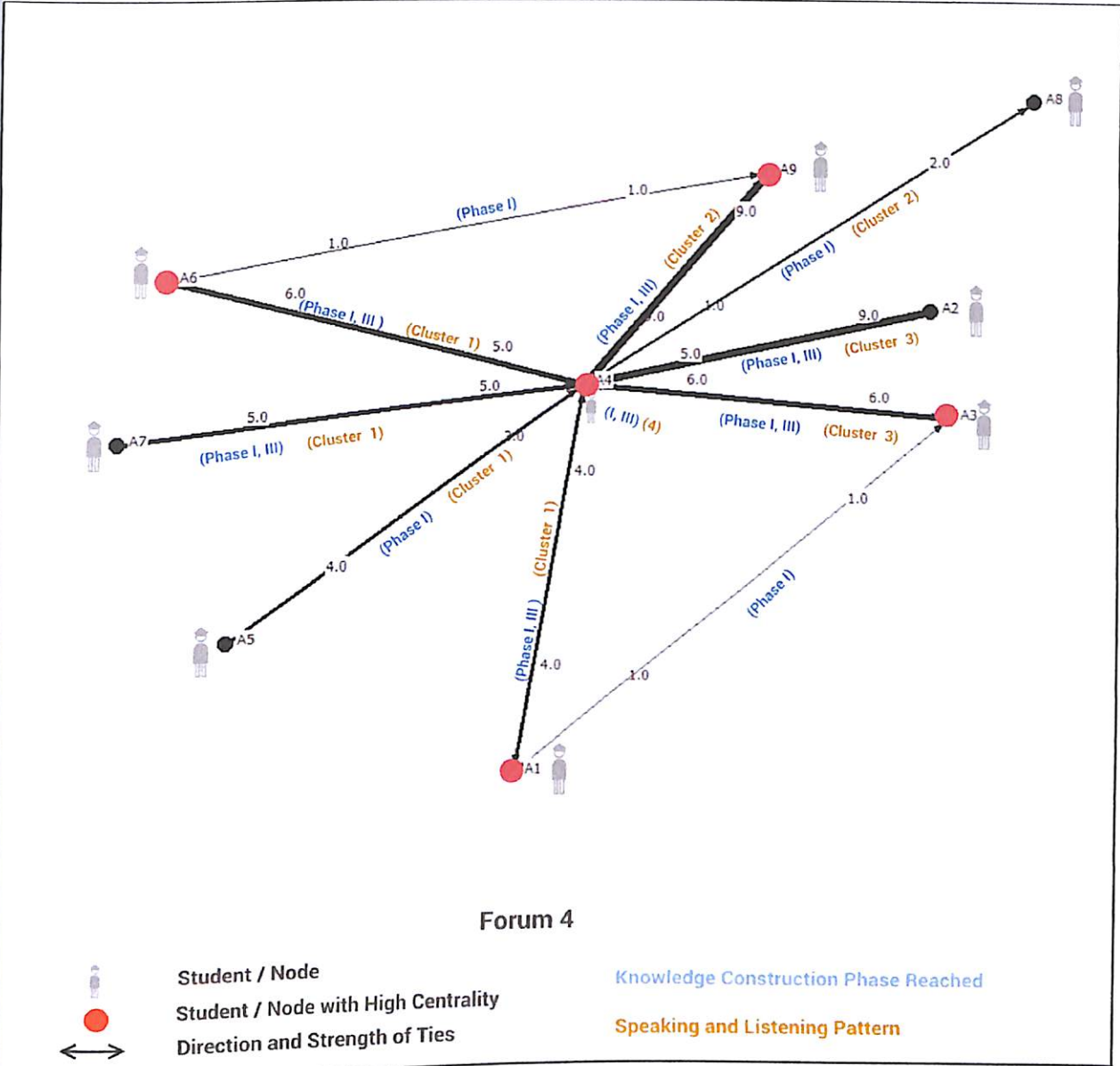


Figure 30 illustrates the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 4. In Forum 4, five students, A1, A3, A4, A6, and A9, have high centrality values. A4, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.11). All five students reached knowledge construction levels I and III. A6 belongs to Cluster 1, A1 and A9

belong to Cluster A2, A3 belongs to Cluster 3 and A6 belongs to Cluster 4. A6 is an infrequent listener and speaker who logged in to discussion forums very seldomly. A1 and A9 are infrequent listeners and speakers who logged in to discussion forums moderately. A3 is a moderate listener and speaker who logged in to the discussion forums very frequently. A4, who logged in to the discussion forums very frequently, is also a very frequent listener who viewed the discussion forums 274 times, and a very active speaker who contributed a total of 31 posts and 7 threads in the discussion Forum 4.

Figure 30. Visualization of online interactions between students in Forum 4



The characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 5 are visualized through a graph in Fig. 31. In Forum 5, one student, A1, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.12). A1, who belongs to listening pattern cluster 4 was able to reach knowledge construction levels I and III. A1 who logged in to the discussion

forums very frequently is also a very frequent listener who viewed the discussion forums 181 times, and a very active speaker who contributed a total of 55 posts and 9 threads in the discussion Forum 5.

Figure 31. Visualization of online interactions between students in Forum 5

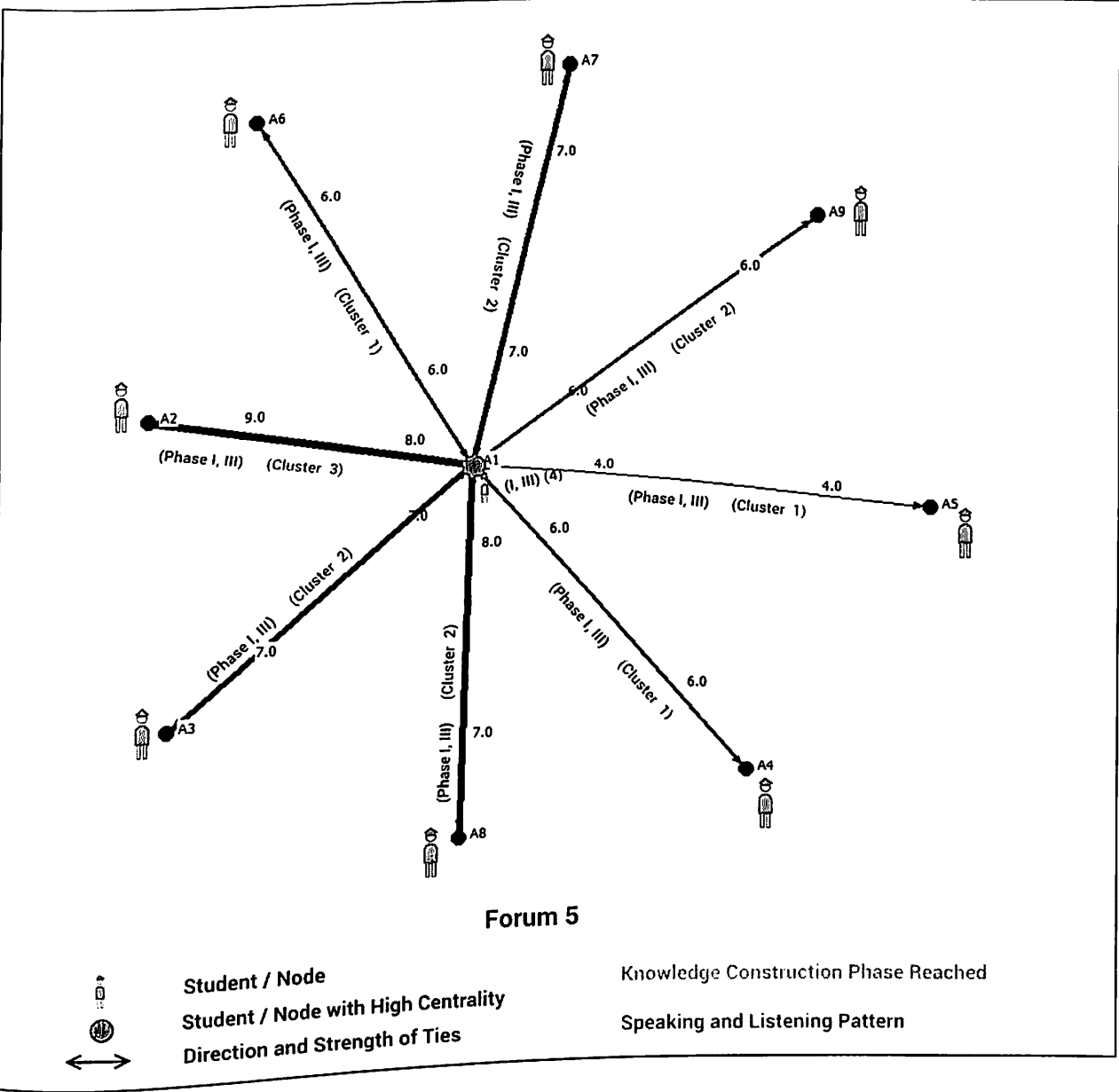


Figure 32 illustrates the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 6. In Forum 6, one student, A7, who is at the center of the star graph has the

highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.13). A7, who belongs to listening pattern cluster 4 also reached knowledge construction levels I and II. A7 who logged in to the discussion forums very frequently is also a very frequent listener who viewed the discussion forums 79 times, and a very active speaker who contributed a total of 30 posts and 8 threads in the discussion Forum 6.

Figure 32. Visualization of online interactions between students in Forum 6

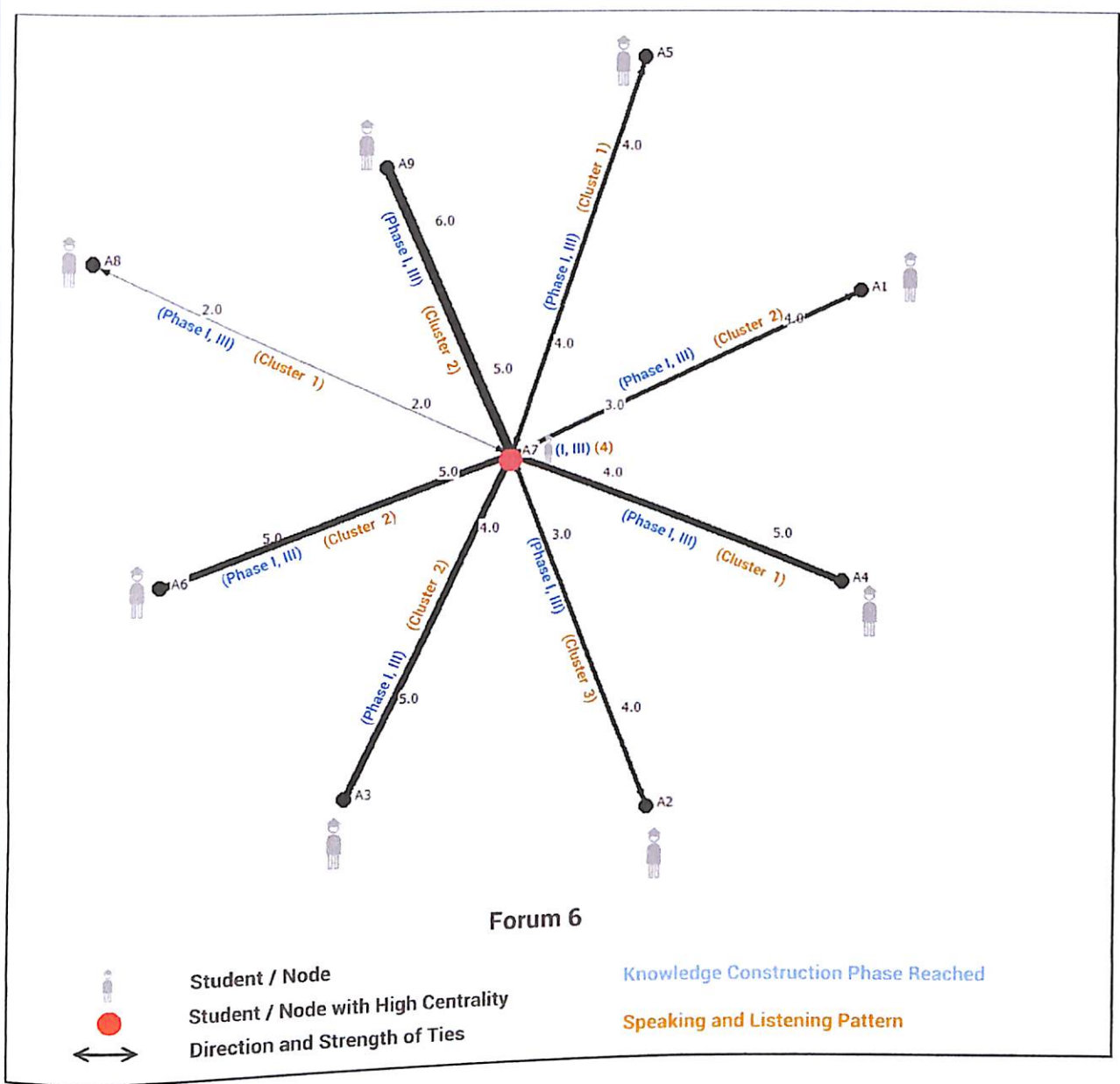


Figure 33 illustrates the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 7. In Forum 7, one student, A9, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.14). A9, who belongs to listening pattern cluster 4 also reached knowledge construction levels I and II. A9 who logged in to the discussion forums very

frequently is also a very frequent listener who viewed the discussion forums 77 times, and a very active speaker who contributed a total of 37 posts and 5 threads in the discussion Forum 7.

Figure 33. Visualization of online interactions between students in Forum 7

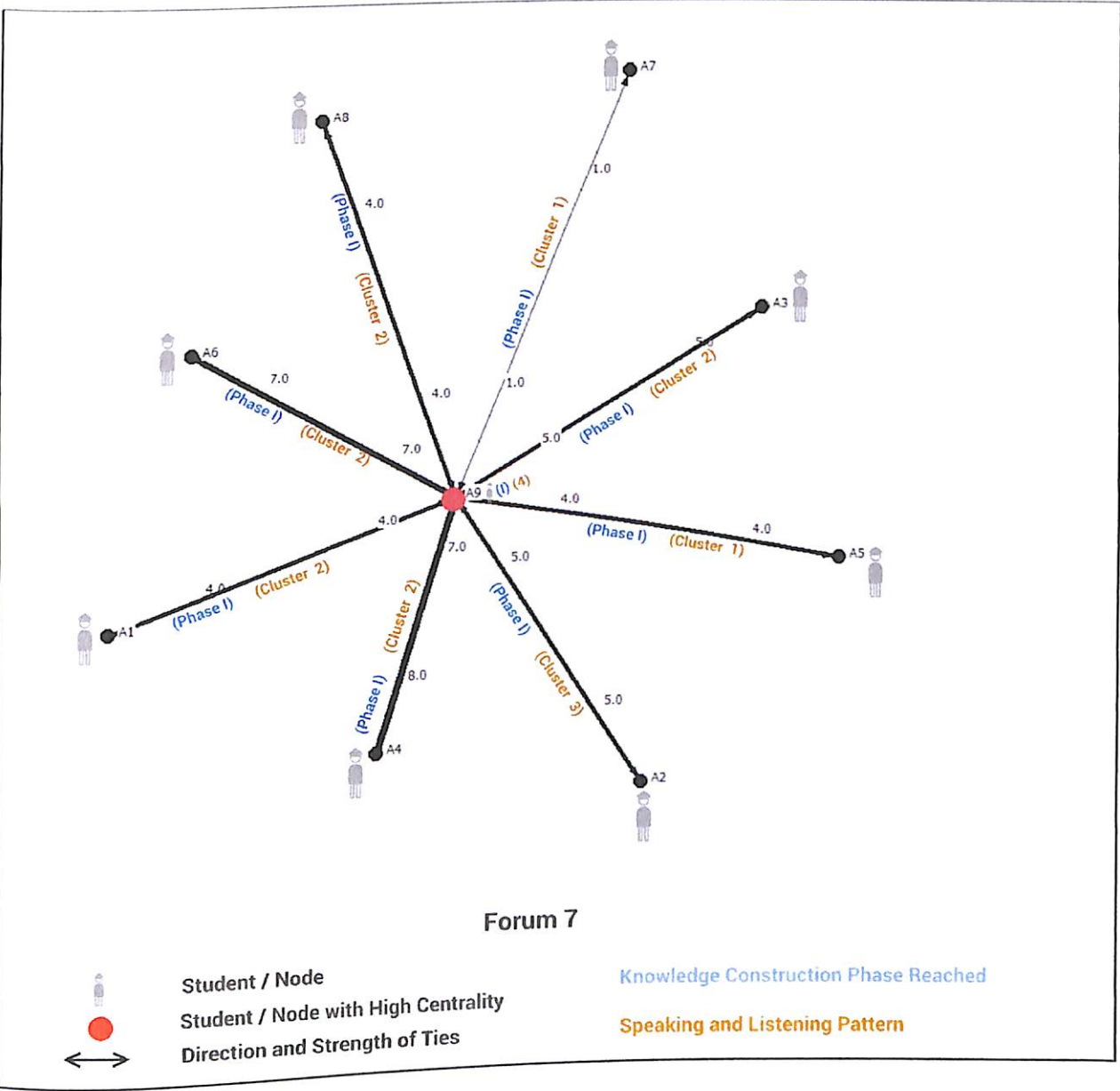


Figure 34 shows the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum

8. In Forum 8, three students, A2, A4, and A5, have high centrality values. A5, who is at the center of the star graph, has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.15). A4 and A5 reached knowledge construction levels I and III while A2 reached level I. A4 belongs to Cluster 1 and A2 belongs to Cluster 3, while A5 belongs to Cluster 4. A4 is an infrequent listener and speaker who logged in to discussion forums moderately. A2 is a very frequent listener and an infrequent speaker who logged-in to discussion forums very frequently. A4, who logged in to the discussion forums very frequently, is also a very frequent listener who viewed the discussion forums 35 times, and a very active speaker who contributed a total of 35 posts and 5 threads in the discussion Forum 8.

Figure 34. Visualization of online interactions between students in Forum 8

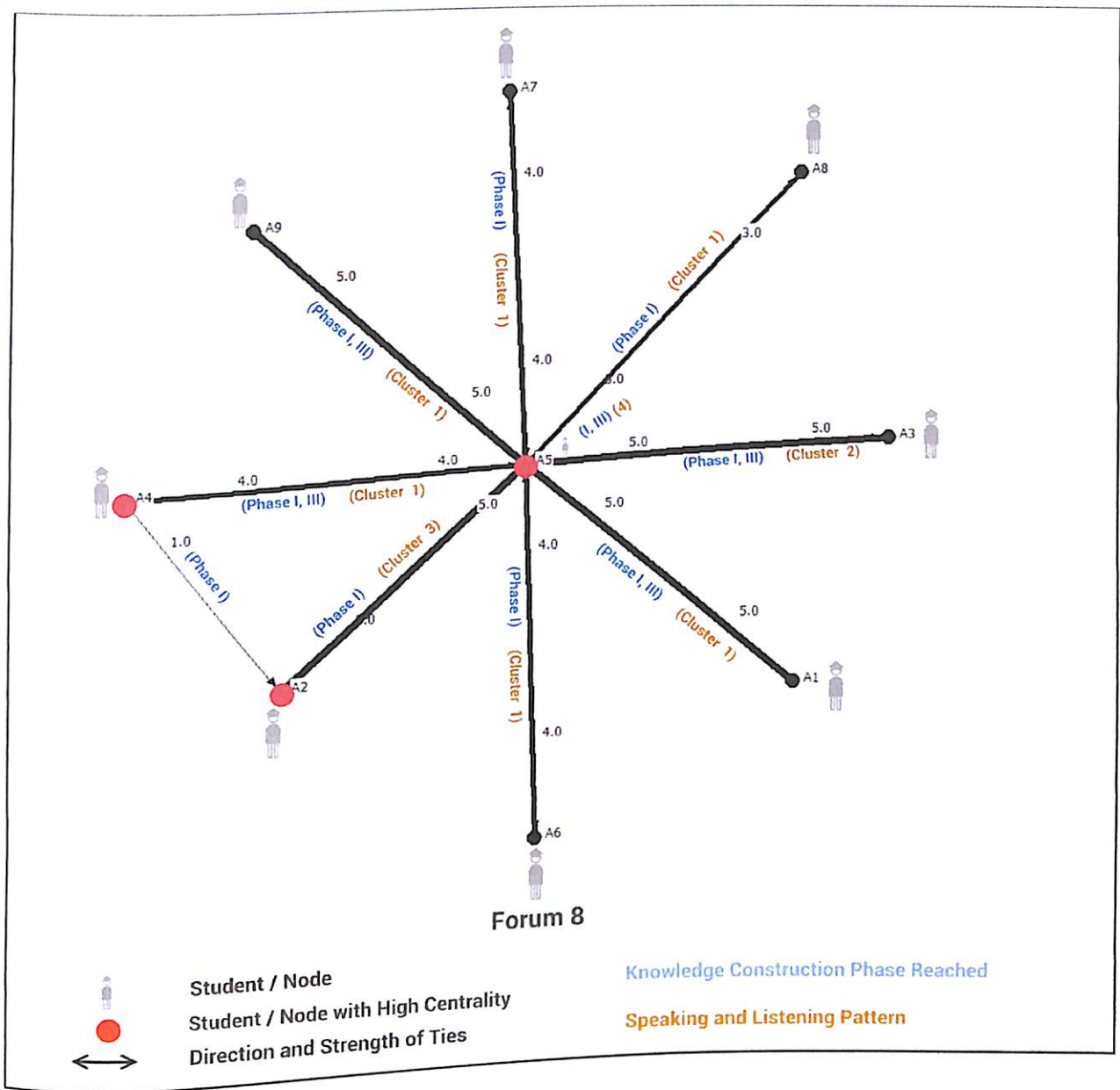
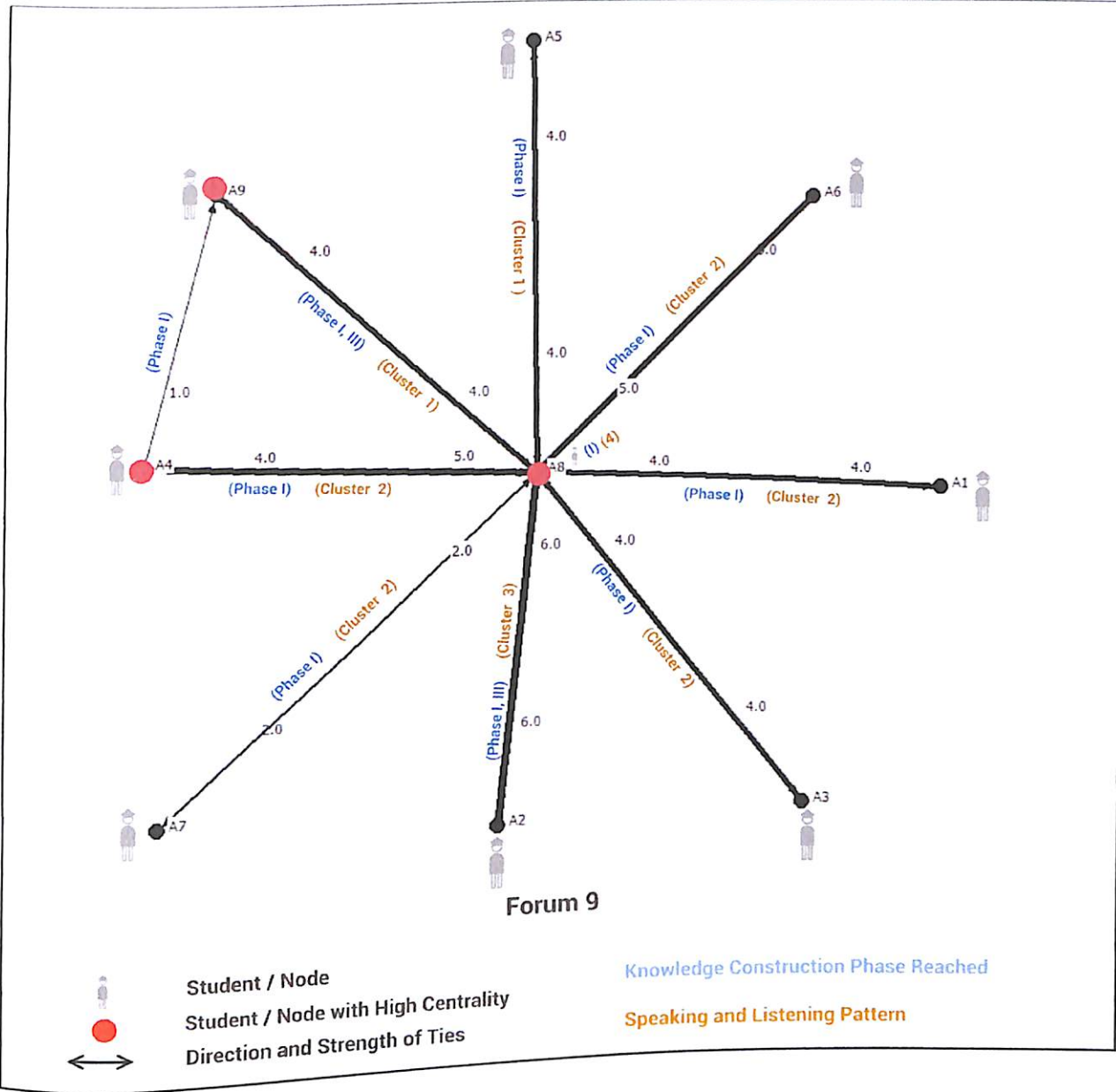


Figure 35 illustrates the characteristics of the interaction patterns (speaking and listening) of nine students and the level of knowledge construction reached in Forum 9. In Forum 9, three students, A4, A8, and A9, have high centrality values. A8, who is at the center of the star graph has the highest degree (8), betweenness (1.0), and closeness (1.0) centrality values (Fig.16). A8 reached knowledge construction level I and III while A4 and A9 reached level I. A9 belongs to Cluster 1

and A4 belongs to Cluster 2, while A8 belongs to Cluster 4. A2 and A9 are infrequent listeners and speakers who logged in to discussion forums moderately. A8, who logged in to the discussion forums very frequently, is also a very frequent listener who viewed the discussion forums 63 times, and a very active speaker who contributed a total of 34 posts and 4 threads in the discussion Forum 9.

Figure 35. Visualization of online interactions between students in Forum 9



Chapter Five

SUMMARY

This study employed multi-analysis methodologies, with Social Network Analysis (SNA) as the primary research approach, in combination with Interaction Analysis Model (IAM) and Cluster Analysis to uncover and understand connections, links, patterns, and structures formed from online interactions (speaking and listening) that may influence the social construction of knowledge that occurred in the online discussion forums.

A. Level of Knowledge Construction Reached in ADFs

To identify the level of knowledge construction that occurred in the online discussion forums, transcripts that were extracted from the learning management system were evaluated using the five-phase Interaction Analysis Model (IAM) by Gunawardena et al. (1997) (*Phase I. Sharing/comparing of information, Phase II. Discovery and exploration of dissonance or inconsistency among the ideas, concepts, or statements advanced by different participants, Phase III. Negotiation of meaning and/or co-construction of knowledge, Phase IV. Testing and modification of proposed synthesis or co-construction and Phase V. Phrasing of agreement, statement(s), and applications of the newly constructed meaning*).

The result shows that most of the messages in the nine discussion forums are coded under Phase I (78.96%), less than one percent under Phase II (0.27%), and

20.77% under Phase III, while the occurrence of messages under Phase IV and V are not present in all discussion forums.

This study suggests some factors on why, based on the results, most of the messages in the nine discussion forums were coded under Phase I or the Sharing/comparing of information level: 1) how the forums were designed, 2) the intention of the moderator, and the 3) discussion points made by the moderators. The online course in this study was designed where moderators of the discussion forums were expected to share their research plans and how they are going to implement their research, while other students were encouraged to give their opinions and share ideas that they think can help in the implementation of the research. This study suggests that the discussion points such as "What do you think is the importance of...", "What are your recommendations...", "I would like you to share...", "You can comment..." might have led other participants to give statements and comment or share their opinions and personal experiences regarding the topic, thus limiting students to give statements of observation, opinion or agreement on the discussion topics.

The small percentage of the messages are recorded in Phase II, the discussions on discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements suggest that most of the students in this class were not keen on identifying or stating areas of disagreement on other students' statements. One factor that can be considered to explain the result is that the design of the discussion forums in this study did not intentionally encourage participants to freely post appropriate diverse or opposing views in the discussion forums as part of their collaborative learning. Another factor that can be considered is the observation from other research studies that discussion of dissonance or opposing ideas online

may not be culturally appropriate, particularly students from Asian countries which is far less appropriate to challenge and criticize the ideas of others (Gunawardena, et al., 2014). Although this reason has yet to be determined applicable in the current study, perhaps by asking directly the participants in future research.

The absence of messages under Phase IV and V in all discussion forums indicate that students in this class were not able to reach the level where they test and modify proposed synthesis or to agree and apply newly constructed meaning. A possible explanation for this is that, at this stage, students are still in the planning stage of their research and they were given a limited time (only one week per discussion forum) to continuously interact with each other until they reach a higher level of knowledge construction. Another factor that can be considered is the lack of the student's motivation to engage which can also be associated with how the discussions were moderated.

B. The extent of students' interactions (speaking and listening) in the online discussion forums

Employing SNA provided the measure on the extent of student's engagement as well as the student's non-engagement in the discussion forums. This study was able to determine the extent to which the students participated in the discussions, identified who speaks to whom, or who among the students were speaking/contributing posts in the discussion forums, and through graphs, provided visualization on how well students are linked or connected to each other.

Network measures such as betweenness centrality, closeness centrality, degree centrality, density, as well as tie strength and direction of ties in the

discussion forums were useful in understanding the strength of interactions and connectedness among students. Graphs generated using Netdraw mapped out information flow between students in the discussion forums and visualized the extent of the students' participation and connection during the discussions in the online forums.

Network density provided the measure of the extent to which the students are linked or connected to each other and the level of their engagement in the discussion forums. Results showed that overall, students in this online class were very connected and were able to engage with each other in the discussion forums. Interestingly, it is also important to note that the network density values measured for each discussion forum are low (Table 5), indicating that the connection and engagement of students with each other are very limited or low if measured per discussion forum. This is because, for each discussion forum, results showed that students only engaged with the moderator and their interaction with other students was very limited or none at all.

This study was able to describe the extent of students' interactions in the online discussion forums through the patterns and structures of the students' participation and engagement in the online course, not only on the extent that students contributed posts but also to the extent of how they view or access the posts in the discussion forums. The transcripts that were extracted from GradCourse01 contained a total of 732 posts (speaking) from nine (9) discussion forums (Table 6). Log records of students' activities including forum posts, views, and session log-ins were also extracted to determine the listening patterns. A total of 8,525 LMS views were recorded in the online course GradCourse01 based on the

data extracted from the LMS (Table 6). The number of sessions (536), discussion views (3179), and posts contributed (732) were also extracted to evaluate the listening patterns of the students in nine discussion forums in the online class (Table 6). The data extracted from the Moodle learning management system, including transcripts and log records of students' activities (forum posts, views, and session log-ins) were used to analyze the extent of interactions in the online discussion forums among nine students of an online graduate course, GradCourse01.

Cluster analysis provided ways to describe the characteristics of the listening patterns of students in the discussion forums. Using Cluster Analysis, this study was able to determine the extent of the students' participation (listening) in terms of the posts they viewed or accessed in the discussion forums. This study also adapted Wise's Taxonomy (2012) using the listening breadth, revisitation, and temporal contiguity dimensions and seven variables extracted from the learning management system. Variables were measured using K-means clustering using IBM SPSS Statistics version 27, a software package used for statistical analysis to come up with the listening patterns. For each discussion forum, students were grouped into four clusters based on the listening breadth, revisitation, and temporal contiguity. Each discussion forum has its own cluster patterns and the number of cases. But in general, students in Cluster 1 are the infrequent listeners and speakers who logged in to the discussion forums very seldomly. While students in Cluster 4 are very frequent listeners and very active speakers who logged in to the discussion forums frequently. Using cluster analysis, this study was able to describe the characteristics of the student's interaction patterns in terms of the listening breadth or the extensiveness of the listening, revisitation or the extent to which a learner returns to

posts made by themselves and others that they have attended to previously, and the temporal contiguity or how a learner manages and divides their time within a discussion.

C. Interaction Patterns and Level of Knowledge Construction of Students With High Centrality

Network centrality has provided a way of looking at the extent of interactions and the direction or flow of information in the discussion forums as seen in this study. Degree centrality serves as indicators of the number of student's links or connections with other participants and the flow of information in the discussion forum such as who speaks to whom, who receives information from whom (in-degree centrality), or who sends information to whom (outdegree centrality). Betweenness centrality provided information on who among the students has a great influence or potential control on the flow of information. While closeness centrality measures the student's potential to easily access information in the discussion forums.

Using network diagrams, this study was able to map the extent of the students' participation (speaking and listening) and their level of knowledge construction during the discussions in the online forums.

Characteristics of students who occupied central positions in the discussion forums in terms of their listening patterns and level of knowledge construction were visualized through network diagrams. All nine students with the highest centrality in nine discussion forums were found to be under Cluster 4, seven of which (77%) have reached Knowledge Construction Level 3, while two students in Forums 2 and 7 reached Knowledge Construction Level 1.

In this study, moderators in the discussion forums were found to have the highest centrality. Being at the center of the network, moderators are found to be in a relevant position in the network which can influence the views of other students. Results showed that moderators receive the most messages or information from the participants and they are in the position to connect the participants. Moderators have a high influence in terms of information sharing and information flow.

Visualization of students' interactions in Forums 1, 2, 5, 6, and 7 showed that participants interacted with the moderator only. Graphs of students' interactions in Forums 3, 4, 8, and 9 showed that aside from interacting with the moderator, a very small number of students engaged (gave and received messages) with other students as well.

While it is expected that the moderator occupies the central position in the flow of information considering the design of this discussion forum where the moderator is assigned to interact with other participants, it is also interesting to note that aside from interacting with the moderator, a very small number of students engaged (gave and received messages) with other students in the discussion forums.

Based on the transcripts extracted from their communication exchanges, these are the noted reasons why the students interacted with each other, aside from interacting with the moderator: 1) to clarify and/or ask questions related to the information posted by the other student; 2) to confirm and acknowledge the relevance of shared information, and/or agree with the other students' posted message; 3) to provide additional information and share own experiences related to the other student's posted message, and 4) to answer an inquiry/question from other students.

Chapter Six

CONCLUSIONS AND RECOMMENDATIONS

Network plays a central role in the knowledge construction formed from the interactions and collaboration of online learners in asynchronous discussion forums. The very nature of networks to form connections, relationships, and links uncovers unique and wider opportunities for online learners to create higher levels of knowledge the more they interact and collaborate with each other.

The opportunities to construct knowledge among online learners elevate as the connections and links formed from interacting with each other widen and enlarge reach. This study found relevant indicators to conclude that the network structures of online interactions (speaking and listening), both in terms of posts contributed and posts viewed, have the potential to influence the knowledge construction of online learners.

The emergence of computer-mediated communication (CMC) and learning networks, introduces new perspectives on how social interaction and learning takes place in an online learning environment. The distance-and-time-independent nature of online asynchronous discussion forums provides students a learning environment that encourages learners to actively interact and construct knowledge, at their own pace, if and how they choose to.

The design of student-centered or student-managed discussion forums used in this study provided a learning environment that encourages online learners to construct knowledge by interacting and collaborating with each other. Findings imply that, even with only minimum supervision of the teacher, knowledge construction formed through interactions and collaborations occurred in a student-centered or

student-managed online learning environment where learners were given opportunities to interact and collaborate with each other.

This paper suggests that the network position of a student in the discussion forums has a potential influence on his or her opportunities to construct knowledge based on the results of the study. Most of the students in central positions (those students who frequently interacted with other students by contributing posts and viewing or accessing posts) were found to reach higher levels of knowledge construction, indicating that as learners interact with each other in the discussion forums, connections, relationships, and links were formed, and the more they interact with each other, the higher the probability that they will construct a higher level of knowledge.

While network centrality measures have typically been used as indicators of power, influence, popularity, and prestige (Scott & Carrington, 2011), network centrality has also provided a way of looking at the extent of interactions among students and the direction or flow of information in the discussion forums as observed in this study.

Degree centrality serves as indicators of the number of student's links or connections with other participants and the flow of information in the discussion forum such as who speaks to whom, who receives information from whom (in-degree centrality), or who sends information to whom (outdegree centrality). Students with high in-degree centrality in each discussion forum received more information or messages from other students while students with high outdegree centrality are those who contributed or gave information to other students in the forum. Betweenness centrality provided information on who among the students has a great influence or potential control on the flow of information. Students with high

betweenness centrality are those at the center of the information flow, those who are in the position to hold or control information. While closeness centrality measures the student's potential to easily access information in the discussion forums. Students with high closeness centrality are in the position to easily reach out to everyone, thus they are very independent and have the potential to easily access and share information.

As expected, the student-managed learning environment design of the discussion forums in this study where students were assigned as moderators of the forums generated a network structure where the moderator occupies the central position in the flow of information since as the moderator/speaker of the forum, he/she has the most opportunity to interact and collaborate with other students.

The role of the students with the highest centrality implicates a critical and influential position in an online learning environment. As the central source of the information, students with high centrality are in the position to lead and drive the flow of discussion in the forums. Being at the center of the network, students who were assigned as moderators were found to be in a critical position in the network to influence the views of other students and to receive important information from other students. The moderators of each discussion forum are the primary source of the information and the main initiators of interactions and collaboration between the students. Moderator has the power and influence since other participants are dependent on him/her and he/she is in the best position to connect the participants with each other. Moderators have a high influence in terms of information sharing and information flow, hence, the role of moderators is crucial in the knowledge construction in the discussion forums.

While it is expected that the moderator occupies the central position in the discussion forums, it is also interesting to note that this study found some instances where, aside from interacting with the moderator, students also engaged (gave and received messages) with other students in the discussion forums. This indicates that the opportunities for knowledge construction in the discussion forums in this study are wider since both the student-to-student and moderator-to-student (or student-moderator) interactions were formed in the discussion forums.

The findings of this study corroborate with the conceptual framework grounded on network theory which posits that relationships are formed or made through a series of interactions - responses to responses to responses (Littlejohn & Foss, 2008), on the theory of connectivism, which asserts that knowledge is distributive and consists of the network of connections formed from experience, conversation, and interaction, on sharing, creation, and participation (Downes, 2019), and on social constructivism which acknowledges that knowledge we generated through social interactions gradually accumulate advances in our levels of knowing (Anderson & Kanuka, 1998).

Recommendations for future research

This study emphasizes the potential of providing more opportunities for online learners to create knowledge by empowering students through the creation of a learning environment that encourages interactions and collaborations among themselves. Thus, the researcher recommends online teachers and practitioners to put into consideration the following factors in creating their discussion forums: 1) how the forums were designed, 2) the intention of the moderator, and 3) the discussion points made by the moderators.

As learning occurs through the creation of networks (Siemens, 2007), it is also recommended that both the student-to-student and moderator-to-student (or student-to-moderator) interactions are encouraged in the discussion forums to widen their potential to create knowledge through interactions and collaborations with other students. It would also be helpful to consider the factors indicated in this study why the students interacted with each other, aside from interacting with the moderator as a guide in designing an online learning environment.

Results of the study recorded a very small percentage of the messages in Phase II, the discussions on discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements, implying that most of the students in this class were not keen on identifying or stating areas of disagreement on other students' statements. However, Siemens (2004) suggested that dissonance may contribute to knowledge construction as learning and knowledge rests in diversity of opinions. Thus, it would be noteworthy to consider incorporating in the designs of discussion forums a learning environment where students can freely express their disagreements with the intentions of collaborative learning. It might also help if explanations on the objectives of the encouragement for healthy and productive disagreements are intentionally and explicitly indicated and incorporated in the course guidelines so students are informed at the start of the class.

Further study on the use of multi-analysis methodologies focusing on network approach to look into the centrality of interaction in terms of posts accessed or viewed in the discussion forum is also recommended by the researcher, should there be available data in the learning management system.

BIBLIOGRAPHY

- Anderson, T. (2003). Getting the mix right again: An updated and theoretical rationale for interaction. *The International Review of Research in Open and Distributed Learning*, 4(2).
- Anderson, T. (2004). Towards a theory of online learning. *Theory and practice of online learning*, 2, 109-119.
- Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. *The International Review of Research in Open and Distributed Learning*, 12(3), 80-97.
- Anderson, T., & Garrison, D. R. (1998). Learning in a networked world: New roles and responsibilities. In *Distance Learners in Higher Education: Institutional responses for quality outcomes*. Madison, Wi.: Atwood.
- Anderson, T., & Kanuka, H. (1998). Online social interchange, discord, and knowledge construction.
- Aviv, R., Erlich, Z., Ravid, G., & Geva, A. (2010). Network analysis of knowledge construction in asynchronous learning networks. *Journal of Asynchronous Learning Networks*, 7(3), 1-23.
- Bada, S. O., & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education*, 5(6), 66-70.
- Beaudoin, M. F. (2002). Learning or lurking?: Tracking the "invisible" online student. *The internet and higher education*, 5(2), 147-155.

- Biesenbach-Lucas, S. (2003). Asynchronous discussion groups in teacher training classes: Perceptions of native and non-native students. *Journal of Asynchronous Learning Networks*, 7(3), 24-46.
- Bento, R., & Schuster, C. (2003). Participation: The online challenge. In *Web-based education: Learning from experience* (pp. 156-164). IGI Global.
- Borgatti, S.P. 2002. *Netdraw Network Visualization*. Analytic Technologies. Harvard, MA.
- Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. *UCINET 6 for Windows: Software for Social Network Analysis*. Harvard, MA: Analytic Technologies.
- Buraphadeja, V. (2010). An assessment of knowledge construction in an online discussion forum: The relationship between content analysis and social network analysis. University of Florida.
- Cela, K.L., Sicilia, M.Á. & Sánchez, S. Social Network Analysis in E-Learning Environments: A Preliminary Systematic Review. *Educ Psychol Rev* 27, 219–246 (2015). <https://doi.org/10.1007/s10648-014-9276-0>
- Chen, Y. W. L. F. C., & Jiang, H. M. (2006). Lurking as Participation : A Community Perspective on Lurkers' Identity and Negotiability. *Making a Difference: Proceedings of the ICLS 2006: Indiana University June 27th-July 1st, 2006*, 1, 402.
- Corich, S. Kinshuk, & Jeffrey, LM (2007). The use of discussion forums in learning communities. *Online learning communities*, 87-108. In R. Luppici (Ed.), *Online learning communities* (pp. 87-108). IAP.
- De Laat, M., Lally, V., Lipponen, L., & Simons, R. J. (2007). Investigating patterns of interaction in networked learning and computer-supported collaborative

learning: A role for Social Network Analysis. *International Journal of Computer-Supported Collaborative Learning*, 2(1), 87-103.

Dennen, V. P. (2008). Pedagogical lurking: Student engagement in non-posting discussion behavior. *Computers in Human Behavior*, 24(4), 1624-1633.

Doran, P. R., Doran, C., & Mazur, A. (2011). Social network analysis as a method for analyzing interaction in collaborative online learning environments. *Journal of Systemics, Cybernetics and Informatics*, 9(7), 10-16.

Downes, S. (2010). Learning networks and connective knowledge. In *Collective Intelligence and E-Learning 2.0: Implications of web-based communities and networking* (pp. 1-26). IGI global.

Downes, S. (2012). Connectivism and connective knowledge: Essays on meaning and learning networks.

Durairaj, K., & Umar, I. N. (2015). A proposed conceptual framework in measuring social interaction and knowledge construction level in asynchronous forum among university students. *Procedia-Social and Behavioral Sciences*, 176, 451-457.

Eccles, R. G., & Nohria, N. (Eds.). (1992). *Networks and organizations: structure, form, and action*. Harvard Business School Press.

Erlin, E., Rahman, A. A., & Yusof, N. (2009, April). Students' interactions in online asynchronous discussion forum: A Social Network Analysis. In *2009 International Conference on Education Technology and Computer* (pp. 25-29). IEEE.

Fritsch, H. (1997). *Witness learning*. Hagen, Germany: Fern Universitat Central Institute for Distance Education Research.

- Galikyan, I., & Admiraal, W. (2019). Students' engagement in asynchronous online discussion: The relationship between cognitive presence, learner prominence, and academic performance. *The Internet and Higher Education*, 43, 100692.
- Garrison, D. R., Anderson, T., & Archer, W. (2003). A theory of critical inquiry in online distance education. *Handbook of distance education*, 1, 113-127.
- Garton, L., Haythornthwaite, C., & Wellman, B. (1997). Studying online social networks. *Journal of computer-mediated communication*, 3(1), JCMC313.
- Garton, L., Haythornthwaite, C., & Wellman, B. (1997). Studying online social networks. *Journal of computer-mediated communication*, 3(1), JCMC313.
- Goldie, J. G. S. (2016). Connectivism: A knowledge learning theory for the digital age?. *Medical teacher*, 38(10), 1064-1069.
- Gomez, D. R. (2018). Analyzing Social Construction of Knowledge and Social Networks in Online Discussion Forums in Spanish.
- Grbich, C. (2013). *Qualitative data analysis: An introduction*. Sage.
- Gunawardena, C., Lucas, M., & Moreira, A. (2014). Assessing social construction of knowledge online: A critique of the interaction analysis model. *Computers in Human Behavior*, 30, 574-582.
- Gunawardena, C. N., Flor, N. V., Gómez, D., & Sánchez, D. (2016). Analyzing social construction of knowledge online by employing interaction analysis, learning analytics, and social network analysis. *Quarterly Review of Distance Education*, 17(3), 35.

- Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of educational computing research*, 17(4), 397-431.
- Hall, B. M. (2010). In support of the interaction analysis model (IAM) for evaluating discourse in a virtual learning community. Manuscript submitted for publication.
- Hanneman, R. A., & Riddle, M. (2005). Introduction to social network methods.
- Hanneman, R. A., & Riddle, M. (2011). A brief introduction to analyzing social network data. *The Sage handbook of social network analysis*, 331-339.
- Harasim, L. (2000). Shift happens: Online education as a new paradigm in learning. *The Internet and higher education*, 3(1-2), 41-61.
- Harasim, L. M., Hiltz, S. R., Teles, L., & Turoff, M. (1995). *Learning networks: A field guide to teaching and learning online*. MIT press.
- Haythornthwaite, C., & Twidale, M. (2002, January). Visualization of Conversationally Constructed Social Networks. In CHI 2002.
- Heo, H., Lim, K. Y., & Kim, Y. (2010). Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning. *Computers & Education*, 55(3), 1383-1392.
- Honeychurch, S., Bozkurt, A., Singh, L., & Koutropoulos, A. (2017). Learners on the periphery: lurkers as invisible learners. *European Journal of Open, Distance and E-learning*, 20(1), 191-211.
- Jan, S. K., Vlachopoulos, P., & Parsell, M. (2019). Social network analysis and learning communities in higher education online learning: A systematic literature review. *Online Learning Journal*, 23(1), 249-264.

- Jan, S. K. (2018). Identifying online communities of inquiry in higher education using social network analysis. *Research in Learning Technology*, 26.
- Jonassen, D. H. (1994). Technology as cognitive tools: Learners as designers. ITForum Paper, 1, 67-80.
- Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past?. *International Review of Research in Open and Distributed Learning*, 9(3), 1-13.
- Lapadat, J. C. (2002). Written interaction: A key component in online learning. *Journal of computer-mediated communication*, 7(4), JCMC742.
- Littlejohn, S. W., & Foss, K. A. (2008). *Theories of Human Communication* 9th edition. Belmont, CA: Thomson Higher Education.
- Lumanta, M., Perez, J., & Dolom, M. (2018). Network Analysis in Assessing Interaction in an Online Colloquium Course. *Assessment Praxis in Open and Distance eLearning: Thoughts and Practices in UPOU*.
- Marin, A., & Wellman, B. (2011). *Social network analysis: An introduction*. The SAGE handbook of social network analysis.
- Martínez, J. A. D., & de Frutos, T. H. (2018). Connectivism in the network society. the coming of social capital knowledge. *Tendencias Sociales. Revista de Sociología*, (1), 21-37.
- Moore, M. G. (1989). Three types of interaction.
- Myatt, G. J. (2007). *Making sense of data: a practical guide to exploratory data analysis and data mining*. John Wiley & Sons.
- Nonnecke, B., & Preece, J. (2003). Silent participants: Getting to know lurkers better. From usenet to CoWebs (pp. 110-132). Springer, London.

- Palloff, R. M., & Pratt, K. (2007). Online learning communities in perspective. *Online learning communities*, 3-15.
- Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education*, 42(3), 243-265.
- Power, M., & St-Jacques, A. (2014). The graduate virtual classroom webinar: A collaborative and constructivist online teaching strategy. *Journal of Online Learning and Teaching*, 10(4), 681.
- Prell, C. (2012). *Social network analysis: History, theory and methodology*. Sage.
- Rigou, M. (2004). On the development of adaptive Web-based learning communities. In *Proceedings of the IASTED International Conference on Web-Based Education* (pp. 625-630).
- Rogers, E. M., & Kincaid, D. L. (1981). *Communication networks: toward a new paradigm for research*. New York.
- Romero, C., & Ventura, S. (2007). Educational data mining: A survey from 1995 to 2005. *Expert systems with applications*, 33(1), 135-146.
- Roseli, M. H. M., & Umar, I. N. (2015). Students' levels of knowledge construction and cognitive skills in an online forum learning environment. *Procedia-Social and Behavioral Sciences*, 197, 1983-1989.
- Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing?. *Computers in Human Behavior*, 21(6), 957-975.
- Scott, J., & Carrington, P. J. (2011). *The SAGE handbook of social network analysis*. SAGE publications.

- Siemens, G. (2004). Connectivism: A learning theory for the digital age. *Ekim*, 6, 2011.
- Siemens, G. (2007). Connectivism: Creating a learning ecology in distributed environments. *Didactics of microlearning. Concepts, discourses and examples*, 53-68.
- Sutton, L. A. (2000). *Vicarious Interaction: A Learning Theory for Computer-Mediated Communications*.
- Swan, K. (2005). A constructivist model for thinking about learning online. *Elements of quality online education: Engaging communities*, 6, 13-31.
- Thormann, J., Gable, S., Fidalgo, P. S., & Blakeslee, G. (2013). Interaction, critical thinking, and social network analysis (SNA) in online courses. *International Review of Research in Open and Distributed Learning*, 14(3), 294-318.
- Tirado, R., Hernando, Á., & Aguaded, J. I. (2015). The effect of centralization and cohesion on the social construction of knowledge in discussion forums. *Interactive Learning Environments*, 23(3), 293-316.
- Wang, Q., Woo, H. L., & Zhao, J. (2009). Investigating critical thinking and knowledge construction in an interactive learning environment. *Interactive learning environments*, 17(1), 95-104.
- Willging, P. A. (2005). Using social network analysis techniques to examine online interactions. *US-China Education Review*, 2(9), 46-56.
- Wise, A. F., Hausknecht, S. N., & Zhao, Y. (2014). Attending to others' posts in asynchronous discussions: Learners' online "listening" and its relationship to speaking. *International Journal of Computer-Supported Collaborative Learning*, 9(2), 185-209.

Wise, A. F., Speer, J., Marbouti, F., & Hsiao, Y. T. (2013). Broadening the notion of participation in online discussions: examining patterns in learners' online listening behaviors. *Instructional Science*, 41(2), 323-343.