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Students' interaction, satisfaction and cognitive presence in online discussions: Comparing novice and experienced instructors with distinguished interaction patterns

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ABSTRACT: This study compares the interaction patterns of a novice and an experienced instructor using Social Network Analysis (SNA) and content analysis and explores how students' interactions, degrees of satisfaction, and cognitive presence differ according to the different interaction patterns of the two instructors. Results showed some differences in the interaction characteristics between the sections. First, the experienced instructor was the most powerful actor in the course, while some students in the novice instructor's section showed higher outdegree centrality than the instructor. In addition, the novice instructor's section was a more active network than the experienced instructor's section in which the instructor showed the highest outdegree and indegree and also seemed to have more reciprocal relations. In terms of satisfaction and cognitive presence levels, the students in the experienced instructor's section in which the instructor focused more on triggering events or exploration activities, reported higher satisfaction than the students in the novice instructor's section. However, there was no significant difference in students' cognitive presence levels. A key finding of research suggests that instructors need to balance their participation, stimulate students' curiosity, and encourage brainstorming—rather than directly offering solutions—to improve students' satisfaction in asynchronous discussion-based online learning. This research also indicates that well-designed discussion topics may contribute more to developing students' cognitive presence than the instructor's interaction patterns. Finally, this research highlights the effectiveness of SNA and content analysis to explore instructors' and students' interactions on discussion boards.

Keywords: Online discussion, Interaction, Online instructor, Cognitive Presence, Social Network Analysis (SNA)

1. Introduction

Interaction is considered to be one of the most essential elements in educational environments. Merriam-Webster Dictionary (2023) defines interaction as "mutual or reciprocal action or influence." It differs from communication, which refers to the exchange or transmission of information by verbal or nonverbal methods, in that communication can be one-way as well as reciprocal. Also, interaction can occur through communication, whereas there are instances where communication can occur without requiring any interaction. In online environment, three different types of interaction—learner-instructor, learner-learner, and learner-content interaction—have been especially emphasized for its potential to overcome the limitations of physical distance (Moore & Kearsley, 2011). Moore and Kearsley (2011) said, "Effective teaching at a distance depends on a deep understanding of the nature of interaction and how to facilitate interaction through technological transmitted communications" (p. 132). Other researchers have also suggested that interaction plays a critical role in the success of online learning (Alqurashi, 2019; Baber, 2020; Yousaf et al., 2022; Zhang & Lin, 2020). In particular, instructor interaction and facilitation have been known as an essential factor influencing students' learning participation, achievement, and satisfaction in online courses (Alqurashi, 2019; Du et al., 2022; Kuo et al., 2014). With the perceived importance of instructor interaction and facilitation for students' learning experiences and outcomes, researchers have explored instructor-student interaction in online courses with various methods. Specifically, previous researchers have analyzed the level of interaction and facilitation with surveys (Lei & Lin, 2022; Wang et al., 2022), frequency of instructor postings (Parks-Stamm et al., 2017), and through content analysis (Koch, 2021; Kwon et al., 2019). However, exploring interaction and facilitation patterns is very complex and challenging and thus various approaches are required to analyze them (Long & Koehler, 2021).

More recently, researchers have started to apply social network analysis (SNA), a method which focuses on relations and connections among social entities and the patterns and effects of these relations (Wasserman & Faust, 1994, p. 3), in exploring the dynamic process and patterns of interactions on discussion boards (Liu et al., 2022; Ouyang & Chang, 2019). However, little research has explored instructor interaction and facilitation characteristics in asynchronous discussion with SNA approaches. Nor has there been much SNA research into the effects of different instructor interaction patterns on students' discussion network attributes, satisfaction, and

cognitive learning. To fill in the gap, this research aims to explore instructor interaction patterns in discussion boards using SNA and content analysis. I also compared students' discussion patterns and their satisfaction and cognitive thinking abilities according to instructor interaction patterns. In particular, this research targeted the interaction patterns of a novice instructor and an experienced instructor because previous online teaching experiences and expertise have been known as important factors influencing instructor interaction and facilitation behaviors (Fidalgo &Thormann, 2012; Gurley, 2018; Long & Koehler, 2021). Specifically, the research questions for this study are:

- RQ1. What were the patterns of a novice and an experienced instructor's interactions on the asynchronous discussion boards?
- RQ2. What were the students' interaction patterns of the online discussion network in the novice and experienced instructor's course sections?
- RQ3. How did cognitive presence level and satisfaction differ according to the interaction patterns of the novice and experienced online instructor?

2. Theoretical background

2.1. Cognitive presence and satisfaction as learning outcome variables

Cognitive presence and satisfaction have been widely adopted by researchers to measure students' learning experiences and outcomes in asynchronous discussion-based online courses. Cognitive presence is one of the elements of the Community of Inquiry (CoI) framework that guides meaningful and successful learning experiences in asynchronous online learning with a socio-constructivist view (Garrison et al., 2001). Cognitive presence describes the extent to which learners can construct knowledge through reflection and discourse in online discussions. Researchers have previously used cognitive presence to measure students' cognitive learning outcomes, particularly higher-order thinking abilities in asynchronous discussion-based online courses (Garrison et al., 2001). Cognitive presence involves four phases: the first phase is the triggering event, which is being aware of a problem through feeling a "state of dissonance" or "unease resulting from an experience" (Garrison et al., 1999, p. 98); the second phase of cognitive presence is exploration, which involves searching for new information, knowledge, and alternatives to address a problem; the third phase is integration, which involves synthesizing and combining information; and the last step is resolution, which emphasizes the application of an idea or hypothesis to a real situation (Garrison et al., 1999). Researchers have used two different methods to measure the degree of students' cognitive presence: (1) quantitative survey (Akcaoglu & Akcaoglu, 2022; Lim & Richardson, 2021) and (2) qualitative analysis of discussion postings addressing the four phases of cognitive presence (Lee et al., 2022; Sadaf & Olesova, 2017).

Satisfaction is another key variable that is commonly used to measure students' affective learning outcomes. Bolliger and Halupa (2012) stated that student satisfaction can be an important factor to evaluate course and program effectiveness. Baruth and Cohen (2023) similarly described student satisfaction as an important indicator in determining the success of online learning. Indeed, many scholars have focused on different aspects of student satisfaction, including students' satisfaction with instructors (Sahawneh & Benuto, 2018), learning from online discussions (Sadaf et al., 2021), and overall online learning experiences (Lim & Richardson, 2021), to evaluate online learning outcomes.

2.2. The importance of instructor-student interaction in discussion boards

Many researchers have reported that students' successful learning experiences and outcomes in online courses can be determined by instructors' interactions and facilitation in discussion boards (Alqurashi, 2019; Du et al., 2022; Kuo et al., 2014; Ladyshewsky, 2013). For instance, instructor facilitation allows students to keep on track and helps them to address some challenges or conflicts in the discussions (Hew, 2015). Furthermore, Ladyshewsky (2013) also pointed out that, although the course design in six different sections of a post graduate managerial leadership course was stable, student satisfaction varied across all different sections. According to the scholar, the variations could have been caused by online instructors' interactions and other behaviors of managing and facilitating the students. Indeed, Ladyshewsky (2013) found that increasing in instructor postings including more social and teaching presence factors has positive impact on students' satisfaction with instructors' feedback and teaching on discussion boards.

Eom and Ashill (2016) also reported that instructor-student dialogue has a positive relationship with students' satisfaction and learning outcomes. The researchers found that instructor-student dialogue showed higher

predictive effects on learning outcomes (β = .24, t = 6.11) than on satisfaction. (β = .08, t = 2.13). More recently, Alqurashi (2019) revealed that learner-instructor interaction was found to be a critical predictor of student satisfaction and perceived learning in online courses while learner-learner interaction did now show any predictive effect on both variables. In particular, considering that recently a fair number of instructors teach courses which have been designed by other faculty, instructor interaction and facilitation in the discussion boards would be more important for establishing instructor presences and characters, which are likely to influence students' satisfaction and learning outcomes.

2.3. Patterns of novice and experienced online instructor interaction on discussion boards

As I discussed in the above section, instructors play a critical role in providing meaningful learning experiences through social and intellectual interactions with students. With the importance of instructor interaction, many researchers have emphasized that instructors need to be effective facilitators or guides in online learning environments (Kwon et al., 2019; Long & Koehler, 2021; Martin et al., 2020). Then which characteristics of instructors impact their interaction and facilitation patterns in online discussion boards? One of the probable potential factors in an instructor's interaction would be their level of experience in teaching asynchronous online courses. Indeed, previous research has shown the possibility that the quantitative and qualitative attributes of interactions and facilitation may differ between experienced and novice instructors. First, Fidalgo and Thormann (2012) compared student and instructor interaction from courses taught by an experienced and a novice instructor using the SNA method. As the result, they found that both the experienced and novice instructor played a primary role in their discussion networks. However, the researchers found that the discussion network which was facilitated by an experienced instructor seemed more student-centered, while the network in the novice instructor's course showed an instructor-centered model. More recently, Long and Koehler (2021) compared an expert and a novice instructor facilitation in discussion boards with SNA and content analysis. According to the scholars, both instructors were active facilitators and used facilitation strategies including social congruence, cognitive congruence, and content expertise frequently. However, they found that the expert instructor has the skills to adjust their facilitation strategies based on students' needs while the novice instructor tended to maintain the same strategies. Watson et al. (2018) also found that the instructor with expertise showed the flexibility by using different facilitation strategies on discussion boards based on course goals and learner needs. This research revealed that the experienced instructor tried to find a balance between using questions and giving helps or answers to students. Finally, Martin et al. (2019) suggested that instructors' years of online teaching experience has significant impact on their course design and facilitation.

The results of previous research imply that there may be some differences between novice and experienced instructors' interactions or behaviors in online discussion boards. However, despite the importance of instructor interaction, there have been only a few studies exploring the characteristics of novice and experienced online instructor interaction or facilitation using both SNA and content analysis.

2.4. Social network analysis research on student and instructor interaction

SNA refers to the method which is used to analyze relations between members in a network. Recently, educational researchers have started to take advantage of SNA to explore instructors' or students' interactions and relations in online discussion boards. Furthermore, they have studied the associations among students' interactions and relation patterns with learning outcome variables such as obtaining certificates (Joksimović et al., 2016), learning achievement (Lim, 2023; Saqr et al., 2022; Ye & Pennisi, 2022), problem-solving skills (Cheng et al., 2022), knowledge construction (Zhang et al., 2021; Zhao et al., 2016), and satisfaction with courses (Lim, 2023). For example, Lim (2023) found that students' outdegree and indegree centrality are not only interrelated but are also correlated with their perceived learning achievement and satisfaction with the course. Zhao et al. (2016) measured students' centrality and density in online discussion boards and compared knowledge construction levels between core and marginal students. In their research, they reported that most students remained at a lower level of knowledge construction, including sharing information and idea exploration rather than reaching higher knowledge construction levels, which involve negotiating, testing, and applying the constructed knowledge. Of course, in their research, there were some differences between core and marginal students. The number of postings from core participants was significantly higher than from the marginal group of students, and they showed more messages at higher levels of knowledge construction than the marginal participants, although most of the core students still stayed at lower levels of knowledge construction. More recently, Cheng et al. (2022) explored the relation between students' interaction patterns on asynchronous discussion boards and their problem-solving skills. They found that the density, outdegree and indegree centrality, and total number of individual connections in the discussion network were significantly related to

students' problem-solving performance. Taken together, the results of previous research show that SNA is an effective way to analyze instructor and student interactions and relationships. In addition, the research implies that learning satisfaction or achievement may be influenced according to interaction and participation degrees or patterns in the discussion network.

3. Methods

3.1. Context and participants

The data for this study were collected from two different sections of a fully online master's course in Learning Design and Technology (LDT) at a large Midwestern public university. The sections, which were offered over eight weeks via Blackboard, shared the same course design, content, and structure. The most significant difference between the two sections was the two instructors' experience in teaching asynchronous online courses. This study divided the two sections into novice and experienced instructors' sections based on previous research that defines novice instructors as those with less than three years of online teaching experience and veteran and experienced instructors as those with more than 15 years of service (Walsh et al., 2020). In this research, one section was taught by a novice instructor (less than 2 years' experience) and the other was taught by an experienced instructor (more than 20 years' experience). There were 15 students (5 male; 10 female) in the novice instructor section, while the experienced instructor's section had 17 students (1 male; 16 female). There was not a significant difference in the GPAs of the students in both sections before taking this course ($p > .05$).

In this course, all students were required to participate in discussion boards every week. Specifically, each student should have posted an initial response about a given discussion topic and then post 2-3 additional responses to move the group discussion forward. Students participated in the discussions in a variety of ways. For example, they could provide examples from their own experience, describe possible consequences, challenge other students' postings, pose a question, suggest a different perspective, or share related information from other sources. The discussion activity was graded according to the frequency and quality of postings. The discussions were worth 24% of the total score for the course.

3.2. Data collection and analysis

In this research, two different types of data sets were gathered. First, archived instructor and student discussion threads were extracted from week 1 to week 7 discussion forums, except for the week 4 discussion. The week 4 discussion board was not included because the instructors asked students to only upload individual postings without replying to other students' postings. The students' perceived satisfaction with their discussion experiences was assessed with a regular online course evaluation survey distributed by the university. The original survey consisted of 15 items evaluating students' satisfaction with their online course and instructor, but this study narrowed the focus to nine items specifically addressing students' satisfaction with discussion activities and instructors' interactions that may occur in discussion (e.g., "Class discussions are helpful to my learning," "My instructor treats all students with respect," "My instructor creates an atmosphere where ideas can be exchanged freely and easily"). All items were rated on a 5-point Likert scale, and Cronbach's alpha coefficient was .960.

To analyze discussion threads, this research used (1) SNA and (2) content analysis. SNA explains relationships with nodes and ties (or links) between nodes that have their own characteristics that can be categorized. For example, nodes can be people, organizations, or countries. The ties between the nodes indicate interactions and relationships. Researchers have proposed that SNA provides more in-depth information and new perspectives for analyzing the interactions and relationships of instructors or students by complementing the limitations of purely qualitative and quantitative measures (Jo et al., 2017; Long & Koehler, 2021; Yen et al., 2019). For the SNA in this study, a researcher read all the discussion postings and determined who talked to whom for each posting to identify who and whom relations. The following is an example of a posting demonstrating a who (Mike) and whom (Jim) relation between two students (the participants are anonymous for this study).

(Mike's posting)

> Jim, your comment about having smaller blocks of texts made me wonder about how instructional designers could/should learn the "best practices" from graphic designers and other related fields to improve distance learning courses. Might there be other applicable "best practices," e.g., color selection, font choice, etc., that would improve a course?

Based on this analysis, I created an adjacency matrix in which the rows and columns represent who created a post for whom, respectively. Next, outdegree and indegree centrality were measured to identify instructors' positions in the network. Outdegree centrality indicates the degree of interaction that initiates from an actor, while indegree centrality means the degree of interaction that is directed toward an actor (Saqr et al., 2022). High outdegree centrality is likely to be a sign of students' active participation or contribution to the discourse. In contrast, high indegree centrality, which is computed as the number of received replies or comments, may be a reliable indicator of high popularity or prestige in the network (Saqr et al., 2022).

In addition, density, degree centralization, and reciprocity were calculated to analyze the student participation and interaction attributions of the online discussion networks in the novice and experienced instructor's courses. Density is a means to measure the number of connections formed within a network. It is calculated as the direct number of actual connections divided by the number of all possible direct connections in a network (Cheng et al., 2022). A higher density indicates that the network is likely to be a more cohesive community than another network with a lower density. Next, degree centralization, which refers to a network that concentrates on actors with high degree centrality, was calculated. The high outdegree centralization indicates that a few core members are creating most of the connections to others, while the high indegree centralization means the network is focused inward on a few core members (Goggings et al., 2016, p. 248). Finally, this research also calculated the reciprocity of the two discussion networks. High reciprocity means that people in the network tend to have more mutual and bilateral relations than a network with low reciprocity (Pfeil, & Zaphiris, 2009).

For content analysis, the discussion posts were analyzed using the four phases of cognitive presence. In addition, the instructors' postings were also analyzed using the same indicators to obtain more information about the qualitative nature of the two instructors' interactions in the discussion boards. Each message posted by instructors or students was treated as a unit of coding indicating one of the four phases of cognitive presence. For inter-rater reliability, this study adopted a consensus approach and percent agreement which is the most common reliability index for content analysis of online asynchronous discussions (De Wever et al., 2006; Sadaf & Olesova, 2017). The discussion postings were coded by two researchers including the primary researcher. Before beginning the coding process, the two researchers met to review the coding scheme. Next, we independently coded the instructor and student postings with the four levels of cognitive presence. We then thoroughly discussed and compared the results to clarify the understanding of the coding scheme and reach a consensus. After discussing the individual coding results, the researchers reached 100% inter-coder agreement.

For the survey data, descriptive statistics (mean and standard deviation) and a Mann-Whitney-Wilcoxon test were used to compare students' satisfaction and cognitive presence levels between the novice and experienced instructor sections. To analyze interaction attributions and network structures in discussion boards, this research used UCINET which is one of the most well-known social network programs. The NetDraw program was also used to generate a sociogram. For statistical analysis, this study used SPSS 26.

4. Results

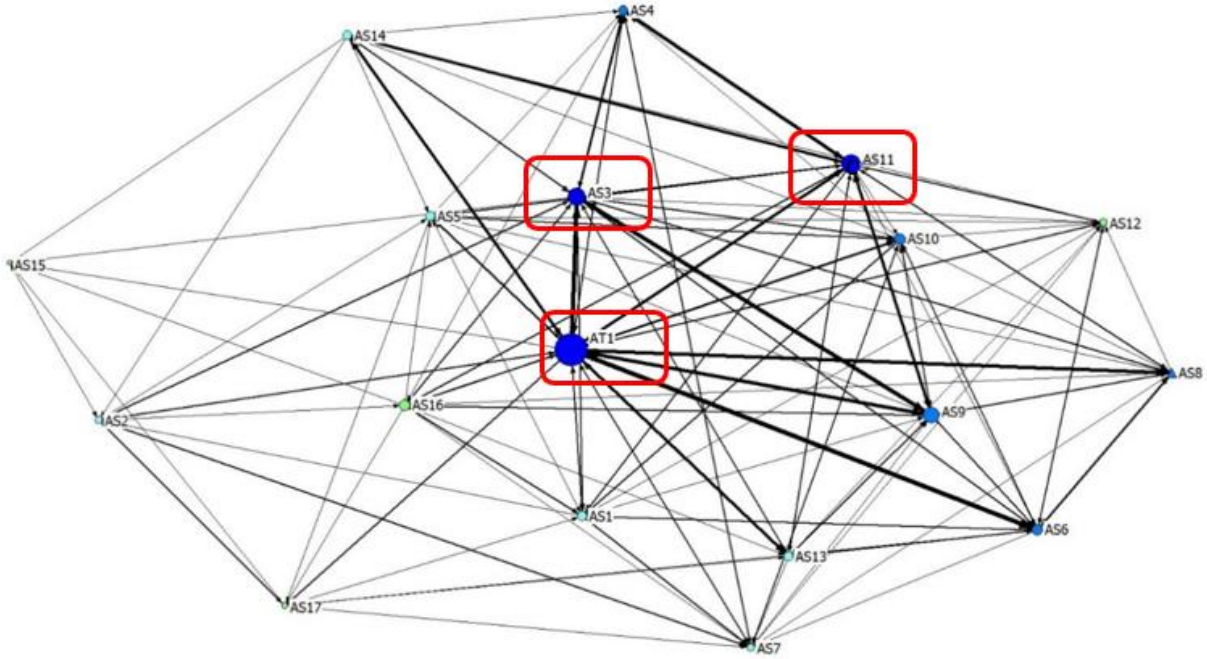
4.1. What were the patterns of a novice instructor's and an experienced instructor's interactions on the asynchronous discussion boards?

For RQ1, both SNA methods and content analysis of instructors' posts were used to explore interaction patterns of a novice and an experienced instructor on the discussion boards. First, according to the network maps for all weekly discussion postings from the two sections, it seemed that both instructors placed in the middle and each took a core role in their respective discussion network (see Figures 1 and 2). As the result of examining the indegree and outdegree centrality of each instructor, both instructors showed high centrality in their discussion network. However, there are some differences between the two groups. First, the experienced instructor (AT1) was the most active and central actor, while the novice instructor section had three students (BS2, BS5, and BS15) who showed higher centrality than the instructor (BT2). Next, the experienced instructor had a much higher outdegree centrality than indegree centrality, while novice instructor showed almost equal values for indegree and outdegree centrality. This implies that the experienced instructor was more eager to contact students and to actively initiate conversations with students than the novice instructor (see Table 1).

With the SNA, this research also explored the nature of instructors' postings qualitatively. To do this, the contents of both instructors' postings were analyzed with cognitive presence indicators. Specifically, I focused on instructors' postings from week 1 to week 7 discussion boards. All instructors' postings were either divided into one of four cognitive presence categories (triggering event, exploration, integration, resolution) or marked

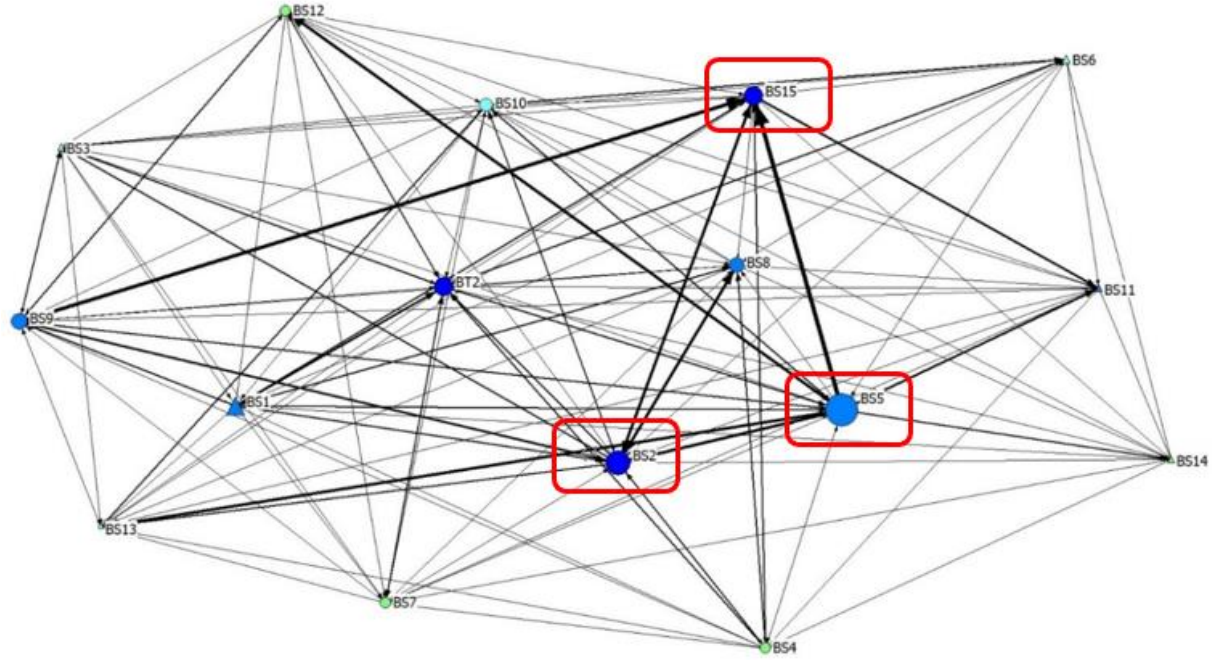
miscellaneous. Most of the experienced instructor's postings were concentrated on triggering events (36.92%) or exploration (46.15%). Triggering event (41.82%) had the highest rate of all four cognitive presence levels in the novice instructor's postings. Notably, the novice instructor showed more integration activities (25.45%), summarizing or synthesizing students' postings than exploration (18.18%) (See Table 2).

Figure 1. The network map for all discussion boards (except for week 4) in the experienced instructor section



Note. Node size by outdegree centrality; Node color darkness by indegree centrality; Circle-shaped node = female; Triangle-shaped node = male.

Figure 2. The network map for all discussion boards (except for week 4) in the novice instructor section



Note. Node size by outdegree centrality; Node color darkness by indegree centrality; Circle-shaped node = female; Triangle-shaped node = male.

Table 1. The indegree and outdegree centrality of each actor in the experienced and novice instructor sections

Experienced instructor section			Novice instructor section		
Actor	Indegree	Outdegree	Actor	Indegree	Outdegree
AT1	**0.218**	**0.447**	BS2	0.339	0.333
AS11	0.159	0.235	BS5	0.224	0.430
AS3	0.188	0.200	BS15	0.315	0.261
AS9	0.147	0.188	**BT2**	**0.279**	**0.248**
AS6	0.147	0.100	BS9	0.224	0.212
AS10	0.112	0.088	BS1	0.176	0.230
AS4	0.118	0.071	BS8	0.212	0.194
AS8	0.118	0.071	BS10	0.158	0.188
AS13	0.106	0.076	BS7	0.127	0.152
AS14	0.094	0.082	BS11	0.176	0.103
AS1	0.100	0.071	BS12	0.127	0.145
AS5	0.094	0.065	BS3	0.170	0.097
AS16	0.071	0.088	BS6	0.139	0.115
AS7	0.094	0.053	BS4	0.091	0.158
AS2	0.076	0.059	BS13	0.170	0.079
AS12	0.065	0.053	BS14	0.109	0.091
AS17	0.047	0.035			
AS15	0.035	0.006			

Table 2. Frequencies and percentage of instructor posts per cognitive presence subcategory

Instructor	Triggering event	Exploration	Integration	Resolution	Miscellaneous	Total
Experienced	24 (36.92%)	30 (46.15%)	6 (9.23%)	0 (0%)	5 (7.69%)	65 (100%)
Novice	23 (41.82%)	10 (18.18%)	14 (25.45%)	0 (0%)	8 (14.55%)	55 (100%)

4.2. What were the patterns of the student participation and interaction in the novice and experienced instructor facilitated discussion boards?

For RQ2, this research measured the quantitative data with SNA to analyze the patterns of discussion board networks in the two sections. First, the network in the novice instructor's section showed a higher mean degree than experienced instructor section. This implies that overall interactivity of participation in the novice instructor's section was higher than in the other instructor's section. In the case of density, the novice instructor's section showed a higher density than the experienced instructor's section. A higher density means that more students participated in the network. Table 3 shows more detailed information about the student participation and interaction patterns of the online discussion networks in the novice and experienced instructors' sections.

Table 3. Comparison of the discussion networks in the novice and experienced instructors' sections

Value	Experienced instructor section	Novice instructor section
Ave degree	7.294	10.400
Out-centralization	0.379	0.276
In-centralization	0.180	0.199
Density	0.456	0.743
Component	1	1
Reciprocity	0.645	0.859

As shown in the table, the novice instructor's section is considered a more active and closely connected network than the experienced instructor's section from higher density, although it is smaller discussion network (n = 16) than the discussion network in the experienced instructor section (n = 18). The network in the novice instructor's section also seems to have more mutual and stable relationships in that it shows high reciprocity. For centralization, the experienced instructor's section showed higher outdegree centralization than the other. This indicates that the network in the novice instructor's section tended to have more distributed power or interactions among discussion participants rather than being dominated by particular actors.

Moreover, the frequency and percentage of each cognitive presence level were examined for both sections to explore the students' postings qualitatively. Table 4 below illustrates the coding results for categories of cognitive presence. For both sections, integration had the highest rate of coded responses, followed next by exploration. Resolution had the lowest rate of all four levels of cognitive presence in both sections.

Table 4. Frequencies and percentages of student posts per cognitive presence subcategory

Instructor	Triggering event	Exploration	Integration	Resolution	Miscellaneous	Total
Experienced	16 (6.87%)	104 (43.64%)	109 (46.78%)	2 (0.86%)	2 (0.86%)	233 (100%)
Novice	29 (8.33%)	147 (38.89%)	190 (50.26%)	3 (0.79%)	9 (2.38%)	378 (100%)

4.3. How did cognitive presence level and satisfaction differ based on the interaction patterns of the novice and experienced online instructors?

To address RQ3, this research compared the levels for satisfaction and cognitive presence between two groups. Because of the small samples size, a Mann-Whitney-Wilcoxon test, which is a nonparametric statistical test, was used to explore any statistically significant differences between the novice and experienced instructors' sections in terms of students' satisfaction with discussion experiences and their cognitive presence levels. As a result, I found a significant difference in students' satisfaction levels between the experienced and novice instructors' courses (Z = -3.057, p < .01). Specifically, the students in the experienced instructor's section showed higher satisfaction than students in the novice instructor's section. However, this research did not find any significant difference in students' cognitive presence levels across sections (Z = -.493, p > .05) (See Table 5).

Table 5. Mann-Whitney-Wilcoxon test result on students' satisfaction and cognitive presence level

Variables	*M±SD*		*Z*	*p*
	Novice	Experienced		
Satisfaction	3.322±1.08	4.759±0.28	-3.057	.002
Cognitive Presence	2.469±0.29	2.415±0.17	-.493	.622

5. Discussion and implications

5.1. Analysis of instructors' facilitation and interaction patterns

This research explored an experienced and novice instructor's facilitation and interaction in online discussions with SNA and content analysis. As the result, the two instructors showed either similar or different patterns and characteristics in interaction. First, while the result of SNA revealed that both instructors are central and influential participants in discussion boards, the experienced instructor in this research played a slightly more central and active role than novice instructor. Considering instructor centrality as a means of measuring instructor control (Wang & Liu, 2020), the experienced instructor section was likely more instructor-led than the novice instructor section. For qualitative content analysis, both instructors posted triggering event messages frequently, asking questions to facilitate students to think the problems with new and in-depth perspectives. However, they showed somewhat differences in the exploration and integration activities. A majority of the experienced instructor's postings remained at the cognitive level of exploration (46.15 %), while the larger percentage of the novice instructor's messages (25.45%) remained at the integration level than exploration (18.18%).

Exploration is related to sharing information, providing different suggestions for consideration, brainstorming while integration is more related to the convergence of various ideas toward finding a solution (Garrison et al., 2001). The results of this research imply that the experienced instructor in this research focused on asking relevant questions to students in order to make them feel a sense of puzzlement, or on exchanging some information or ideas which students can consider. Contrary to this, the novice instructor in this research put more efforts toward synthesizing what students had discussed and toward creating solutions than exploration activities. Probably, considering the results of the qualitative content analysis, the novice instructor's section might be more instructor-centered in that the instructor took a more active and dominant role in knowledge construction through synthesizing or creating solutions him/herself, rather than guiding students to find their own solution.

While these results cannot be generalized to all novice and experienced instructors, they constitute an important reference for researchers and practitioners interested in finding effective methods for analyzing instructors' facilitation and interaction patterns. In this study, the experienced instructor appeared to take a dominant role in the discussion network, as he or she had the highest score for both outdegree and indegree centrality. However, the results of content analysis with cognitive presence indicators revealed further relevant details concerning the respective roles assumed by the two instructors. The experienced instructor was likely to play the role of facilitator or guide, concentrating on posing the relevant questions, providing supplemental resources or novel

viewpoints by triggering events or exploration activities. In contrast, the novice instructor was more concerned with synthesizing and constructing solutions for him/herself than the experienced instructor.

To summarize, this research suggests that patterns of instructor facilitation and interaction cannot be adequately assessed based on a single data set. It illuminates the importance of considering multiple datasets in order to ascertain whether online discussions are instructor-dominated or instructor-guided. Jo et al. (2017) have also contended that analyzing the centrality and density of a network may provide only limited information about the interactions within it, because these measures do not include analysis of the specific content of each posting on a discussion board. As they suggested, using qualitative content analysis as well as SNA would provide more in-depth information about students' interactions on discussion boards, given the ways in which the two methods complement each other.

5.2. Instructor centrality and student participation and interaction

The results of this research imply that frequent instructor participation or high prestige may not necessarily lead to active student participation and interaction. In this research, students in the experienced instructor's section, where the instructor showed the highest outdegree and indegree centrality, had lower density and less frequent discussion postings than students in the novice instructor section. Some previous research reported similar results about the relationship between the position or power of instructor and the participation rates or density of student interactions. For example, Fidalgo and Thormann (2012) demonstrated that students in a more instructor-centered network had lower density and participation rates in discussion boards than students in networks where the instructor shared his/her power with students. Ertmer and Koehler (2015) revealed that there was no relation between frequency of instructor postings and frequency of student postings. More recently, Wang and Liu (2020) identified that as the instructor centrality decreased, student's interaction density increased over the course duration. These results contradict to research showing that instructors' participation and facilitation are positively associated with students' engagement in discussions. Lee (2020) revealed that facilitator engagement has a significantly positive influence on the quality of students' discussion postings. Parks-Stamm et al. (2017) also revealed that instructor participation has significantly predictive effects on student participation in discussion boards.

The inconsistent results of previous research highlight the importance of keeping balance in the amount and power of instructor participation in discussion networks (Larson et al., 2019). Indeed, some researchers suggested that too much instructor participation may reduce the amount of student interaction and create over reliance on the instructor and thus overwhelm their abilities to interact with peers (Larson et al., 2019; Murphy & Fortner, 2014). Furthermore, it supports the necessity of considering the qualitative nature of instructor and student interactions in order to more deeply understand the attributes of discussion networks.

On the other hand, the inconsistencies in these results may be related to the class size of online discussions. Parks-Stamm et al. (2017) revealed that the relation between instructor participation and student engagement in discussions may vary depending on class size. They found that in small-sized online courses (less than 15 students), instructor participation contributes to increased student participation, whereas instructor participation does not impact student participation in medium classes (15–30 students). The present study confirms that frequent instructor participation does not guarantee active student participation and interaction. The result may be due to the fact that both courses in this study were medium size classes. The findings of previous and current research show that instructors and instructional designers should consider applying different interaction and facilitation strategies according to their course sizes.

5.3. Differences in students' cognitive presence levels and satisfaction based on instructors' interaction patterns

The results confirmed that there is a significant difference in students' satisfaction with the discussion experiences depending on the different interaction patterns between a novice and an experienced instructor. Importantly, the most distinguished difference between two sections was the two instructors' interaction patterns in asynchronous discussion boards while both sections shared the same course design, content, and structure. The results of this research allude that instructor interaction and facilitation activities play an important role contributing on student satisfaction even in the courses which have same course design and content.

Interestingly, in the experienced instructor's section, which showed higher levels of student satisfaction, the instructor participated in discussions more actively and frequently than the novice instructor. This may be

explained by previous research which found that students prefer instructor-led facilitation, because they expect their instructors to be effective moderators and subject matter experts who can improve their discussion (Hew, 2015; Hoey, 2017; Phirangee et al., 2016). Another factor which may explain students' higher satisfaction with their discussion experiences in the experienced instructor's section relates to actual and qualitative features of instructor facilitation styles, which were analyzed through content analysis. As stated above, the experienced instructor focused more on triggering events or exploration activities, whereas the novice instructor uploaded more integration postings than the experienced instructor, by synthesizing ideas or constructing solutions. Students may prefer instructors to ask questions to pique their curiosity or sense of puzzlement or to assist them in brainstorming new ideas, rather than directly offering solutions.

Notably, although the novice instructor section is more closed and stable network than the experienced instructor section, students' satisfaction with their discussion experiences is higher in the experienced instructor section than in the novice instructor section. The result of this research implies that more interaction in the asynchronous discussion boards may not guarantee higher student satisfactions with the discussion experiences. The similar results were confirmed by other research. An et al. (2009) reported that students' satisfaction with instructor and online course may not be correlated to their interaction level by confirming a group which had little interaction (with relatively low density, mean number of initial postings and replies) showed higher satisfaction than other groups which had more interactions. Lim (2023) did not observe any significant predictive effect between SNA interaction measures (outdegree and indegree centrality) and learning satisfaction. The results of previous and current research suggest that additional factors may be required to improve the effects of interactivity on satisfaction.

Regarding the cognitive presence level, there was no significant difference in students' cognitive presence level between the experienced and novice instructor section. While students in the novice instructor section showed more interaction and participation in the discussion boards, their cognitive presence levels did not have any difference from students in the experienced instructor section. The result corresponds to previous research indicating that student's social interaction does not guarantee their cognitive engagement (Liu et al., 2022; Ouyang & Chang, 2019).

Finally, for both sections in the current research, the largest percentage of messages was at integration level, which was followed by exploration. The result corresponds to the previous research which reported that the postings in the integration level were the highest percentage of all students' postings (Akyol & Garrison, 2011; Oh et al., 2018). Probably, this is because the same course design of two sections played a more critical role in developing students' cognitive presence than the distinguished patterns of instructor interaction. The discussion topics or questions in these studies might be more appropriate to lead students' response at the integration level. Similarly, several researchers confirmed that there are significant relations between question types and students' cognitive presence levels (Richardson et al., 2013; Sadaf & Olesova, 2017).

6. Limitations and future research

Although this study has resulted in valuable findings, it also has several limitations which are acknowledged. First, the present study only evaluated one experienced instructor and one novice online instructor with a small sample size of students. As a result, the findings of this research cannot be generalized to other experienced and novice instructors. Further research should be performed with larger participant samples from more diverse settings to identify more common interaction patterns of experienced and novice instructors. Second, the gender ratio of the students in this research is disproportionate between the sections which may have led to some differences in the learning outcome variables. Future research should ensure a balance between participants' genders. Also, it is possible that other characteristics of instructors (e.g., instructors' behaviors to improve students' social presence such as calling students by their first name, using humor, expressing agreement) may impact the study's results. Future research should consider the impacts of other teaching styles on students' cognitive and affective learning outcomes more closely.

Next, in this research, the current research explored the patterns of instructor and student interaction with their discussion postings. However, future research may need to investigate the intentions or purposes of instructor and student interaction by conducting interview with instructors and students. This is because instructors' pedagogical intention which are hide in frequency or outward nature of their interactions are likely to important in understanding their interaction patterns more in-depth. Students also may have undisclosed reasons or intentions for their interaction patterns. It would be good to explore the patterns of instructor and student interaction with varied datasets, including their interview for triangulation. The multiple dataset will allow a

more comprehensive understanding of the effects of instructor interaction patterns on students' interaction, satisfaction, or cognitive thinking abilities. Despite these limitations, the findings of this study will hopefully provide some insights for researchers and practitioners seeking a more in-depth and comprehensive understanding of instructor or student interaction and participation.

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Appendix. Levels and examples of cognitive presence indicators

Phase of cognitive presence	Indicator	Examples
Triggering events	• Recognizing the problem • Sense of puzzlement	• XXX, your comment about having smaller blocks of texts made me wonder about how instructional designers could/should learn the "best practices" from graphic designers and other related fields to improve distance learning courses. Might there be other applicable "best practices," e.g., color selection, font choice, etc., that would improve a course?
Exploration	• Divergence – within the online community • Divergence – within a single message • Information Exchange • Suggestion for consideration • Brainstorming • Leaps to conclusions	• I'm not sure I agree with her black/white presentation that some people are concrete thinkers and others are abstract thinkers. • I was thinking, your approach is more similar to neo-Fordist, not post-Fordist in my opinion, because like you stated, the class has a pre-defined syllabus and the learning theories and communicating methods are all assigned. There are some certain things that are designed for each individual (like project topics and such) but the main idea and path is all one. That sounds like neo-Fordism.What do you think? • https://www.youtube.com/watch?v=f5X64QCDVnI Neil deGrasse Tyson gave a speech that has always made me smile. It discusses religion and doctors (the MD type, we love the PH.D and Ed.D types), so if you are religious or a doctor and don't like it… sorry? If you watch the video, focus on the 2:14 mark. He makes a statement that could apply to our discussion and a result of mass produced education.
Integration	• Convergence – among group members • Convergence – within a single message • Creating solutions • Connecting ideas, synthesis	• Hi XXX I can see how the dated studies are relevant and do form a baseline to help the field advance. An example that comes to mind from the chapter was how Garrison discussed and used distance education technology. Garrison (1990) stated, "a description of audio teleconferencing was used to argue for an appropriate concentration on the role of the teacher and the importance of two-way communication in the education process." That statement has advanced According to out text, a second study based on the work of Ross, Morrison, Smith and Cleveland (1991), "researchers concluded by emphasizing the importance of assessment of learner satisfaction to overall success of a distance education program" (2012, pg.70). Other studies illustrated in our text, showed a direct link between attrition and anxiety. According to research "anxiety felt by DE leaners played a higher role in attrition than that previously considered" (2012, pg. 71). Based on these previous findings, motivation will play an important role in retention. By applying motivational factors that my minimize potential anxiety found within distance education (DE), students may be more willing to complete DE programs.
Resolution	• Vicarious application to	• In the training I'm currently developing at work, there are a

	real world • Testing solutions • Defending solution	variety of learning objects that we are going to be utilizing (instructional videos, video examples, screen-capture modules, eLearnings, job aids, etc.). We are also in the process of designing and building an online learning portal to deliver these objects to learners. The portal design will incorporate background functionality to track the learners' progress, me to proficiency, number of _times they try to complete an "assignment", how long it takes them to complete it, how well they do in the completion of the assignment, what resources they use, what they use first/second/third, what they come back and reuse later, and so on and on. By tracking details this in-depth, we'll be able to determine which resources are the most beneficial to the assignment, which are most useful on the job, which hurt them in the completion of an assignment, which resources may not be clear enough, etc. An example might be that each learner watches the instructional video, but then immediately refer to the eLearning, which may indicate that the instructional video isn't helpful. Another example could be that learners use the screen capture to learn how to complete the assignment initially, but they refer back to the job-aid as a quick process check later when doing that function on the job. Or we may find that every learner who refers to a particular job aid fails the assignment the first time, but upon using a different learning object passes it the second _me. This could indicate a problem with that particular object, leading us to remove it and update it. While this level of tracking and analysis on the back end will help us study the effectiveness of learning objects, we'll also utilize pre- and post-tests along with L1-3 evaluations to determine the learner experience and the effectiveness of the training as a whole….
Miscellaneous		• Great find XXX! Thanks for sharing with us! :)