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Peer Scaffolding in Promoting Critical Thinking Engagement

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Abstract*: This study investigates the potential of the peer scaffolding technique in promoting students' critical thinking engagement. It was conducted using a quantitative descriptive research design. A problem-solving approach was applied in designing the learning activities in Facebook. The Facebook discussion transcripts were analysed using content analysis and social network analysis techniques. The findings showed that offering feedback and offering opinion from the Content dimension were the dominant types of peer scaffolding techniques among students, whereas, for students' critical thinking engagement, Clarification was the dominant level. Meanwhile, the correlation analysis showed a high and significant relationship between the peer scaffolding applied and the level of critical thinking engagement, compared to the peer scaffolding received and the level of critical thinking engagement. The peer scaffolding patterns applied in promoting high levels of critical thinking engagement were offering cues and offering explanations. In conclusion, peer scaffolding techniques should be utilised in learning, as they encourage students to enhance their critical thinking engagement through the interaction process.

Keywords* : Critical thinking, facebook, peer scaffolding, social network analysis.

I. INTRODUCTION

Scholars have suggested that the development of critical thinking skills could occur by applying the scaffolding technique [1] in either content, instructions, or interactions. It is crucial for a learner to be scaffolded by a more knowledgeable person, especially in an asynchronous online discussion (AOD) environment because, if students have not received adequate scaffolding, they are more likely to disengage from the learning process [2]. By requiring the students to take ownership of their own learning, they are better trained to become knowledge producers rather than knowledge consumers [3]. In addition, by doing so, instructors can avoid being central to the discussion [4] and be less burdened by having to deal with all the students' needs [5]. Thus, peer scaffolding's implementation in an AOD environment should be explored further, particularly in relation to enhancing critical thinking engagement in online learning. However, to exercising effective critical thinking engagement and peer-scaffolding techniques might depend on the learning activities applied. Learning activities that are based on problem solving can be used to activate an online discussion in which critical thinking engagement can be demonstrated through peer scaffolding techniques [6]. Through the problem-solving approach, students who are involved in the discussion will have better self-study skills than those who are not enrolled in courses with problem-solving tasks [7]. Basically, a problem-solving approach examines how students interpret problems, analyse information, and develop an argument [8]. The ability to establish each of these skills calls for students to employ critical thinking skills [8]. To this end, scaffolding seems to be effective in increasing students' critical thinking engagement in a discussion, especially in the presence of a problem-solving challenge. Therefore, the purpose of this research was to:

- identify the dominant type of peer scaffolding among students through Facebook.
- identify students' critical thinking engagement level on Facebook.
- analyse students' critical thinking engagement level based on the type of peer scaffolding applied and received on Facebook
- analyse peer scaffolding patterns in promoting students' critical thinking engagement on Facebook

II. THEORETICAL OVERVIEW

A. Scaffolding

In general, scaffolding has been interpreted in a wide sense as "a form of support for the development and learning of children and young people" [9]. Many scaffolding types and strategies (e.g., the intelligent scaffolding system and human-based scaffolding - peer scaffolding, instructor scaffolding) have been introduced by previous researchers in AOD environments to support critical thinking, with varying levels of success [10]. For the purpose of this study, we focus only on peer scaffolding. Reference [11] defined peer scaffolding as the asking for and giving of help by peers regarding learning. Through peer scaffolding, learners could have the opportunity to develop their cognitive learning strategies by sharing artefacts with peers; comparing feedback on structure, content, and design [12];

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clarifying meaning; sharing diverse positions; and monitoring each other's learning processes [13]. As this study aims to identify the types of peer scaffolding used by students to develop critical thinking engagement, peer scaffolding must be appropriately measured.

Reference [14] developed a coding scheme to measure peer scaffolding, which consists of three dimensions - *Strategy*, *Content* and *Affection* - to properly code the online discussions. This coding scheme was selected because it was developed with the integration of problem-solving processes and is suitable for application in an AOD.

B. Critical Thinking

One of the most familiar definitions of critical thinking was coined by [15], who stated that "critical thinking refers to the use of cognitive skills or strategies that increase the probability of a desirable outcome" (p. 70). Critical thinking is purposeful, reasoned, and goal directed. It is the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions. Since the majority of university students are learning using online resources these days, it has become necessary to inculcate critical thinking engagement through this medium. Furthermore, it is easier to practise critical thinking online compared with face-to-face settings because the students can decide for themselves what to read and write and can edit peers' posts [16]. This also means that, through the online medium, instructors are no longer able to present essential information without considering student input [17]. Furthermore, previous studies have demonstrated Facebook's positive effect as an academic platform [18] in relation to learning critical thinking processes [19]. Assuming that critical thinking engagement can be well developed in a constructivist online learning environment, this study has used the critical thinking engagement model proposed by [20] to measure the learners' critical thinking engagement in the context of online discussions through four dimensions – *Clarification*, *Assessment*, *Inference* and *Strategies*.

C. Problem Solving

With the accessibility of online discussion tools, students can engage in active exchanges of ideas that can lead to critical thinking. For instance, [21] conducted a web-based problem-solving activity to study learning behaviour and cognitive development in music courses and discovered that such an approach fostered the students' learning performance and enhanced their higher order thinking ability. Moreover, [22] stated that instruction in problem-solving had the potential to enhance and sustain the learners' problem-solving skills over an extended period. These scenarios also pointed to the fact that the faculty must shape the online discussion by providing a repertoire of problem-solving learning activities. To address this, the instructional guideline suggested by [14] for developing the learning activities for effective problem solving in an AOD environment was used. This guideline was chosen because the four phases of problem solving (i.e., understanding, planning, solving, and reviewing) are suitable for application to encourage learners to apply peer scaffolding.

III. METHODOLOGY

A. Design

A quantitative descriptive research design was employed in this study. Descriptive research is a common method for quantitative research; it is designed to provide a picture of a situation, to justify a current practice, to make judgments, and to develop theories [23]. Although the data for this study were gathered qualitatively, the results are presented quantitatively, through frequency counts, percentages and social network analysis diagrams. The qualitative data came from the Facebook discussions where the students needed to discuss the given tasks and answer the problems based on the problem-solving approach. The students' responses were then analysed through the content analysis and social network analysis techniques and were coded according to the peer-scaffolding types and critical thinking engagement levels.

B. Samples

The respondents for this research were 18 postgraduate students (aged between 25 and 35 years old) who registered for the Authoring System course at a Malaysian university. Out of 18 students, 6 students were male and 12 were female. Most of these students were schoolteachers. This research used a purposive sampling technique to determine the sample, which is based on the characteristics of interest [24]. The characteristics of interest are (1) courses that actively use Facebook and (2) the course learning outcome requires students to engage in critical thinking discussions.

C. Instruments

- *Learning Activities:* Across the whole semester, students were given six learning tasks that had been designed by the researchers based on the problem-solving approach put forward by [14]. The learning tasks were developed based on the Authoring System course syllabus.
- *Facebook discussion transcripts:* Facebook discussion transcripts were collected to gather evidence of students' online interactions and critical thinking engagement processes. The students' levels of critical thinking engagement were identified based on the types of peer scaffolding that they applied and received. The researchers analysed the peer scaffolding techniques based on [14]'s coding scheme, whilst students' critical thinking engagement was analysed through [20]'s critical thinking engagement model.
- *Interviews:* In this research, interviews were conducted in order to triangulate the results obtained from the Facebook discussion transcripts and to gain in-depth explanations of peer scaffolding types in relation to critical thinking engagement directly from the respondents.

D. Pilot Study

A pilot study was conducted for this research to obtain the inter-rater reliability of the coding between two raters. Inter-rater reliability refers to a measure used to certify the agreement between two raters when making behaviour observations [25].

A statistical measure of inter-rater reliability is based on Cohen's kappa, and its value ranges from 0 to 1.0, where 1.0 represents the better level of reliability; this is based on [26]'s study. The inter-rater reliability result for the peer scaffolding technique was = 0.957, with 90 percent of agreement (72 from 80 items were agreed between two raters). For critical thinking engagement, the inter-rater reliability value was = 0.721, with 84 percent of agreement (48 from 57 items were agreed between two raters). Based on both the inter-rater reliability values, the coding process was therefore considered as acceptable.

IV. DATA ANALYSIS

In this study, the Facebook discussion transcripts were classified and analysed based on [14]'s coding scheme and [20]'s model for identifying the dominant types of peer-scaffolding techniques and critical thinking engagement levels, respectively. The discussion transcript analysis was conducted by a content analysis technique (via a deductive approach), using 'message' as the unit of analysis. The students' critical thinking levels were categorised as high and low based on their critical thinking percentages (Table I).

Table- I: Classification of the level of critical thinking

Critical Thinking Process	Level of CT Process
Clarification	Low
Assessment	Low
Inference	High
Strategies	High

Next, the relationship between peer scaffolding and critical thinking engagement was identified using Statistical Package for the Social Sciences (SPSS) software. As the findings were discrete data from an ordinal scale, the researchers used Spearman's rho correlation coefficient. To identify the patterns in promoting critical thinking engagement through peer scaffolding techniques, the researchers classified the students into two groups: students with low critical thinking engagement and students with high critical thinking engagement. Each individual pattern of peer scaffolding received or applied was analysed using social network analysis software, namely, UCINET software. Social network analysis is utilised since it can provide a better perspective on understanding students' interactions compared to content analysis, which mainly allows for understanding of the discussions' contents [27].

V. RESULTS

In total, 530 messages posted by the instructors and students were recorded (Table II). This statistic also shows that the ratio between the messages from the instructors and those from the students was 1:6, where 427 messages (80.6%) came from the students and 103 messages (19.4%) were from the instructors. The findings show the general discussion results in the Facebook environment. The following subsection will present the results based on this study's research objectives.

Table- II: Tabulation of the messages posted by instructors and students

Category	Frequency	Percentage (%)
Instructors	103	19.4
Students	427	80.6
Total	530	100

A. Dominant Type of Peer Scaffolding among Students

From the 427 messages posted by the students, 233 posts were identified as the peer-scaffolding type. Content appeared to be the dominant peer scaffolding dimension, having received the highest percentage of posts (57%, 133 posts), followed by the Affection (26%, 61 posts) and the Strategy (17%, 39 posts) dimensions. Within the Content dimension, offering feedback and offering opinions received the highest number of posts, which indicates that these peer scaffolding types were often used by the students to scaffold each other in the Facebook discussions. The detailed findings of the types of peer scaffolding among students are summarised in Table III.

B. Students Critical Thinking Engagement Level

From the 427 posts posted by the students, only 185 were categorised as the critical thinking type. Table IV (which was derived from the individual frequency of critical thinking engagement) shows that *Clarification* received the highest number of posts (44.5%, 83 posts), followed by *Strategies* (28.6%, 53 posts), *Inference* (18.9%, 35 posts) and *Assessment* (7.6%, 14 posts). The engagement consisted of two levels: high and low. The total number of posts for the low level of critical thinking processes (*Clarification* and *Assessment*) was 97, whilst the total number for the high level of critical thinking processes (*Inference* and *Strategies*) was 88. Initially, this implies that the students mostly applied low level critical thinking engagement instead of high level critical thinking engagement. However, simply adding together the total number of low and high processes cannot specifically express the levels of critical thinking engagement. Therefore, the engagement levels were assessed by comparing the percentages of the low-level and the high-level critical thinking processes in Table IV with categorization of critical thinking engagement as shown in Table V. As a result, 7 students were considered to have high levels of critical thinking engagement, as the percentage of their total high-level processes was higher than that of their total low-level processes, whereas 11 students had low levels of critical thinking engagement since the percentage of their total low-level processes was higher than that of their total high-level processes. From the data tabulation in Table IV, it was found that the students with a high level of critical thinking had mostly adopted the *Strategies* process when involved in Facebook discussions whereas students with a low level of critical thinking engagement had mostly applied *Clarification* when they participated in the discussions.

C. Students' Critical Thinking Engagement Level Based on the Type of Peer Scaffolding Applied and Received

Table VI shows the tabulation of the peer scaffolding types applied by the students in the Facebook discussions.

The total number of peer scaffoldings applied was 233, with the *Content* dimension identified as the highest type of peer scaffolding applied among students (57.1%, 133 posts), whilst the *Strategy* dimension was the least adopted (16.7%, 39 posts).

Table- III: Dominant types of peer scaffolding among students

Dimension	Types	Total	Percentage (%)	Subtotal
Strategy (S)	Maintaining direction (S1)	27	11.6	16.7
	Assigning role taking (S2)	12	5.2	
Content (C)	Offering cues (C1)	19	8.2	57.1
	Offering opinions (C2)	37	15.9	
	Offering explanations (C3)	30	12.9	
	Offering feedback (C4)	47	20.2	
Affection (A)	Offering praise (A1)	28	12.0	26.2
	Inviting participants (A2)	33	14.2	
Total		233	100	100

Table- IV: Students' critical thinking engagement level

Student	Critical Thinking Engagement									
	CF	*AS*	*Total Low Process*	*%*	*IN*	*ST*	*Total High Process*	*%*	*Total*	*Level of CTE*
Student1	0	1	1	1.0	1	6	7	8.0	8	HIGH
Student2	12	1	13	13.4	2	9	11	12.5	24	LOW
Student3	2	1	3	3.1	1	0	1	1.1	4	LOW
Student4	4	0	4	4.1	1	0	1	1.1	5	LOW
Student5	3	0	3	3.1	1	3	4	4.5	7	HIGH
Student6	4	1	5	5.2	4	7	11	12.5	16	HIGH
Student7	16	1	17	17.5	1	6	7	8.0	24	LOW
Student8	1	0	1	1.0	4	1	5	5.7	6	HIGH
Student9	3	1	4	4.1	1	1	2	2.3	6	LOW
Student10	2	0	2	2.1	0	0	0	0.0	2	LOW
Student11	0	0	0	0.0	2	2	4	4.5	4	HIGH
Student12	13	1	14	14.4	5	2	7	8.0	21	LOW
Student13	0	1	1	1.0	3	2	5	5.7	6	HIGH
Student14	7	0	7	7.2	1	3	4	4.5	11	LOW
Student15	5	1	6	6.2	2	2	4	4.5	10	LOW
Student16	3	2	5	5.2	2	7	9	10.2	14	HIGH
Student17	5	1	6	6.2	2	2	4	4.5	10	LOW
Student18	3	2	5	5.2	2	0	2	2.3	7	LOW
TOTAL	83	14	97	100	35	53	88	100	185	-

CF = Clarification, AS = Assessment, IN = Inference, ST = Strategies, CTE = Critical thinking engagement

Table- V: Categorization of Critical Thinking Engagement [28]

Details	Level of CTE
High-level > Low-level	High (H)
High-level = Low-level	High-Low (HL)
High-level < Low-level	Low (L)

Furthermore, Table VII presents the tabulation of the peer scaffolding types received by the students in the Facebook discussions. The total number of peer scaffoldings received was 1,107, which is a much higher figure than the total number of peer scaffoldings applied. In this instance, the *Affection* dimension was recorded as the highest type of peer scaffolding received by the students (43.3%, 479 posts), followed by the *Content* (34.7%, 384 posts) and *Strategy* dimensions (22%, 244 posts). The results in Table VIII show 7 students were classified as having high critical thinking engagement, while the other 11 students had low critical thinking engagement.

Table- VI: Individual peer scaffolding applied

Student	Peer Scaffolding Applied								Total
	Strategy		*Content*				*Affection*		
	S1	*S2*	*C1*	*C2*	*C3*	*C4*	*A1*	*A2*	
Student1	0	0	2	3	2	0	0	0	7
Student2	7	3	2	10	4	8	7	5	46
Student3	0	0	0	0	0	0	0	0	0
Student4	2	0	0	0	0	7	3	2	14
Student5	1	1	0	0	2	1	0	1	6
Student6	2	1	2	1	3	5	2	1	17
Student7	5	0	4	3	3	8	1	5	29
Student8	0	1	1	0	2	0	1	0	5

Student9	0	0	0	0	0	0	1	2	3
Student10	0	0	0	1	0	0	0	0	1
Student11	2	0	2	2	0	4	4	3	17
Student12	4	4	2	6	2	6	3	3	30
Student13	0	0	1	2	1	1	1	0	6
Student14	2	1	1	1	1	4	2	4	16
Student15	1	0	1	1	2	0	1	2	8
Student16	0	1	1	3	4	0	2	2	13
Student17	1	0	0	3	4	1	0	2	11
Student18	0	0	0	1	0	2	0	1	4
Total	27	12	19	37	30	47	28	33	233
Percentage (%)	16.7		57.1				26.2		

S1= Maintaining direction, S2 = Assigning role taking, C1= Offering cues, C2 = Offering opinions, C3 = Offering explanations, C4 = Offering feedback, A1= Offering praise, A2= Inviting participants

Table- VII: Individual peer scaffolding received

Student	Peer Scaffolding Received								Total
	Strategy		*Content*				*Affection*		
	S1	*S2*	*C1*	*C2*	*C3*	*C4*	*A1*	*A2*	
Student1	9	4	1	9	5	3	7	22	60
Student2	8	6	4	9	16	9	9	22	83
Student3	9	4	1	9	6	0	4	23	56
Student4	11	4	5	10	7	4	3	21	65
Student5	9	4	1	10	5	0	3	22	54
Student6	10	4	2	11	7	4	7	22	67
Student7	11	5	1	13	9	9	9	21	78
Student8	9	4	1	9	5	0	3	22	53
Student9	9	4	1	10	9	0	3	20	56
Student10	9	4	1	8	5	0	3	22	52
Student11	9	5	2	13	5	4	2	21	61
Student12	10	4	1	11	11	13	7	24	81
Student13	9	5	1	8	4	0	5	23	55
Student14	9	4	1	9	7	3	3	20	56
Student15	10	4	1	9	6	4	4	21	59
Student16	9	4	1	8	5	2	5	25	59
Student17	8	4	3	10	5	0	4	21	55
Student18	9	4	1	10	6	1	4	22	57
Total	167	77	29	176	123	56	85	394	1107
Percentage (%)	22		34.7				43.3		

S1 = Maintaining direction, S2 = Assigning role taking, C1= Offering cues, C2 = Offering opinions, C3 = Offering explanations, C4 = Offering feedback, A1 = Offering praise, A2 = Inviting participants

For the high critical thinking engagement category, the students mostly engaged in the *Content* dimension during peer scaffolding applied. In contrast, for the peer scaffolding received, the students engaged more frequently in the *Affection* dimension followed closely by the *Content* dimension. Regarding the low critical thinking engagement category, the students mostly engaged in the *Content* dimension during peer scaffolding applied, except for Students 3 and 9, whereas, for peer scaffolding received, the students engaged more frequently in the *Affection* and *Content* dimensions. However, the differences in the frequency count between the *Affection* and *Content* dimensions are not very large. This also perhaps indicates that students are comfortable in applying and receiving the same type of peer-scaffolding category during the discussion process. A further correlation analysis was performed to distinguish the relationship between peer scaffolding and critical thinking engagement using data from Table VIII (column total for peer scaffolding applied, column total for peer scaffolding received, and column total for critical thinking). Table IX shows the SPSS correlation analysis using Spearman's rho correlation coefficient. The analysis indicated that the relationship between peer scaffolding received and peer scaffolding applied was significant, with a correlation coefficient r_s = 0.798, and that this relationship was highly significant (p<0.000). The relationship between peer scaffolding received and critical thinking engagement was substantial (correlation coefficient, r_s = 0.599), and the correlation coefficient was highly significant (p<0.009). The correlation analysis also showed a significant relationship between peer scaffolding applied and critical thinking engagement (r_s = 0.719), and the correlation coefficient was highly significant (p<0.001). Therefore, it can be concluded that the relationship between peer scaffolding applied and critical thinking engagement was stronger than that for peer scaffolding received.

D. Peer Scaffolding Patterns in Promoting Students' Critical Thinking Engagement

In order to visualise the individual patterns in promoting critical thinking engagement through peer-scaffolding techniques, the data in Table VIII were used for analysis using UCINET software. From Table X, it can be concluded that C1, C2, C3, and A1 were the most frequently applied peer scaffolding, while all peer scaffolding types, except for C4, were recognised as the peer scaffolding most frequently received by the highly capable students. Furthermore, it can be concluded from Table XI that S1, C2, C4, A1, and A2 were the most frequently applied peer scaffolding, while all peer

scaffolding types, except for C4, were recognised as the peer scaffolding most frequently received by the low capability students. Both the high and low critical thinking engagement patterns were further compared to clearly identify the differences and similarities between them (Table XII). In terms of the similarities, students in both the high and low categories applied the same peer scaffolding, that is, C2 and A1. In addition, the peer scaffolding received by the students was S1, S2, C1, C2, C3, A1, and A2. Regarding the differences, students in the high category often applied C1 and C3 whereas, in the low category, students mostly

Table- VIII: Critical thinking engagement through peer scaffolding applied and received

Student	Peer Scaffolding Applied			Total	Peer Scaffolding Received			Total	Critical Thinking				Total	Level
	S	*C*	*A*		*S*	*C*	*A*		*CF*	*AS*	*IN*	*ST*		
Student1	0	7	0	7	13	18	29	60	0	1	1	6	8	HIGH
Student2	10	24	12	46	14	38	31	83	12	1	2	9	24	LOW
Student3	0	0	0	0	13	16	27	56	2	1	1	0	4	LOW
Student4	2	7	5	14	15	26	24	65	4	0	1	0	5	LOW
Student5	2	3	1	6	13	16	25	54	3	0	1	3	7	HIGH
Student6	3	11	3	17	14	24	29	67	4	1	4	7	16	HIGH
Student7	5	18	6	29	16	32	30	78	16	1	1	6	24	LOW
Student8	1	3	1	5	13	15	25	53	1	0	4	1	6	HIGH
Student9	0	0	3	3	13	20	23	56	3	1	1	1	6	LOW
Student10	0	1	0	1	13	14	25	52	2	0	0	0	2	LOW
Student11	2	8	7	17	14	24	23	61	0	0	2	2	4	HIGH
Student12	8	16	6	30	14	36	31	81	13	1	5	2	21	LOW
Student13	0	5	1	6	14	13	28	55	0	1	3	2	6	HIGH
Student14	3	7	6	16	13	20	23	56	7	0	1	3	11	LOW
Student15	1	4	3	8	14	20	25	59	5	1	2	2	10	LOW
Student16	1	8	4	13	13	16	30	59	3	2	2	7	14	HIGH
Student17	1	8	2	11	12	18	25	55	5	1	2	2	10	LOW
Student18	0	3	1	4	13	18	26	57	3	2	2	0	7	LOW
TOTAL	39	133	61	233	244	384	479	1107	83	14	35	53	185	-

S = Strategy, C = Content, A = Affection, CF = Clarification, AS = Assessment, IN = Inference, ST = Strategies

Table- IX: Correlation between peer scaffolding and critical thinking engagement

			Received	Applied	Critical Thinking
Spearman's rho	Received	Correlation Coefficient	1.000	.798**	.599**
		Sig. (2-tailed)	.	.000	.009
		N	18	18	18
	Applied	Correlation Coefficient	.798**	1.000	.719**
		Sig. (2-tailed)	.000	.	.001
		N	18	18	18
	Critical Thinking	Correlation Coefficient	.599**	.719**	1.000
		Sig. (2-tailed)	.009	.001	.
		N	18	18	18

**. Correlation is significant at 0.01 level (2-tailed).

Table- X: Frequency of peer scaffolding applied and received in high critical thinking engagement

	Peer Scaffolding							
Types	***S1***	***S2***	***C1***	***C2***	***C3***	***C4***	***A1***	***A2***
Applied	3	4	6	5	6	4	5	4
Received	7	7	7	7	7	4	7	7

No. of students =7

Table- XI: Frequency of peer scaffolding applied and received in low critical thinking engagement

	Peer Scaffolding							
Types	***S1***	***S2***	***C1***	***C2***	***C3***	***C4***	***A1***	***A2***
Applied	7	3	5	8	6	7	7	9
Received	11	11	11	11	11	7	11	11

No. of students =11

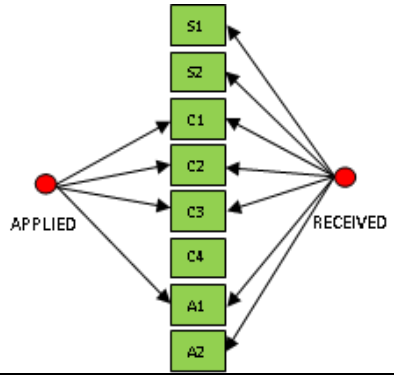
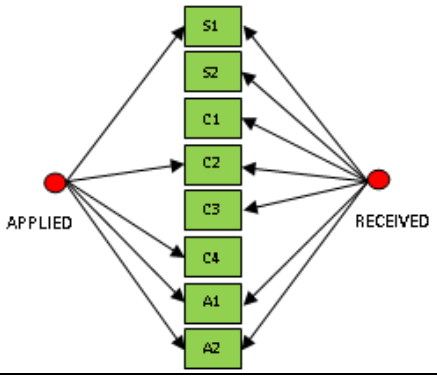
applied S1 and A2. Furthermore, there was no difference in the type of peer scaffolding received for both the high and low category students.

VI. DISCUSSION

Throughout this study, the problem-solving tasks and other related questions were posted on the Facebook platform by the instructors and students, and all the students were required to discuss the tasks with their peers. Although most of the tasks and questions posted were from the instructors, interestingly, students also posted quite a few questions on their own throughout the discussion sessions. The degree of student participation in the discussions was also encouraging, probably due to the peer scaffolding implementation.

The students also raised many questions, particularly requesting feedback, suggestions, and solutions from their peers. They seemed comfortable with the Facebook discussion environment and were actively discussing with their peers. From the interview responses, it was learned that the majority of the students felt excited about the discussions using Facebook, and they acknowledged that this discussion approach had been very helpful.

Table- XII: Pattern of peer scaffolding applied and received for high and low critical thinking engagement

Type	High Critical Thinking Engagement	Low Critical Thinking Engagement
Pattern		
Similarity	Peer Scaffolding Applied: C2 and A1 Peer Scaffolding Received: S1, S2, C1, C2, C3, A1, A2	
Difference	Peer Scaffolding Applied: C1 and C3 Peer Scaffolding Received: None	Peer Scaffolding Applied: S1, C4 and A2 Peer Scaffolding Received: None

Regarding the dominant types of peer scaffolding practised by the students, the results show that each student adopted different types of peer scaffolding (Table III). The *Content* dimension appeared to be the dominant dimension of peer scaffolding, having received the highest percentage of posts, followed by the *Affection* and *Strategy* dimensions. This finding agrees with [14]'s study, which analysed peer-scaffolding patterns in problem-solving approaches. However, when looking at the specific scaffolding types under the *Content* dimension, this study's findings were not in accordance with [14]'s study. The dominant types of peer scaffolding for this present study were *offering feedback* and *offering opinions*, whereas for [14]'s study, the dominant types were *offering explanations* and *offering cues*. It is worth noting that the respondents in [14]'s study were doctorate and master's degree students with more than ten years of work experience in the middle, upper, and higher positions in different fields of administrative divisions. Their respondents were also between 40 and 50 years of age, unlike the less experienced students in the present study, who were aged between 25 and 35 years old. As stated by [29], experienced workers were able to apply their existing knowledge and skills to address problems, as they were not new to them. Thus, they were more experienced and mature compared to the respondents of the present research. The contradictory findings in the present study might also be due to the subject matter. The Authoring System subject used in the present study involves the process of learning new knowledge and skills in a computer-based subject, which often engages the students in providing feedback and opinions, compared to the subjects in [14]'s study, which focused on topics related to work experiences. In particular, [14] found that students were able to provide feedback and opinions if they had enough knowledge related to the content. Providing appropriate feedback has also been identified as an important factor in promoting reflection. In a learning activity, students revisit the concepts and refine their own opinions during *offering feedback* [30]. Furthermore, [31] stated that an interactive online environment that integrates peer and instructor interaction will make students actively communicate and provide feedback.

For the *Affection* dimension, the percentage for *inviting participants* was greater than the percentage for *offering praise*, which indicates that the peers took over the instructor's role in enhancing students' participation. As [32] described, invitation is one of the interactive indicators that support interpersonal interaction between students. This behaviour can be seen to appear during the Facebook discussions. Regarding the *Strategy* dimension, the peer scaffolding percentage was greater for *maintaining direction* compared to *assigning role-taking*. *Maintaining direction* requires the students to ask questions and, thus, its frequency was in line with the frequency of questions posted by the students. The lowest percentage for *assigning role-taking* shows that the students were not familiar with this type of peer scaffolding. The students provided less *assigning role-taking* in the discussions because they might have been afraid to appoint others. Furthermore, due to the status of being first-year students, they were not confident of their level of expertise, as can be seen from the student discussions in the Facebook group.

For critical thinking engagement among students in the Facebook environment, most of the students engaged more in *Clarification* than in *Assessment*. *Clarification* is known as the process of identifying and elaborating upon ideas and thoughts, and, according to [33], students mostly engaged in *Clarification* because they focused more on explaining their own ideas, perspectives, and beliefs than on addressing specific points in others' contributions. These findings are similar to those by [34], who suggested that most students can apply all the critical thinking processes, with the highest percentage being *Clarification* and the lowest being *Assessment*. However, [34]'s study did not focus just on the use of scaffolding for knowledge building but also focused on other learning materials (i.e., notes created and revised, revisions, keywords, levels of questions designed etc.).

Surprisingly, the present study managed to achieve similar results to [34]'s study even though it employed only peer scaffolding as the main treatment. Despite being labelled as a low level of critical thinking, *Clarification* is considered to be the first step to critical inquiry [35], [36], which could trigger the higher level of critical thinking engagement contributions.

Regarding the present study it is interesting to note that, although the students mostly engaged in *Clarification*, this present study managed to move the students towards a more convincing and higher level of critical thinking.

This can be seen from the combined weightage of *Strategies* and *Inference*, which exceeded the weightage for *Clarification*, which would seem to indicate a very promising development. It can be stated that, with peer scaffolding, all the activities planned resulted in the advancement of the students' critical thinking engagement. Although it was not easy to persuade the students to engage in *Inference* and *Strategies*, this study concludes that peer scaffolding has the potential to promote students' critical thinking engagement to a higher level.

Both peer scaffolding applied and peer scaffolding received were significantly correlated with critical thinking engagement. However, the relationship between peer scaffolding applied and critical thinking engagement was stronger compared to peer scaffolding received and critical thinking engagement. As the peer scaffolding applied increases, so does the critical thinking engagement among students. This relationship suggests that students were preparing themselves with additional knowledge, probably in making the extra effort by searching for new knowledge in order to scaffold their friends. It could be hypothesised that the existing and additional knowledge would have brought about positive engagement in the Facebook discussions. As mentioned by [37], once students were asked to offer feedback to their peers, progress beyond the cognitive process was required (for, e.g., reading, comparing, questioning ideas, or reflecting). Thus, the act of scaffolding peers after they had personally researched and learned independently would lead to improvements in critical thinking engagement. Furthermore, the interview results have shown that all the learners agreed that the peer scaffolding in the group discussions had promoted their critical thinking engagement.

This study has revealed that the students with both high and low critical thinking engagement received the same patterns of peer-scaffolding types, but they differed in terms of the peer-scaffolding types that they applied. Due to the similarities in peer scaffolding received, it can be stated that the students were comfortable in receiving all types of peer scaffolding and that the differences did not affect their critical thinking engagement. Considering the peer-scaffolding patterns applied, similar patterns of *offering opinions* and *offering praise* were applied in both high and low critical thinking engagement categories. However, the difference is that the low-engagement students frequently provided *inviting participants* and *offering opinion* compared with the high-engagement students, who had been regularly scaffolding their peers by *offering cues* and *offering explanations*. These results provide empirical evidence that students who apply *offering cues* and *offering explanations* would have a better chance of engaging in higher critical thinking processes compared to those who apply only *inviting participants* and *offering opinion*. By referring to the definition in [14]'s models, *offering explanations* is a statement adjusted to fit a student's increasing understanding about what is being learned, and why, when, and how it is used while *offering cues* is a statement related to an item set as a problem area to focus students on completing the tasks. Thus, it can be speculated that the students' acts of scaffolding their peers by *offering cues* and *offering explanations* would lead to high critical thinking engagement.

To ascertain the best pattern of peer scaffolding applied and received in promoting students' future critical thinking engagement, it is important to refer to the pattern of high critical thinking engagement, as in Table XII. This pattern suggests that it is important for students to receive all types of peer scaffolding, but that they should individually make efforts to offer cues, offer opinions and explanations, and offer praise to their peers to benefit their own learning. It is suggested that, by scaffolding their peers with these four scaffolding types, specifically providing cues and explanations, their own higher order cognitive processes can be encouraged more effectively, and this, in turn, might promote critical thinking engagement. Moreover, adopting various types of peer scaffolding is important for the enhancement of critical thinking engagement. Reference [38] found that students performed better when they were able to interactively ask questions and receive answers from their online peers. However, it is very likely that emphasising providing opinions, praise, cues, and explanations will promote students' critical thinking engagement. While receiving all these peer scaffolding types is important, students who provide scaffolding to their peers may actually benefit more because in order for them to provide scaffolding, they need to make an extra effort to comprehend the problems posted by their peers, and by doing so, they may perhaps increase their understanding of the topic being discussed. This finding also strengthens the peer-scaffolding theory, which is that the effects on students of providing peer scaffolding are better compared to the effects of receiving scaffolding from their peers. It seems that this study also is in accordance with the famous quotation by [39] who stated, "To teach is to learn twice", where, when a student works with others, he/she will experience new discoveries, too. Hence, peer scaffolding can be a potential learning and teaching technique to enhance students' critical thinking.

VII. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

In regard to the dominant types of peer scaffolding, the *Content* dimension appeared to be the dominant dimension, with *offering feedback* and *offering opinions* as specific types of peer scaffolding under the *Content* dimension. As detailed in the discussion section, this could be attributed to the aspect of experience, knowledge, and skills on the subject matter. Critical thinking, meanwhile, shows students' dominant engagement in the *Clarification* level; however, this study has also shown a promising development of higher levels of critical thinking, e.g., *Strategies* and *Inference* levels. In terms of the students' critical thinking engagement based on the type of peer scaffolding received and applied, it can be concluded that the relationship between peer scaffolding applied and peer scaffolding received was significant.

However, the relationship between peer scaffolding applied and critical thinking engagement was actually stronger compared to peer scaffolding received and critical thinking engagement. This result, which favours peer scaffolding applied, implies that students who provide more scaffolding to their peers are more likely to engage better with critical thinking compared to those who merely receive scaffolding from their peers. This study also has proven that scaffolding by means of *offering cues* and *offering explanations* would provide a greater opportunity for students to engage at a higher level of critical thinking.

Finally, all the students had a positive acceptance of peer scaffolding in Facebook discussions, as it was considered to have helped them in promoting their critical thinking engagement. Peer scaffolding also offered several benefits to the students, as it allowed them to have more comfortable discussions, thus promoting a good environment for the discussion and sharing of ideas. Through the interview responses, the majority of the students preferred peer scaffolding compared to instructor scaffolding because, through the former, the students found that receiving friends' feedback was helpful to their learning, that is, in terms of facilitating understanding and problem solving. Nevertheless, they still expressed their need for instructors to guide them in their learning process and to keep the discussions on the right track. In conclusion, students should be informed about the different types of peer scaffolding, specifically about which type they should provide more often, so that they can engage better in high quality critical thinking processes. In order to apply peer scaffolding, students should prepare themselves with knowledge, as this will give them the confidence to contribute to the discussions. This is because knowledge and confidence will encourage their active participation in a comfortable and supportive environment, such as in a Facebook discussion, which will also allow them to engage more in critical thinking processes.

The role of peers as scaffold providers is important in online discussions. The promising trend from the present study's findings suggests that instructors should implement peer scaffolding in teaching and learning through online discussions, especially via Facebook. However, without decreasing the role of peer scaffolding, the instructors can still play an important role in providing students with enough guidance in learning. The findings might be used to guide instructors in creating an effective and meaningful learning environment through Facebook through promoting the use of peer scaffolding techniques. This study suggests that, for the students to engage critically in problem-solving tasks, they should be encouraged to offer praise, opinions, and frequent cues and explanations in facilitating and providing feedback. Prior to providing scaffolding to peers, students should prepare themselves by searching, comparing, digesting, summarising, and synthesising the information in order to provide cues and explanations that might lead to better engagement in critical thinking. This suggests that Facebook can provide an effective environment where peer scaffolding can take place and that scaffolding peers is one of the best ways to engage students with critical thinking. However, *offering feedback* was not consistently applied and received in this study; thus, its effect on students' critical thinking engagement is unknown. Future studies should apply this type of support to better understand its relationship with and influence on students' critical thinking engagement.

Despite careful planning, the study is not without its limitations, the most obvious of which is its time constraints. A period of six weeks was allocated to run all six learning topics, and the specific time for each topic was one week. However, the participants did not comply with the one-week discussion limitation, as the discussion of a particular topic sometimes continued until the following week. Thus, in one week, the participants could discuss many tasks, as they could post and share their own questions. Second, this study was carried out in an asynchronous online environment where students could choose their own times if they wanted to participate in the discussion. Hence, the students were able to recall and revise the topics before posting any messages online. Some students were merely silent readers and did not post any messages. Some entered the discussion after being called to participate, while some just copied and pasted the information from the internet. This indicates that the students' involvement in an AOD depends on their attitudes and behaviour and their own sense of responsibility. However, these aspects were not measured in depth to understand their effects on critical thinking engagement. Third, in this study, the students had not previously been exposed to peer scaffolding techniques, so they did not have any guidance and reference to scaffolding others; they just applied their existing skills, knowledge, and experience in the Facebook discussions. Therefore, students who were not familiar with online discussions would have needed some time to adapt to this new approach. Additionally, this study did not investigate the effects of the peer scaffolding on the students' examination results at the end of the semester, as this research was concerned only with peer scaffolding's relationship with critical thinking engagement, which was measured through online discussions.

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