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Patterns of Critical Thinking Processing in Online Reciprocal Peer Tutoring Through Facebook Discussion

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ABSTRACT Reciprocal Peer tutoring (RPT) can support students in enhancing their critical thinking during learning process. The evolution of internet technology has shifted face-to-face peer tutoring to an online environment such as use of a social networking site, Facebook. In addition, Facebook Group provides a space for students and instructor to discuss academic related matters. However, depending solely on the Facebook medium without proper design learning activities do not guarantee active learning among students. In addition, educators might face multiple challenges by using social networking site such as Facebook for teaching and learning purpose. Thus, this study integrated online reciprocal peer tutoring arrangements in Facebook to stimulate students’ critical thinking. A total of 29 students involved in the online discussions through Facebook with 14 Facebook Group pages were created. During discussion, tutor will used guided peer questioning strategy initiate tutee to think to the higher levels. This study employed lag sequential analysis to empirically explore patterns of critical thinking processing in Facebook discussions among High and Low critical thinking groups. The results showed that, apparently, High critical thinking group emerged thinking pattern which progressing from lower to higher order thinking processes which are very crucial in shaping their thinking to the higher levels. Additionally, by asking students’ prior knowledge and understanding frequently can help students to gain greater understanding of the topic and further initiate their higher level of critical thinking.

INDEX TERMS Facebook, critical thinking, online reciprocal peer tutoring, sequential analysis, type of question.

I. INTRODUCTION

The evolvement of technology has made tremendous contribution in the field of education. Appropriate tools or technique by integrating technology has a great potential to harness the teaching and learning purposes [1]. One of the example is by using web technology as online learning platform. Online learning has been expanding through the years within higher education, and its success in the education world has led to better learning and teaching experiences for both students and educators. Online learning enables active interaction between students and educators through computer-mediated communication such as communications via emails, chat rooms and online forums [2]. For the same reason, educators need to catch up with students who are currently more proficient in these technologies, especially in using Social Networking Sites (SNSs). Boyd and Ellison [3] claimed that these SNSs such as Twitter, Facebook, MySpace, Snapchat and Instagram have attracted millions of users around the world by enabling users to build and access their social networks.

Thus, the increasing number of SNS users has attracted researchers to undertake educational research on SNS in order to understand whether an online social learning environment is suitable for teaching and learning in higher education. In addition, learning through Facebook may promote active student interactions through online discussions and can establish a student-centered environment. For instance,
allowing students to construct new knowledge [4] and develop higher order and complex cognitive skills [5]. Therefore, this paper aims to investigate the pattern of critical thinking process in online discussion using Facebook Group. With respect to that, the peer tutoring strategy has been implemented and King Type of Question (1994) has been used to initiate the discussion among tutor and tutee to reach higher level of critical thinking.

II. PROBLEM BACKGROUND

A. DISCUSSION THROUGH FACEBOOK

Students’ participation in online discussions can be prompted through the use of popular and trendy online platforms, including SNSs. SNSs are popular among young people and adults, for social engagement purposes. These innovative technologies can be used to increase college student engagement, and to improve educational outcomes [6]. Lucas and Moreira [7] have suggested that SNSs have the potential to support innovative pedagogical practices, and to support different students’ learning approaches. In addition, SNSs can support the continuation and extension of learning and discussions outside formal classroom settings [8]. Therefore, various students’ learning styles indicate the appropriateness of SNS as a medium for effective learning.

The most popular SNS, to an astounding level, is currently Facebook. The site has more than one billion active users monthly. In addition, SNS such as Facebook can facilitate active learning through online discussions. Irwin et al. [9] have claimed that Facebook presents an opportunity for students to collaborate and cooperate with their peers through online discussions. According to [10], Facebook facilitates many natural student interactions. A possible reason is that Facebook has an element of social connectivity, and personal profile spaces which current students are familiar with [11].

Recently there is a growing number of studies regarding the potential for using Facebook as a means of teaching and learning. Research studies regarding the use of Facebook for teaching and learning have reported both positive and negative findings. A study by [12] created a Facebook Group as a Learning Management System (LMS), in which two courses put up announcements, shared resources, organized weekly tutorials, and conducted online discussions with postgraduate students. The results showed that students were basically satisfied with the affordances of Facebook, as the fundamental functions of LMS could be easily implemented within a Facebook Group. One of the possible reasons for this outcome is that younger students are more accepting of the idea of using a Facebook Group as an [12].

In addition, [13] created a Facebook Group as an introductory programming course, specifically for examining whether any learning could take place within Facebook. Students involved in the studies also had access to Blackboard (the university’s LMS), through which they could discuss, chat and brainstorm about programming. They compared student’s participation within the two environments, including the Blackboard discussion forum and the Facebook programming group, over a semester of the course. The results showed that when fulfilling a discussion forum function, Facebook attracted more students and saw more comments posted than Blackboard. This was due to Facebook’s social and community learning benefits, through which students are encouraged to support one another, while Blackboard was viewed as an authoritative and valid method for accessing official course material.

The positive findings discussed above indicated that Facebook has the potential to be integrated into courses, and alternatively Facebook could be considered a replacement for students’ LMS. This also shows that Facebook can significantly encourage students’ participation in discussions compared to existing LMS resources such as Blackboard. Therefore, Facebook can be considered a medium for encouraging students’ participation in the discussion of academic-related matters.

Furthermore, not all students participate significantly in Facebook, in contrast with the positive result reported above. A study undertaken by [14], that investigated course-related online discussions between students and teachers via Facebook, revealed that only 26 per cent of students participated through means of posting or commenting on the course’s web page. A majority of them, specifically 46 per cent, were passive observers. This meant that they made neither comments nor likes, and that they did not upload any links or publications. DiVall and Kirwin [14] suggested further strategies, such as active learning, to be used in order to encourage students to be more interactive. Despite the appropriate selection of medium to be used as a discussion platform, other factor such as teaching strategy also important to be considered to encourage learning. Therefore the lack of appropriate teaching strategies implemented through the Facebook platform can result in the passive behaviour of students, which leads to their inactive participation in online discussions. Hence, an appropriate teaching strategy that could be implemented through Facebook is the use of peer tutoring to encourage students’ learning in online discussions.

B. PEER TUTORING AS TEACHING STRATEGY TO INITIATE STUDENTS’ LEARNING IN ONLINE DISCUSSION THROUGH FACEBOOK

An appropriate teaching strategy that could be implemented within online discussions through Facebook is the peer tutoring strategy, which can initiate students’ learning within an active learning environment. Moreover, Facebook features offered to students the opportunities to learn with peers in social and familiar environment which increase their motivation to construct knowledge [15]. Peer tutoring is one example of peer learning. According to [16], the Facebook Group feature in which peer learning can take place, offers benefits to learners. For instance, Facebook allows group members to share information and ideas conveniently and serves as a platform for communicating easily with group members. It also allows various kinds of collaboration within the social
learning environment. Therefore, the peer tutoring strategy is suitable for implementation through Facebook.

Peer tutoring involves students acting as surrogate teachers whose aim is the transmission of knowledge [17]. Undoubtedly, some learners prefer to study with teachers, who are recognized as experts within their fields, and are considered professional. Within an online discussions environment, some researchers suggest that the presence of teachers can improve learning [18]–[20] and can increase participation [18], [21]. However, some students find the presence of teachers in online discussions to be an overbearing influence on them and their [22] and the presence of teachers should be minimally active in online discussion [23]. In addition, [24] and [23] argued that when teachers are involved in online discussions, the numbers of students’ posts do not increase. As a result, the presence of a teacher can hinder student’s participation and learning [25]. Therefore, some students are very comfortable learning with their peers, as they can build rapport with them compared to when they are learning with a teacher, as in the latter case they might feel too shy to ask about or discuss the subject content with their teachers.

Within the Malaysian context, the factors that impede students from engaging within classroom discussions, for instance by not asking questions in class, include shyness, fear of being mocked by classmates, and fear of making mistakes [26]. Online discussions could overcome this shyness problem in face-to-face learning, as students may comfortably write their thoughts in online discussions without fear of being directly teased by their peers. Additionally, they have more time to think before posting their comments within online discussions.

Peer tutoring has often been implemented within a classroom environment, and only in the recent past has peer tutoring shifted from the classroom environment to an online learning environment particularly in online discussion [27]. With the flexibility of online learning, in terms of space and time, learning is likely to take place outside of classrooms, anytime, anywhere. There is an absenteeism problem which often occurs within peer tutoring sessions, [17] either during regular classroom times or outside classroom times [28] where students need to be in class and face-to-face with their peers in order for learning to take place. This could be avoided through online learning, as it can be carried out anywhere and anytime, within a virtual space, provided that students have access to the required technology devices such as smartphones, tablets or computers, and can access the Internet. Moreover, teachers could monitor discussions between tutors and tutees more closely, if peer tutoring is conducted through a text-based discussion where it is possible for teachers to check if discussions are on the right track, or if the conversation has gone off-topic. Therefore, monitoring by educators is one of benefits conducting the peer tutoring online.

In addition, the online peer tutoring strategy also can be used to enhance students’ academic achievement. Chu et al. [29] used an online formative peer-tutoring approach in Mathematics courses in higher education. They examined the effectiveness of the proposed approach towards students’ learning performance. The results showed that both formative and conventional peer tutoring approaches significantly improved the students’ learning achievement as well as reduced their cognitive load in comparison with conventional online collaborative learning approaches. They also claimed that the proposed approach could motivate both the tutors and tutees to become active learners with good learning conceptions. This also seems to be consistent with the previous result [30], which found the success of the online peer learning in enhancing students’ academic achievement.

Based on systematic reviewed of literature, several researchers have conducted studies that consider online peer tutoring within a higher education context [31]–[33]. Most online peer tutoring studies have focused on the impact of online peer tutoring on social knowledge construction [32], the dynamics of peer tutor’s behaviour in online discussion [31], or on the effects of the two types of e-tutoring that include text-based (TB) and face-to-face (F2F) video-conferencing [33]. However, there has been little discussion about students’ critical thinking in regards to their use of online peer tutoring. Therefore, by evaluating these findings, promoting students’ critical thinking can be done by implementing the peer tutoring teaching strategy in online discussion. Shamir et al. [34] claimed that online peer tutoring may increase the sharing of information and critical thinking.

Basically, the peer tutoring has various formats and setting such as cross-age tutoring, same-age tutoring, and others. With this regard, in the present study, the reciprocal peer tutoring (RPT) teaching strategy is used to enhance students’ critical thinking in this study. RPT is characterised by the structured switching of the roles tutors and tutees at strategic moments during peer learning [28]. It reaps the specific benefits derived from teaching (tutor) and being taught (tutee). RPT is mostly associated with same-age, same-level or same-ability settings. Additionally, previous studies have reported that reciprocal peer tutoring may enhance students’ higher level thinking which includes critical thinking [17], [35], [36], [28]. Thus, this looks promising to approach RPT as a pathway to develop students’ critical thinking in online discussions through a medium such as Facebook.

C. RECIPROCAL PEER TUTORING (RPT) STRATEGY FOR PROMOTING STUDENTS’ CRITICAL THINKING IN ONLINE DISCUSSION THROUGH FACEBOOK

Nurturing critical thinking skills is crucial among higher education students and educators have continued to emphasize on the development of students’ critical thinking especially in higher education [37]–[40]. Additionally, the purpose of developing students’ critical thinking skills in higher education is to prepare them for the workforce as these skills are part of employability skills that are needed in the working place whether they are self-employed or working with others [41], [42]. As Clanchy and Ballard [43] stressed that
there are three main forms skills in employability skills which are (1) thinking skills, (2) research skills and (3) communication skills. Therefore, the thinking skills which involve elements of critical thinking skills are important to be developed especially among higher education students as these skills will help them to make critical and wise decision in workplace. According to [44], critical thinking means making clear, reasoned judgements. Thus, ideas should be reasoned and well thought out or judged during the process of critical thinking.

In addition, several studies claimed that critical thinking can improve students’ academic performance. A study found that a strong relationship between CGPA and critical thinking disposition among polytechnic students [45]. Similarly, [46] found that a strong relationship between critical thinking and academic achievement. While another study reported poor correlation between critical thinking and academic performance among first year medical students [47]. Conversely, [48] reported no correlation between academic achievement (CGPA) and critical thinking dispositions among pre-service teachers. This indicates a need to understand the various empirical evidence of the relationship between critical thinking and academic performance.

In Malaysian context, developing high level thinking skills such as critical thinking, metacognitive, logical and problem solving skills has been the main and critical issues for improving education in Malaysia. One element of the Malaysia Education Development Plan 2013-2025 is focused towards developing high level thinking skills among Malaysian students. There are six important skills are required for students to compete globally which are (1) general knowledge, (2) thinking skills, (3) leadership skills, (4) bilingual skills, (5) ethics and abilities, (6) national identity [49]. One of the important skills to complete globally is to develop thinking skills to the higher levels. Therefore, improving Malaysian students’ thinking skills is important for bringing nation to compete in international levels.

Concurrent with the rapidly growing online technology nowadays, developing students’ critical thinking can be done in online medium such as SNS, Facebook. Macknight [20] proposed that critical thinking can be promoted through online discussions. Moreover, the issue on promoting students’ critical thinking should be explored, regardless whether the learning takes place in a formal online discussion platform or otherwise. Experts in online learning presented various methods or teaching strategies to foster students’ critical thinking in higher education including student-centered learning such as RPT. Prior research regarding fostering critical thinking using RPT models were originally initiated in a classroom based setting [50], [36], [51].

King [50] introduces the use of peer guided questioning strategies in RPT models to stimulate students’ critical thinking. The peer guided questioning strategies emphasize on reciprocal tutor-tutee roles, supportive communication and elaborated explanation and questioning skills. When in the tutoring role, students learn to use different kinds of questions to prompt their partners to make corresponding response and the tutor roles in the group discussions is considered as the questioner while the tutee role is considered the explainer where the tutee will provide response with high level elaborations [50]. The tutors and tutees will reciprocally change role in the peer tutoring session. King used a set of generic questions stems as guidance for students to generate higher level questions [50]. Tutors also learn to sequence their questioning in a particular way from review questions to thought-provoking questions [50]. References [50] and [52] highlighted that for higher level thinking and learning to occur in peer-directed groups, the interaction must be guided to an extent that students engage in the mutual exchange of ideas, explanations, justifications, speculations, inferences, hypotheses, conclusions, and other high-level discourse known to promote peer learning. Without providing the guidance in asking questions such as the question stem [50], students tend to ask low-level questions. Thus, [36] found that the reciprocal peer tutoring model can effectively scaffold each other’s thinking and learning progressively to a higher level.

Besides the questioning strategies that can develop students’ critical thinking in teaching and learning, [53] added up that the educators need to provide critical thinking task activities such as problem-based questions to students or real-life situation questions in every topic in class to promote students’ critical thinking. Therefore, not only asking the right questions is important to promote student’s critical thinking [54], it is also needed to provide critical thinking task that can trigger their higher level of thinking [53].

In conclusion, without proper guidelines for teachers on how to embed the learning content using Facebook, the goal of learning could not be achieved. Learning through Facebook might be perceived as a form of distraction to students’ learning [54] and eventually affect their academic performance [55]. Thus, this study investigate the students’ critical thinking processing patterns in online RPT through Facebook discussion based on guided peer questioning strategy [50] and critical thinking process [56]. Therefore, it is best to develop structured RPT strategy through Facebook which can maximize students’ interaction, additionally increase students’ critical thinking.

Due to the above discussions on problem occurred especially in developing critical thinking via Facebook discussion, therefore this study embark to investigate the following research questions:

1) What are the levels of critical thinking processing among students in online RPT through Facebook discussion?

2) How do students reach the higher level of critical thinking in an online reciprocal peer tutoring (RPT) environment?

3) What are the types of questions used among students in online RPT through Facebook discussion?

4) What are the students’ critical thinking processing patterns in online RPT through Facebook discussion?
III. RESEARCH METHODOLOGY

In this study, a total of 29 students (S1-S29) involved in the online discussions through Facebook. The participants were second year undergraduate students who are taking Multimedia subject. 14 Facebook Group pages were created. Students were randomly formed 13 dyads group and one triad group.

During this study, four critical thinking task were provided in Facebook group discussions for four weeks of treatments. The task was created based on revised Bloom's Taxonomy [57] and followed the syllabus of Computer and Multimedia subject. The topics include in this subject were Web Design (Task 1), Interface Design (Task 2), Instructional Design Process (Task 3), and Motivation Component in Developing Software or Website (Task 4).

In group, each student changed role in the middle of the week during each task. Both students enacted the role of tutors during the discussion. When they in tutor role, they need to seek knowledge and gain understanding of the topic they will discuss. Hence, mastering the topic first is essential to solve the problem together with their tutee.

The tutors use guided peer questioning strategy to enhance their critical thinking skills by asking questions using generic questions stems by [50] to discuss the critical thinking tasks. In each critical thinking tasks, the roles of tutors and tutees were changed and every students had a chance to become a tutor (the roles of tutor and tutee are reciprocal). The process of the peer tutoring involved was illustrated in Figure 1. The tutor will change role every task in Facebook discussion in the middle of the week.

IV. DATA ANALYSIS METHOD

At this phase, all the data gathered from the Facebook discussion transcripts which include all the posts, statuses, comments and feedback from both the tutors and tutees from the Facebook Group page were collected to analyse. The Facebook discussion transcripts were analysed using content analysis technique based on [57] coding scheme of messages and the types of questions based on [50] coding scheme. The interview scripts also were transcribed and analysed using thematic analysis. Details of each process or method conducted during the coding phase were discussed as below.

A. CODING FOR CRITICAL THINKING LEVEL

To study the level of critical thinking of students’ responses in critical thinking task, the students’ Facebook discussion were analysed using content analysis technique based on [57] coding scheme. There are four processes in critical thinking process by [58] are (1) clarification, (2) assessment, (3) inference and (4) strategies. The four critical thinking processes were coded as ‘CL’ (clarification), ‘AS’ (assessment), ‘IN’ (inference) and ‘ST’ (strategies) as shown in Table 1

| Critical Thinking          | Description                                                                 | Code |
|---------------------------|-----------------------------------------------------------------------------|------|
| Clarification             | All aspects of stating, clarifying, describing (but not explaining) or defining the issue being discussed. | CL   |
| Assessment                | Evaluating some aspects of the debate; making judgements on a situation, proposing evidence for an argument or for links with other issues. | AS   |
| Inference                 | The process of the peer tutoring involved was illustrated in Figure 1. The tutor will change role every task in Facebook discussion in the middle of the week. | IN   |
| Strategies                | Taking action. Describes possible actions. Evaluates possible actions. Predicts outcomes of proposed actions. | ST   |
TABLE 2. Types of questions (King, 1994).

| Types of questions      | Description                                      | Code |
|-------------------------|--------------------------------------------------|------|
| Integration questions   | Goes beyond what was explicitly stated in the lesson, connects two ideas together, or asks for an explanation, inference, justification, etc. | I    |
| Comprehension questions | Asks for a process or term to be described or defined | C    |
| Factual questions       | Asks for recall of facts or other information explicitly covered in the lesson | F    |

are inference and strategies. However, they suggest that the higher education students should be included in high level which are inference and strategies processes. Moreover, this classification also supported by other researchers such as [60] and [61].

In this present study, the total frequencies of students’ discussion were then categorized to High (H) and Low (L) level of critical thinking category according to range. Before that, the inter-rater reliability test of critical thinking process was also conducted. The level of agreement between the researcher and the rater was 95.8 % and the Cohen Kappa value was 0.939. The results showed high agreement rates between the two raters in coding the online discussion transcripts in implementing the Perkins and Murphy’s critical thinking model.

B. CODING FOR TYPES OF QUESTIONS USED

Next, to answer research question regarding which is the types of questions used in Facebook discussion by students were analysed by using content analysis technique. This study used the types of questions introduced by [50]. King [50] suggested that a series of generic questions can be used in any context including the transfer of critical thinking skills which occurs when students understand the transfer as the goal of activities that improve their thinking abilities. King [50] also has conducted a series of studies on guided peer questioning strategy in reciprocal peer tutoring setting on guiding students to generate appropriate questions for their peer. This guided peer questioning strategy is used to stimulate students’ critical thinking; the learners learn to pose thoughtful questions that they then take turns answering.

Hence, in this study the three types of questions were integration, comprehension and factual questions. This study coded the integration questions as “I”, comprehension questions as “C” and factual questions as “F”. Table 2 provides the description of each type of questions and its code.

Same procedure as critical thinking process for students’ discussion, the inter-rater reliability test of types of questions used by students was also conducted which involved two raters where the level of agreement between the researcher and the rater was 95.5 % and the Cohen Kappa value was 0.808. The results showed high agreement rates between the two raters in coding the online discussion transcripts in the implementation of types of questions by [50].

C. SEQUENTIAL ANALYSIS

To study the patterns of students’ critical thinking process through Facebook discussion, lag sequential analysis [62] was implemented using Generalize Sequential Querier (GSEQ) software for analysing sequential observational data. This study identified two categories of students in development of their critical thinking processes which were High (H) category and Low (L) category group of students. Using lag sequential analysis, which is to investigate whether there is a sequential pattern of interaction in H and L groups using types of questions (I-integration, C-comprehension, and F-factual) and critical thinking process (CL-clarification, AS-assessment, IN-inference, and ST-strategies). Thus, this present study investigated the patterns emerged between H and L group.

The sequential analysis was calculated based on the transitions from one code to the subsequent code (lag 1) was tallied in a table using overlapped sampling and transitional probabilities. The columns represent previous behaviour; rows represent which was immediately subsequent. Transitional probabilities represent the chances that an activity followed another (or the same) activity. An arrow was used to express the transition probability and the greater expression was represented by the arrow thickness. A significance level of 0.05 and the Q-value was at least 0.30 [60] was used in this study. The transition from one code to another code was considered significant if z-score was positive value greater than or equal to 1.96 [62].

V. RESULT AND DISCUSSION

A. LEVELS OF CRITICAL THINKING PROCESSING AMONG STUDENTS IN ONLINE RPT THROUGH FACEBOOK DISCUSSION

Facebook transcripts of 4 critical thinking tasks were coded and segmented into 4 critical thinking processes (i.e. Clarification, Assessment, Inference, and Strategies). Table 3 presents the distribution of the frequency of the critical thinking process according to Task 1, Task 2, Task 3 and Task 4. From the data in Table 3, it is apparent that the difference between the low-level (65%) and the high-level CT processes (35%) is considered small with a 30% difference. This shows that the use of high-level CT processes is very encouraging in Facebook discussions.

Next, an overview of percentages of each of level of critical thinking in each task is presented in Figure 2.

From Figure 2 we can observe that in Task 1, Task 3 and Task 4, the most used critical thinking process was Clarification for 49.5%, 45.5% and 70.6% respectively. While, for Task 2, the most used critical thinking process was Assessment by 37.8%. However, it can be noticed that this critical thinking process was mostly used in Task 2 compared to the other tasks. This might be because Task 2 was about the evaluation of the interface between two websites; students were likely to use this critical thinking process when answering this task. In addition, the highest critical
### TABLE 3. The distribution of 29 students’ level of critical thinking processes for each task.

| Task |  | Low-Level CT | High-level CT |
|------|-----------------|-----------------|
|      | CL | AS | IN | ST |
| Task 1 | Total each level of CT process | 197 | 47 | 67 | 87 |
|      | Total CT processes | 244 | 154 |
| Task 2 | Total each level of CT process | 148 | 176 | 99 | 42 |
|      | Total CT processes | 324 | 141 |
| Task 3 | Total each level of CT process | 220 | 36 | 62 | 166 |
|      | Total CT processes | 256 | 228 |
| Task 4 | Total each level of CT process | 278 | 30 | 33 | 53 |
|      | Total CT processes | 308 | 86 |

Note: CT = Critical Thinking, CL = Clarification, AS = Assessment, IN = Inference, ST = Strategies

### FIGURE 2. Percentage of each critical thinking level in four tasks.

### FIGURE 3. Overall percentages of critical thinking processes used in Facebook discussion.

### FIGURE 4. Percentages of students’ low-level and high-level critical thinking process in each task.

thinking processes, ‘Strategies’ was mostly used in Task 3 (34.3%) compared to in the other task. The possible explanation that Task 3 was about how the students applied the motivation model in designing the websites, as a results, the students were likely to propose or design the websites which embedded the motivation component in it and tended to use this critical thinking process. Next, a graphic representation of the overall percentages of the total of each of level of critical thinking processes in all tasks is presented in Figure 3.

From Figure 3, the proportion of the Clarification process in the pie chart is approximately about the semi-circle size with 48.4% which is dominant in almost all of the tasks (Task 1, 3 and 4), followed by Strategies (20.0%), Assessment (16.6%) and Inference (15.0 %). Even though majority students were highly engaged in the Clarification process which is the lowest-level processes, almost all tasks but the second one used critical thinking process is Strategies which was the highest-level processes, where it was not easy for students to engage in the highest level of critical thinking, thus, developing students critical thinking to the highest level seems to be promising. This demonstrates that the students tended to identify and evaluate possible practical proposals when dealing with the task. Interestingly, the students engaged with other high-level critical thinking processes, Inference is quite high and the smallest difference is (5%) between the Strategies process even though it remained the least frequently used among the four CT processes. Next, a graphic representation for a total low and high level critical thinking processes used in each task is presented in Figure 4.

From Figure 4, we can observe that the students contributed to low-level and high-level critical thinking processes differently in each task. The smallest difference (1.8%) between the low-level critical thinking (14.9%) contributions and the high-level (13.1%) contributions can be observed in Task 3 (Application of Motivation Components). As mentioned before, task 3 needed students to design websites embedded with a motivation model, thus, the students tended to use this critical thinking processes. The slight difference between low-level and high-level critical thinking processes used in Task 3 revealed to be considerably encouraging as it is difficult to inculcate high-level and low-level critical thinking similarly. While, in Task 4, it is apparent that the difference
between the low-level (17.9%) and the high-level critical thinking (4.9%) is large with a 13% difference which implies that the students rarely engaged in high-level critical thinking processes. This might be because Task 4 (Systematic ID Process) required students to describing and defining when dealing with this task.

In conclusion, the findings shows that the development of students’ critical thinking in learning through Facebook discussion is initiated by the reciprocal peer tutoring (RPT) strategy which falls under the low-level of critical thinking. Clarification was the most used process by students when discussing in each task given. But, the high level of critical thinking was still encouraging, though it might be low in frequency. For instance, students showed the highest critical thinking process, Strategies process in Task 3 (Application of the motivation model) compared to other tasks. This proved that the type of task given to students may influence them to think critically.

B. STUDENTS’ ATTAINMENT OF A HIGHER LEVEL OF CRITICAL THINKING IN AN ONLINE RECIPROCAL PEER TUTORING (RPT) ENVIRONMENT.

The findings of the development of critical thinking processes in Facebook discussion apparently suggested that students overall scored lower on high-level engagement, which consisted high-level critical thinking processes (35%) (Inference and Strategies) compared to low-level critical thinking processes (65%) (Clarification and Assessment) (Refer Table 3). However by looking at them individually, their critical thinking process was the majority in low level critical thinking. But, a few students were able to reach high level critical thinking which was very difficult to achieve. Hence there is a need to bring many diverse pieces of evidence together in a form that would shed light on how this would transfer to the practicality of development of the students’ critical thinking engagement to higher-level via Facebook discussion through online reciprocal peer tutoring.

Therefore, students’ level of critical thinking process via Facebook discussion were categorised into two categories High (H) and Low (L) based on range (refer Table 4). The range is the difference between the lowest and highest value of data set. First, the highest and lowest numbers of frequency of students’ critical thinking process were identified. Next, subtract the smallest number in the data set from the largest numbers. Finally, the range was divided into two to find the range of H and L categories.

In this study, the total frequency of critical thinking process among student was obtained by the sum frequency of high level and low level of their critical thinking. Therefore, the highest value or frequency of critical thinking processes among students was 109 (S17) and the lowest value is 28 (S24) (refer Figure 5). Thus, subtracted the smallest number from the largest number which is subtract 28 from 109 (109-28) to get 81 and finally divided by two to get the range for H and L critical thinking category. 81 divided by two (81/2) to get 40.5 (round the number up to 41), the range of the set. The table 4 shows the range of H and L critical thinking categories used in this study. Total critical thinking process with frequency below than 70 will be labelled as Low (L) critical thinking category while, 70 and above will be labelled as High (H) critical thinking category.

Next, based on the range set above, the frequency of critical thinking process of each student was categorized. It shows that 9 students were identified in H critical thinking category (S17, S20, S2, S23, S11, S8, S28, S25, and S14). While 20 students were identified in L critical thinking category (S12, S15, S4, S26, S10, S21, S3, S22, S13, S1, S19, S18, S6, S7, S5, S29, S9, S16, S27, and S24). The data was illustrated in Table 5.
From the finding above, there might be several other factors that contribute to the students’ attainment of higher levels of critical thinking in online discussions such as (1) well-designed and well-structured online discussions, (2) the proper functioning of the role of a peer tutor, (3) tutor training sessions. Firstly, such a study was probably made possible due to the well-designed and well-structured online discussions. In this study, a few principles and guidelines were followed with the intention of having students experience pedagogically sound online discussions. Combining the popular and trending online social networking platform, Facebook with well-established learning theories such as social development theory [64] and revised Bloom’s taxonomy for creating learning tasks resulted in fantastic outcomes. For example, students were able to think at higher levels and learnt to generate questions to stimulate their critical thinking [65]. Previous studies by [66] also found that structured discussions are more engaging than unstructured discussions.

Secondly, this result may be explained by the proper functioning of the role of a peer tutor in helping to attain higher level critical thinking. In this study, the interactions of reciprocal tutoring pairs might have created greater mutuality and symmetry. Both the tutor and tutee might have gained mutual benefits as they reciprocate to be a tutor in solving the task. Furthermore, the tutor and tutee were working together in their respective zone of proximal development (ZPD) [64]. Additionally, once the students took the role of tutors, they were accountable to prepare the learning materials beforehand and gaining knowledge regarding the topics. They needed to enhance their knowledge regarding the topic to work effectively with their peers. As the more knowledgeable others (MKO) were helpful in assisting peers within their ZPD [64], the individual accountability and interpersonal skills were needed when working in a group. Besides that, in online RPT environments where there is more emphasis on a student-centred experience, the peer tutors would generate their own questions in the Facebook discussion which leads to a deeper learning [67], [68]. Furthermore, requiring students to generate their own questions can elicit a better understanding of the subject matter.

Thirdly, another possible factor that could contribute to the students’ attainment at higher level critical thinking is that the tutor training sessions were held prior to the actual treatment. Tutors were trained to ask review and thinking questions (i.e. factual, comprehension and integration) and adopt the tutoring behavior by e-moderation model [69] (i.e. motivator, social support, information deliverer, knowledge constructor, and challenger for personal development) in online discussions. De Smet et al. [32] concluded that giving explicit tutor training might determine the adoption of the expected types of tutoring activities. In this study, the instructor expected the tutoring activities regarding stimulating tutees’ critical thinking in the tutor training session, and this activity then appeared in an actual online discussion.

To conclude, the students’ attainment of higher levels of critical thinking in this study might have been influenced by the questioning strategies, a well-designed online RPT environment (including the types of task, and questions, dynamic tutor’s behaviour) and tutor training sessions. The next section, will discuss the type if question used among students that initiated them to discuss in high critical thinking level.

### C. TYPES OF QUESTIONS USED AMONG STUDENTS IN ONLINE RPT THROUGH FACEBOOK DISCUSSION

In the present research, generic questions stems consisting of three types of questions (=integration, c=comprehension and f=factual) by [47] were used to trigger students’ critical thinking in the Facebook discussion. Total of questions asked when the students became a tutor were calculated. Based on table 6, the most type of questions asked by the students were integration questions (78.8%), followed by comprehension questions (13.7%) and factual questions (8.9%). Integration type of questions went beyond what was explicitly stated in the lesson, connecting two ideas together, or asking for an explanation, inference, justification which could stimulate students’ critical thinking.

Finding shows that the types of questions that rarely used among students were Comprehension and Factual questions. However, both of these types of questions are essential for students to obtain well-inform about subject matter to make a better conclusion and judgement. Next, the Spearman correlation was conducted to determine the association between critical thinking process and types of questions used by students in Facebook. Both of the variables were ratio data. However, since the sample is below than 30, it was assumed that the data not normally distributed [67], [68].

In examining the relationship between critical thinking process and types of questions, there was a strong, positive correlation between critical thinking process and types of questions, which was statistically significant ($r_c(29) = .668$, $p=.000$). This shows that the types of questions used in the online RPT framework influence students’ critical thinking. The types of questions prompted by students, for instance, factual questions can recall students’ prior knowledge before they can progress to higher level questions such as integration questions, which connecting ideas and propose solution. In addition, for their own understanding about the topic, the comprehension type of questions can be asked them to describe and define in their own words.

In this study revealed that the relationship between critical thinking process and types of questions was strong, positive and significantly correlated. This shows that questioning

### TABLE 6. Total students in critical thinking process category.

| Types of questions     | Frequency | Percentage |
|------------------------|-----------|------------|
| Integration Questions  | 328       | 78.8       |
| Comprehension Questions| 57        | 13.7       |
| Factual Questions      | 37        | 8.9        |
| Total                  | 416       | 100        |
strategies are essential in stimulating students’ critical thinking. To develop students’ thinking, tutors have to constantly ask questions to get answers. With the established answers through questioning, tutors are then able to challenge tutees’ thinking. Additionally, they are also able to express their views and thoughts through questioning them.

Moreover, Asian students are rarely asked questions in class [72], with the guidance of the questions stem in Facebook discussions, can develop their critical thinking and motivate them to become actively involved in discussions. There were two categories of questions that were used in this study, such as lower level questions (comprehension and factual) and higher level questions (integration). In this study, tutors were encouraged to use higher level questions frequently to attain higher level critical thinking. However, simply asking higher level questions also does not necessarily lead students to produce higher level critical thinking [73]. It is because, they need a sufficient factual knowledge to infer and make a judgement [73]. Therefore, by asking lower level questions are essential to lead them to give higher critical thinking response.

This study found that the students used the Integration questions frequently compared to Factual and comprehension questions. This also proved that the questioning strategy used in an online RPT environment may influence students to attain a higher level of critical thinking. This finding corroborates the ideas of previous studies [74] in which the students were provided guidelines to ask questions in structured online discussions. This method stimulates students to ask thought provoking questions and challenge peers and fares better than just asking students to recall items from their previous knowledge. Additionally, significant correlations was found between students’ critical thinking processes and types of questions asked. Thus, this finding strengthens the fact that questioning strategies can stimulate students’ thinking to a higher level. In conclusion, the type of questions had been strong, positive and significantly correlated with students’ critical thinking processes. Thus, the next section, will discuss the pattern of student in High (H) and Low (L) critical thinking category discussed through Facebook.

D. STUDENTS’ ATTAINMENT OF A HIGHER LEVEL OF CRITICAL THINKING IN AN ONLINE RECIPROCAL PEER TUTORING (RPT) ENVIRONMENT.

For the last research question which is to obtain critical thinking processing patterns in online RPT through Facebook discussion, the sequential analysis of two categories of students which were H critical thinking students and L critical thinking students were investigated. The findings helped to suggest several rules from the results. For this purpose, the type of questions (I- Integration, C- comprehension and F-factual) and also the critical thinking process (CL- clarification, AS- assessment, IN- inference and ST- strategies) were the variable for sequential analysis of both types of critical thinking categories (H-high and L-low) of students.

### Table 7. The z-score matrix of H critical thinking groups.

| Sequence | Z-value | Q-value |
|----------|---------|---------|
| I → AS   | 2.42    | 0.32    |
| C → CL   | 2.32    | 0.49    |
| F → CL   | 3.45    | 0.88    |
| CL → C   | 2.31    | 0.51    |
| CL → IN  | 4.27    | 0.61    |
| AS → AS  | 5.49    | 0.62    |
| AS → IN  | 2.25    | 0.33    |
| IN → IN  | 2.54    | 0.37    |
| ST → ST  | 3.24    | 0.34    |

### Table 8. Element of sequence, z-value and q-value.

| Sequence | Z-value | Q-value |
|----------|---------|---------|
| I → AS   | 2.42    | 0.32    |
| C → CL   | 2.32    | 0.49    |
| F → CL   | 3.45    | 0.88    |
| CL → C   | 2.31    | 0.51    |
| CL → IN  | 4.27    | 0.61    |
| AS → AS  | 5.49    | 0.62    |
| AS → IN  | 2.25    | 0.33    |
| IN → IN  | 2.54    | 0.37    |
| ST → ST  | 3.24    | 0.34    |

### Figure 6. Transfer diagram of H critical thinking groups.

1) PATTERNS OF HIGH (H) CRITICAL THINKING STUDIES GROUPS

The pattern of High critical thinking group students was analysed and results is illustrated in Table 7.

In Table 7, positive values greater than or equal to 1.96 suggest that previous behaviour activates the subsequent, constituting a pattern of critical thinking processes. The columns represent the details of the previous behaviour and rows show that which was immediately subsequent. For example C → CL (z=2.31), this means, Comprehension questions promotes Clarification process. Thus, there were 9 significant elements of the sequence identified in the high critical students’ category pattern (filled with grey colour in Table 8) which can be summarized in Table 8.

The 9 elements of sequences was illustrated and transferred to diagram. The pattern of critical thinking processes for H group can be represented in Figure 6. In this diagram,
previous and subsequent critical thinking processes are joined by arrow (→). In addition, indicated that the arrow is the probability of transition and, for greater expression, such probability is represented by the arrow thickness.

As depicted in Figure 6, there are 9 elements of sequences produced based on the probability of transition frequencies between each component of the interaction in the peer tutoring for H critical thinking groups. In conjunction, in this study, three differentiated itineraries were identified: (1) lower-order critical thinking sequence, (F→CL, CL→CL, CL→C, C→CL, CL→CL); (2) progressing critical thinking (lower to higher order) sequence, (I→AS, AS→AS, AS→IN, IN→IN); and (3) higher-order critical thinking sequence, (ST→ST). The explanation of the three itineraries as Table 9.

2) PATTERNS OF LOW (L) CRITICAL THINKING STUDIES GROUPS

For Low (L) critical thinking students’ group’s results produce in Table 10.

The significant sequences were summarized in Table 10. There were three element of sequence identified which were CL→C, AS→AS and ST→ST. The three elements of sequences are transferred to diagram in Table 11.

Based on Figure 7, there were three elements of sequences produced based on the probability of transition frequencies between each component of the interaction in the peer tutoring for L critical thinking students’ groups which were independent and were not correlated with other elements of sequence. This was different with H critical thinking students’ group which identified three itineraries, however, L critical thinking group identified two itineraries which were (1) lower order critical thinking sequence consisted of two elements of sequence (CL → C, AS → AS); and (2) higher order critical thinking sequence consist only one element of sequence (ST → ST). The two itineraries and its explanation can be seen in Table 12.

3) COMPARISON PATTERN OF CRITICAL THINKING BETWEEN HIGH AND LOW GROUPS OF STUDENTS

Upon learning in the online RPT environment in enhancing students’ critical thinking through Facebook, the patterns of H (High) and L (Low) critical thinking categories were investigated and it was found that for H category, all of the types of questions (Integration, Comprehension and Factual) and critical thinking processes (Clarification, Assessment, Inference and Strategies) emerged but for L category, the integration and factual types of questions and inference process did not appear.

These findings indicated that the L critical thinking groups rarely asked integration and factual questions while H critical thinking groups often asked these types of questions. There was also a difference in critical thinking process which L critical thinking group did not really engage in the inference process. The L critical thinking groups began engaging with clarification process and asked comprehension types of questions. Furthermore, they always engaged the same critical thinking processes such as assessment and strategies. It seems possible that these results are due to the students might usually focus on shallow learning (memorizing, comprehension and imitation) and hardly performing high

| Itinerary | Explanation |
|-----------|-------------|
| Lower order critical thinking sequence. | F → CL → C → CL sequence |
| Progressing lower to higher order critical thinking sequence. | I → AS → IN sequence |
| Higher order critical thinking sequence. | ST → ST sequence |

TABLE 9. Three itineraries for high critical thinking students and its explanations.
level thinking (giving justification, well-reasoned and giving opinions). As the previous study [75] found that questions of knowledge based and comprehension based were mostly asked compared to higher levels questions in learning.

On the other hand, H critical thinking groups in lower order thinking sequence began with factual questions promote clarification processes, and then engaged in comprehension questions and followed by clarification process again. Students in H critical thinking group began the discussion by asking peers’ prior knowledge and understanding of material. The results of this study show that H critical thinking group gained better understanding and lack of confusion of material compared to L critical thinking group. For example in Task 4, the students asked comprehension and recall prior knowledge types of questions as shown below.

(Factual Questions) S14: As we both acknowledged, designing the teaching approach includes 5 steps…. What are the 5 steps involved?

(Clarification Process) S6: …Analysis, Design, Development, Implementation and Evaluation. ADDIE…. 

(Comprehension Questions) S14: We are already clear on the meaning of evaluation and the purpose of formative and summative evaluation… What is the difference between formative and summative evaluation?

(Clarification Process) S6: Summative evaluation if I’m not mistaken the evaluation is at the end of the courseware while formative evaluation is in every steps of development.

In this study, comparing L with H groups showed that, H group emerged three types of itineraries while L category, emerged 2 types of itineraries. Both groups emerge higher and lower order thinking sequences while only H group emerge progressive critical thinking (lower to higher order) pattern. These results indicated that H critical thinking group managed to sequence their thinking from lower to higher. They began by asking integration questions and engage in assessment process and attain higher level thinking, inference process. These findings support the ideas of previous study [76], where students attained more critical thinking when they are able to draw out conclusions (inference process) from the discussions. For example in Task 2, the sequencing thinking processes appeared when the tutor asked about the weaknesses of Yale’s websites and tutee provides the answers and tutor drew conclusions from discussed topic:

(Integration Questions) S25: …May possibly explain Yale’s Website? What need to be fixed?

(Assessment Process) S20:… In my opinion, things that need to be changed are colour and background selection. We need to use consistent colour and reduce the brightness of the background.…. 

(Inference Process) S25:…Conclusively, visual design must have colour that not disturbed the consumer.
Besides, the visuals also need to have an attractive graphic and multimedia to attract attention of consumers to read. …

In this study comparing H and L patterns showed that H group students managed to sequence their questions in discussion in the patterned order (from lower-order to higher-order questions) to elicit meaningful responses from peers. In addition, both of H and L groups managed to balance their questions as both groups ask convergent (review and factual questions) and divergent questions (integration questions) from various knowledge at varying cognitive levels. It is interesting to note that, the H group possesses the sequencing and balance in asking questions while L group only possesses the balancing in asking questions. Previous study [73] claimed that both sequence and balance components are needed for effective questions in learning.

VI. CONCLUSION

Based on the findings, there were huge differences in the pattern between H and L critical thinking groups. H critical thinking group engaged in rich and critical discussions compared to L critical thinking group. The types of question could also influence students’ to attain a higher level of critical thinking. Asking students on their prior knowledge and comprehension of the material may also lead to engagement in critical thinking. Thus, this study stressed that students can learn to be a critical thinker starting from shallow learning (asking prior knowledge and comprehension) and progressively to deep learning (deduces conclusions, connecting ideas and conflicting argument).

Moreover, as the types of questions and critical thinking processes were significantly correlated, this study then proceeds to investigate the pattern of the H and L critical thinking student groups. The findings showed that, the H critical thinking group emerged with three itineraries, namely (i) the lower order critical thinking sequence, (ii) progressing from a lower to a higher order critical thinking sequence, and (iii) the higher order critical thinking sequence. The Low critical thinking group showcased two itineraries, (i) the lower order critical thinking sequence and (ii) the higher order critical thinking sequence. The H critical thinking group showed a thinking pattern that progressed from lower to higher order thinking processes which is very crucial in shaping their thinking to the higher levels. Additionally, although both groups exhibited lower order thinking sequence, the H critical thinking group asked review and comprehension type questions more frequently. This revealed the importance of asking about the students’ prior knowledge to gain greater understanding of the material. In conclusion, based on the findings of this research, students need to enquire on prior knowledge and understanding before they reach the higher level of thinking processes. Students also need to give opinions, connect ideas between peers, draw conclusions from the discussions and propose solutions to reach the higher levels.

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