Investigating Students' 21st-Century Skills In A Project Work Online Learning Environment: A Case Study

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***Abstract* – 21st-century skills are essential for students to master in the information age. Among the 21st-century skills, critical thinking is essential as it forms the foundation for acquiring other 21st-century skills. Nevertheless, students' lack of critical thinking skills is a significant concern in education. Previous studies indicate that the lack of extensive development and practice of critical thinking strategies in most classrooms is the root of the problem. According to previous research, there are several ways to improve students' critical thinking skills. One effective way to enhance students' critical thinking skills is to employ project-based teaching strategies that actively involve students in collaborative activities. However, there has been limited research on implementing project-based activities to foster students' critical thinking within integrated courses. This study thus aims to investigate students' critical thinking by employing a backward design approach to design a project-based activity in an online learning environment. The project task designed in the online learning environment is integrated with three courses. Based on the desired learning outcomes of the three courses, a "big idea" (theme) is created to guide the instructor in designing the project task. A case study was adopted in the current study. The participants were 47 first-year trainee teachers at an institute of teacher education in southern Malaysia. To examine the depth of students' critical thinking exhibited through their participation in the project work online learning environment, the Newman, Webb, and Cochrane (1995) model was used to analyse the asynchronous transcripts qualitatively. Based on the findings, most students could provide meaningful and analytical responses in the designed project work online learning environment. Besides critical thinking, the project task also encourages students' collaboration, creativity, and communication skills when given freedom, ownership, and authority to determine the topic and design of their project.**

***Keywords* – 21st-century skills: Critical thinking; Project-based learning; Integrated courses**

I. INTRODUCTION

21st-century skills, commonly known as the "four Cs": Critical Thinking, Creativity, Communication, and Collaboration are recognised as essential skills for students to master in the information age (Chalkiadaki, 2018; Kennedy & Sundberg, 2020). Critical thinking is a process that involves analysing, evaluating, and synthesising information to make reasoned judgments and decisions using knowledge, facts, and data to support arguments (Bailin & Siegel, 2003). Creativity involves thinking outside the box to find innovative solutions to problems (Baruah & Paulus, 2019). Collaboration involves working together to understand the issues and find the best solutions (Sayers, 2008). Communication requires effectively sharing information and ideas to reach a consensus (Luterbach & Brown, 2011). Developing these skills empowers students to become independent thinkers, problem solvers, and lifelong learners in the 21st century (El et al., 2018; Greenhill, 2010; Salas Pilco, 2013).

Among the 21st-century skills, critical thinking is particularly important as it is the basis for acquiring other 21st-century skills (Dilekçi & Karatay, 2023; Higgins, 2014; Kennedy & Sundberg, 2020). For example, critical thinking and creativity are closely linked. Creativity generates new ideas, and critical thinking helps students refine and evaluate them. Students learn to question assumptions, think outside the box, and create innovative solutions by applying critical thinking. Second, critical thinking is vital for effective communication. It involves organising thoughts, evaluating information, and choosing the most appropriate words and expressions to express ideas coherently and clearly. Therefore, critical thinking enables individuals to communicate accurately, coherently, and efficiently. Third, critical thinking is crucial for collaboration. During discussions, team members share ideas, and critical thinking enables them to evaluate opinions, weigh pros and cons, and make informed decisions based on evidence and arguments. Critical thinking enables team members to bring different perspectives, challenge assumptions, and identify effective problem-solving strategies. In summary, critical thinking enables students to collaborate meaningfully, communicate effectively with clarity and logic, and find new or different solutions to problems.

II. PROBLEM STATEMENT

Although critical thinking is recognised as an essential skill for students in the 21st century, the lack of critical thinking skills is a significant concern in education. The viewpoint is highlighted by a recent report from the Organization for Economic Co-operation and Development (OCED, 2022), which claims an increasing disparity between the degrees obtained by students at colleges and universities worldwide and the skills necessary for them to thrive in the 21st-century workforce. These essential skills encompass literacy, analytical thinking, problem-solving, and effective communication.

The problem has been evident in previous studies (Nauman, 2017; Tempelaar, 2006), which shows that students rarely use their critical thinking skills to deal with difficult situations in the real world. The reason for this may lie in the teaching strategies used in the classroom. This assumption is supported by Fena and Xiaodongb, 2023, who claim that instructors should teach students how to think rather than what to think. Although content is necessary, the process of students learning the material is equally

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important. When the focus is on learning, students should have the freedom (and responsibility) to explore content, analyse resources, and apply what they learn to real-life situations.

Previous studies (Brodie & Irving, 2007; Jackson, 2015; Mutakinati et al., 2018) have shown that several factors hinder the integration of critical thinking skills in the classroom. One factor that impedes the development of a student's critical thinking skills is the lack of time. This is because teachers often must teach much material within a limited time. When the focus is on content delivery rather than student learning, it is less likely that active learning strategies such as group work, debates, case studies and project-based learning are used to engage students and promote critical thinking. In addition, the lack of formal teacher training is another key factor in students' lack of critical thinking skills. Although primary and secondary teachers are trained in teaching techniques and are familiar with their subject area, little to no time is spent teaching critical thinking skills.

To summarise, students' lack of critical thinking abilities can be attributed to various factors, such as insufficient development and practice of critical thinking strategies in classrooms, shortage of time, and inadequate competence of teachers, particularly at primary and secondary levels.

III. LITERATURE REVIEW

According to previous research (Kaddoura, 2013; Nelson & Crow, 2014; Nold, 2017; Ten et al., 2004), several ways exist to improve students' critical thinking skills. One is to use teaching strategies that actively engage students in the learning process rather than relying on lectures and memorisation, another is to focus teaching on the learning process rather than just the content, and a third is to use assessment strategies that provide students with an intellectual challenge rather than testing them on their memory.

Research studies conducted by Anazifa and Djukri (2017), Farindhani and Wangid (2019), Sari and Prasetyo (2021), Thomas and MacGregor (2005), Umam et al. (2022), and Yustina et al. (2020) have shown that actively involving students in project-based or collaborative activities is an effective teaching approach that promotes the development of critical thinking skills in students. This is because project-based learning is an instructional strategy that emphasises learning through completing hands-on activities or real-world projects and encourages team members to leverage each other's strengths to solve problems or overcome challenges. Table 1 summarises how project-based learning can develop students' 21st-century skills from prior studies.

To summarise, project-based learning is an effective teaching strategy that provides hands-on and interesting learning experiences. This approach aligns with developing essential 21st-century skills such as critical thinking, collaboration, communication, and creativity, which are necessary for preparing students to tackle the challenges of the 21st century.

Most importantly, engaging students in project-based learning helps them to develop critical thinking skills such as problem-solving, decision-making, and logical reasoning. Moreover, project-based learning hones their critical thinking skills by enabling them to assess information, recognise biases, and draw conclusions based on evidence. By applying their knowledge and skills to real-world problems, they learn to identify issues, analyse information, generate solutions, and make informed decisions. This approach encourages students to become active problem solvers, not just passive learners.

TABLE I: 21ST-CENTURY SKILLS DEVELOPED FROM PROJECT-BASED LEARNING STRATEGY

21st-century skills	Description	Source(s)
Collaboration and teamwork	- Project-based learning promotes teamwork and collaboration. It assigns tasks to groups of students to encourage shared responsibility and working on different project components. - Students collaborate to address problems, develop solutions, and reach a consensus on decisions. They share knowledge from different academic areas to tackle challenging issues, learn to appreciate others' contributions and use group intelligence to achieve project goals. - In project-based learning, students share the success of the project, promoting accountability and teamwork. They take ownership of their tasks and collaborate to find solutions to any challenges that may arise.	Al Rasyid and Khoirunnisa (2011); Chang and Lee (2010); Hasanah et al. (2023); Mutakinati et al. (2018); Nguyen (2011); Safarini (July, 2019)
Communication and presentation skills	- Project-based learning helps students improve communication skills by presenting their work to teachers, peers, and external audiences. Effective communication enables students to express their ideas clearly, actively listen, and provide feedback. These skills are essential for successful academic and professional collaboration.	Kovalyova, Soboleva, and Kerimkulov (2016); Putri and Hidayat (October, 2019); Walters and Sirotiak (April, 2011)
Creativity and innovation	- Project-based learning encourages creativity by allowing students to experiment with different solutions and strategies. Students have the freedom to choose their project topics, empowering them to explore their interests and passions, which inspires innovation. By developing original solutions to real-world problems, students use their imaginations to tackle challenges, which fosters their creative thinking abilities.	Birgili (2015); Munakata and Vaidya (2015); Ulger (2018)
Critical thinking	- Project-based learning helps students develop critical thinking skills by breaking down real-world problems, considering various viewpoints, analyzing data, and making informed decisions. Collaboration and teamwork in group discussions enable students to express their ideas clearly, listen to others, question assumptions, and analyze ideas critically.	Anazifa and Djukri (2017); Farindhani and Wangid (2019); Sari and Prasetyo (2021); Thomas and MacGregor (2005); Umam et al. (2022); Yustina et al. (2020)

Even though project-based learning has been shown to enhance student's critical thinking skills effectively, there has been limited research on implementing project-based activities to foster students' critical thinking within integrated courses. The current study thus aims to investigate students' critical thinking exhibited through their participation in a project work online learning environment within different courses.

IV. RESEARCH QUESTION

To what extent is the depth of students' critical thinking exhibited through their participation in the project work online learning environment?

V. METHOD

A case study was selected to address the research question because the study was conducted using a small sample size. The participants in this study were 47 first-year trainee teachers, consisting of 36 females and 11 males, taking either Malay or English language as their major subject in an institute of teacher education situated in the southern part of Malaysia. The participants were between 19 and 20 years old. Participation in this study was based on informed consent obtained from the participants before conducting this study.

VI. DESIGNING A PROJECT WORK IN AN ONLINE LEARNING ENVIRONMENT TO FACILITATE STUDENTS' 21ST-CENTURY SKILLS

The project task designed in the online learning environment was integrated with the three courses required to be enrolled by year one trainee teachers in the third semester, academic year 2022/2023. The three courses include GAPD1032 Basic Digital Education, GKKO1062 Co-curriculum and Personal Health, and GKEB1072 Learning Skills. A synopsis of the three courses is presented in Appendix 1.

The project task was designed using the Backward Design (Curriculum-Assessment-Pedagogy) approach. The following is a brief description of the three phases of Backward Design:

Phase 1: Curriculum (Identify the desired learning outcomes)

The learning outcomes of the three courses were identified, as shown in Table 2.

TABLE 2: LEARNING OUTCOMES FOR THREE DIFFERENT COURSES

Name of course (Course code)	The focused learning outcome
Basic Digital Education (GAPD1032)	At the end of the course, students can apply technology and digital resources to design meaningful teaching and learning activities.
Co-curriculum and Personal Health (GKKO1062)	At the end of the course, students can explain the principles and importance of co-curricular implementation.
Learning Skill (GKEB1072)	At the end of the course, students can produce a learning product by using thinking tools to improve their learning skills.

Adapted from Malaysian Institute of Teacher Education, 2021

This study generated an integrated learning outcome from the three different courses. At the end of the courses, students are expected to produce a learning product using thinking tools to explain the principles and importance of co-curricular implementation by applying technology and digital resources. Based on the desired learning outcome, a "big idea" (theme), namely "The digital world generates the creativity of first-class leaders", is created to guide the instructor in designing an assessment task.

Phase 2: Assessment

An integrated assignment (a project) is designed for students to complete throughout the study. The project requires students to produce a Digital Learning Object in the form of an e-book (a learning product) that conveys the principles and importance of implementing co-curricular activities in primary schools (GKKO1062) by using different types of thinking tools (GKEB1072) through the application of appropriate digital resources (GAPD1032). The students are required to create the e-book in groups. The product will be evaluated at the end of the semester.

Phase 3: Pedagogy (Design activities that help students to achieve the desired learning outcomes)

A project-based learning strategy is employed during the learning process. The students are expected to demonstrate 21st-century learning competencies, such as critical thinking, collaboration, communication, and creativity while completing the assessment task, as described in Table 3.

TABLE 3: THE 21ST LEARNING CENTURY SKILLS DEVELOPED IN THE PROJECT TASK

Skill	Description
Critical thinking	- Students justify the affordances of the selected digital resources to support meaningful learning activities. - Students create an e-book to publish on social media.
Collaboration	Group work increases student involvement in producing a learning product (e-book).
Communication	Ideas related to the content and types of thinking tools presented in the e-book are obtained from the discussions of group members.
Creativity	The task stimulates students' creative/innovative thinking in producing the digital learning object as an e-book using *Canva*.

All students were required to form a group of three to four members. Each group is requested to complete the task over eight weeks. A brief description of the time frame for producing the project is shown in Table 4.

As part of the e-book production process, students must ensure that the content or information presented through *Canva* promotes the concept of Triple E (Kolb, 2017). The Triple E Framework is used to determine the extent to which the e-book, as a technology tool, is aiding students in engaging with, enhancing, and extending their assessment tasks. A brief description of the Triple E is shown in Table 5.

TABLE 5: THE CONCEPT OF TRIPLE E (3E)

Criteria	Concept	Description
E1	Engagement	The content (policy and importance of co-curricular implementation) presented in the e-book through the use of digital resources (elements in *Canva*) can attract the attention/interest of the target audience.
E2	Enhancement	The content presented in the e-book through digital resources (e.g., through the graphics used in *Canva*) can facilitate the target audience's understanding of the policies and the importance of co-curricular implementation.
E3	Extension	Digital resources used/applied in the product (e-book) create opportunities for students to obtain audience feedback. For example, the product (e-book) can be shared on social media (such as *Facebook*, *Youtube*, *Telegram*) to receive comments, suggestions, or other positive/ constructive feedback to help students improve the content and design of the e-book.

Adapted from Kolb (2017)

TABLE 4: PROJECT TIMELINE

Week	Stage	Researcher's role	Participant's role	21st-century skills developed
1	Briefing	The instructor conducts a briefing session to explain the assessment task to the participants.	Students attend the briefing session. They are encouraged to ask questions.	Students must be able to listen well and ask questions to clarify information (oral communication).
2	Planning	The instructor assigns students to 15 groups. Each group consists of 3-4 members.	- Group members discuss the content (principles and importance of co-curriculum implementation) that will be presented in the e-book. - Group members determine the thinking tools that will be used to present the content in the e-book.	- Students learn to convey ideas using *Google Docs*. The ideas/ opinions/ arguments provided must be able to convince other people (written communication). - The information is presented creatively using the thinking tools (creativity).
3	Preparing	The instructor supervises students' work.	Students search for information related to the principles and importance of co-curriculum implementation.	Students are required to analyse and evaluate the information (critical thinking).
4-6	Constructing	The instructor observes, monitors, and guides the students as a facilitator.	- Students explore the elements in *Canva* to present their ideas. - Students ensure the information presented through the e-book can promote the concept of triple E (Engagement, Enhancement, Extension). The concept of triple E (3E) is shown in Table 2.	- Group members create an e-book comprising 15-20 pages (critical thinking) in groups (collaboration). - Students present the information creatively using technological tools (creativity).
7	Showcasing	The instructor evaluates students' presentations.	- Students make presentations and showcase their projects. - Students promote their e-books to the public. - Students received feedback from peers/public and improved/amended their work.	Students are required to justify/ suggestions when commenting on their peers' work.
8	Evaluating	The instructor evaluates students' products.	Students evaluate their work by referring to the received comments from the instructor.	Students evaluate their work (critical thinking).

VII. DATA COLLECTION AND ANALYSIS

The data was collected from the transcripts of text messages. The online discussion transcripts extracted from *Google Docs* form this study's primary source of qualitative data. The qualitative data were analysed using a content analysis method. The data analysis process involves two coders coding the responses the participants contributed. The first coder was the researcher who taught the participants involved in this research study. The second coder was a graduate with a Bachelor's degree in English for Professionals. Any ambiguity between the two coders was negotiated during the coding process until a 100% consensus was reached.

The data were coded according to Newman, Webb, and Cochrane's (1995) critical thinking model to examine the depth of students' thinking in the online group discussion for completing the project task. The rationale for the selection of this model as a coding scheme includes: (i) it is relatively straightforward to use because indicators are included, thereby lessening the potential ambiguity of participants' postings and making categorisation of postings easier than with other models; (ii) this instrument allows CT to be quantified (Tan & Ng, 2014); (iii) the coding scheme that has already been widely applied to determine the level of students' critical thinking in educational settings internationally help to increase the validity of the content analysis (Hou et al., 2008; Lan et al., 2012).

The unit of analysis used to analyse participants' critical thinking was the thematic unit which refers to a single thought unit or a main idea of a message. This is consistent with Merriam's (1998) viewpoint, which claims that the meaning of a main idea in the message should be the main focus of communication.

The depth of critical thinking demonstrated by participants in the discussions was computed in the form of the critical thinking ratio (x ratio): x ratio = $(x+ - x-)/(x+ + x-)$, where x represents the number of statements categorised according to the critical thinking indicator as shown in Appendix 2. For example, if 52 positive statements of Importance (I+) and four negative statements of Importance (I–) are found in a transcript, then the critical thinking ratio of Importance (x ratio) is $(52 - 4)/ (52 + 4) = 0.86$. The selected coded messages are described in Table 6.

TABLE 6: NEWMAN'S CRITICAL THINKING INDICATORS

Critical thinking indicators per category	Researcher's inference	Example(s) extracted from the transcripts
Relevance (R+)	Be able to provide relevant information to the topic discussed throughout the responses.	Co-curriculum is a group activity where planned activities are an extension of the teaching and learning process in the classroom (G7).
Importance (I+)	Be able to provide significant points of view on the topic discussed.	…co-curricular activities align with the National Education Philosophy's goal of developing individuals holistically, intellectually, emotionally, spiritually, and physically…(G3) … participating in co-curricular activities helps students to enhance and develop their talents, potential, and abilities. …(G2)
Referring (O+)	• Refer to relevant outside materials and use the referred information in the situations related to the topic discussed. • Use prior knowledge/ individual experience and apply it in the situations of the topic discussed	…conducting a workshop searching for the talents of football players…(G6)
Linking (L+)	Connect the facts, ideas, and notions to the situations of the topic discussed.	…invite national football game players to the workshop to attract students' interest and participation …(G6)
Critical Assessment (C+L+);	Be able to compare one's ideas and others' contributions toward the topic discussed with the logical thinking process. Be able to critically assess others' contributions toward the topic discussed with a logical thinking process.	There are two types of objectives: general objectives that are comprehensive and specific objectives that are specialised for a particular activity (G13). …for the introduction section, your ideas are broad and general…To ensure clarity, I think it is crucial to start with a broad overview before discussing specific activities in detail…(G10) …the use of a thinking tool flow chart is very appropriate because it shows the process and flow of activities…(G11)
Accuracy (A+)	Use the references/ literature/ information/ data collected to support the participant's position to be accurate and true.	According to the nationality co-curriculum main policy (2), participation in co-curricular activities is mandatory for all students in the school's education system (G4).
Justification (J+L+)	• Provide a logical statement of opinion with proof or examples. • Provide a logical statement of agreement or disagreement with supporting reasons. • Be able to support/ defend their opinion/ position/ decision/ solution by providing additional support from outside resources	…. I agree with you because… engaging in handcrafted activities can promote community participation and social responsibility among young cadets because, through fundraising for orphanages, pupils can develop empathy, compassion, and a drive to contribute towards the betterment of society…(G12)
Novelty (N+)	• Offer new ideas/points of view for discussion. • Generate new data from the collected information.	Implement the "Gadget Building Workshop" for the members of the Malaysian Red Crescent Unit (G9)
Practical utility (P+)	• Be able to relate proposed (new) solutions to the situations or topics discussed. • Be able to discuss the practical utility of the proposed (new) ideas.	…incorporates the concept of 5E: Engage, Explore, Explain, Extend (or Elaborate), and Evaluate when designing the activities for the "Gadget Building Workshop"… (G9)
Width of understanding (W+)	• Be able to see things from a larger perspective. • keeping the topic under discussion open wide.	… the gadget created in the workshop will be rented out to raise funds for the Red Crescent Uniform Unit at the school… (G9) The Handcraft Activity for School Youth Cadets aims to engage students in creating handcrafted items to sell and raise donations for an orphanage (G12).

VIII. FINDINGS

A comparison of the depth of critical thinking among all discussion groups

Table 7 contains data on the critical thinking ratios of 15 discussion groups. Out of the 15 groups, the highest number of groups (G1, G2, G7, G8) scored 0.79. The average critical thinking ratio achieved by all discussion groups was 0.81. The results indicate no significant difference in the groups' critical thinking ratios, ranging from 0.75 to 0.87. Group three had the highest ratio (0.87) of critical thinking among all the groups, indicating that the students in this group provided more constructive responses than the others. Conversely, group 11 had the lowest number of critical responses (0.75) compared to the other groups.

TABLE 7: THE RATIO AND FREQUENCIES OF POSITIVE AND NEGATIVE CRITICAL THINKING INDICATORS FOR ALL DISCUSSION GROUPS

Group	X+	X-	Critical Thinking Ratio $(x+ - x-)/(x+ + x-)$
1	61	7	0.79
2	87	10	0.79
3	127	9	0.87
4	92	10	0.80
5	134	15	0.80
6	92	12	0.77
7	68	8	0.79
8	94	11	0.79
9	88	9	0.81
10	113	12	0.81
11	90	13	0.75
12	75	10	0.76
13	81	6	0.86
14	96	9	0.83
15	120	9	0.86
Total	1418	150	0.81

Although a high level of critical thinking was displayed in all discussion groups, it does not necessarily mean that every group member actively participated or contributed to the discussion. Two main reasons can explain the findings of the study. Firstly, the different critical thinking ratios in the 15 discussion groups may have resulted from randomly assigning participants to groups without considering their abilities and performance levels. As a result, certain groups (such as group 13) had more participants with high critical thinking ratios, while others (such as group 12) had more participants with low critical thinking ratios. Secondly, some students may have hesitated to participate in the discussion because they were not grouped with classmates, they felt familiar or comfortable with.

This is supported by a previous study by Cheung et al. (2008), which found that interpersonal relationships between participants or familiarity with group members could affect a student's willingness to participate in online learning projects. Some students may have exhibited lurking or non-posting behaviour during the discussions (Xie, 2013). This could be because participants' learning attitudes and behaviours may affect their contributions to the discussions (Cheung et al., 2008). Therefore, the depth of critical thinking in student discussions was analysed and discussed in greater detail in the following section.

The depth of individual students' critical thinking in the project work online learning environment

The results, as presented in Table 8, show that most students could provide substantive responses during the online discussion. This was demonstrated by the critical thinking ratios of the students, which ranged from 0.69 to 1, with no scores below that range. In other words, the average critical thinking ratio exhibited by the students was 0.81, with the ratio of positive to negative indicators being about 1:0.1.

TABLE 8: THE RATIO AND FREQUENCIES OF POSITIVE AND NEGATIVE CRITICAL THINKING INDICATORS FOR INDIVIDUAL STUDENT

Group	Student	Total		CT ratio
		X^+	X^-	
1	1	24	4	0.71
	2	16	0	1.00
	3	21	3	0.75
2	4	33	2	0.89
	5	26	3	0.79
	6	28	5	0.70
3	7	42	3	0.87
	8	46	4	0.84
	9	39	2	0.90
4	10	23	3	0.77
	11	37	5	0.76
	12	32	2	0.88
5	13	43	4	0.83
	14	47	6	0.77
	15	44	5	0.80
6	16	35	3	0.84
	17	31	5	0.72
	18	26	4	0.73
7	19	24	3	0.78
	20	26	2	0.86
	21	18	3	0.71
8	22	26	4	0.73
	23	21	3	0.75
	24	18	2	0.80
	25	29	2	0.87
9	26	32	5	0.73
	27	27	3	0.80
	28	29	1	0.93
10	29	35	3	0.84
	30	37	5	0.76
	31	41	4	0.82
11	32	22	4	0.69
	33	37	6	0.72
	34	31	3	0.82
12	35	35	4	0.79
	36	24	4	0.71
	37	16	2	0.78
13	38	21	2	0.83
	39	28	1	0.93
	40	32	3	0.83
14	41	37	4	0.80
	42	24	2	0.85
	43	35	3	0.84
15	44	22	1	0.91
	45	31	4	0.77
	46	38	3	0.85
	47	29	1	0.93

The study's findings also further show that approximately 85% of the students could make constructive responses in their discussions online, with 42.5% of students at scores ranging from 0.7 - 0.79 and 0.8 - 0.89, respectively. This implies that most students could provide a high number of positive critical thinking indicators in the project work online learning environment. Based on the results, only student S2 achieved the highest critical thinking ratio of 1.0 among the students. No negative indicators were found in the student's online discussion transcript despite his low number of contributions, which totalled only 16 responses.

However, a higher number of positive indicators of critical thinking found in students' contributions may not necessarily reflect their ability to generate high-level responses. The following section analysed the types of messages that contributed to Newman's Critical Thinking Model category.

The types of messages contributed to the project work online learning environment

The findings, as presented in Table 9, show that 1,568 messages were corded in the discussion transcripts extracted from *Google Docs*. From these messages, 1,418 positive indicators were identified. Analysis of the excerpt shows that the responses contributed by students tended to aggregate in the category of R+ (Relevance) (n = 820). The results reflect that the students focus more on articulating and elaborating a wide range of relevant ideas, opinions or suggestions to the topic discussed. The category with the second highest postings was I+ (n = 268). This is followed by N+ (n = 94). This reveals that the students could generate new suggestions or solutions to the situation or issue discussed.

TABLE 9: THE TYPES OF MESSAGES CONTRIBUTED IN EACH CATEGORY OF NEWMAN'S CRITICAL THINKING MODEL

Category	Code	Total number of responses (Percentage)
R (Relevance)	*R+*	820 (57.82%)
	R–	6 (4.16%)
I (Importance/Significance)	*I+*	268 (18.93%)
	I–	8 (5.37%)
N (Novelty)	*N+*	94 (6.64%)
	N–	18 (12.17%)
O (Referring)	*O+*	61 (4.32%)
	O-	0 (0%)
L (Linking)	*L+*	53 (3.72%)
	L-	5 (3.13%)
A (Accuracy)	*A+*	1 (0.07%)
	A–	0 (0%)
J (Justification)	*J+L+*	60 (4.25%)
	J+L–	0 (0%)
	J–	107 (71.02%)
C (Critical Assessment)	*C+L+*	33 (2.3%)
	C+L–	0 (0%)
	C–	6 (4.15%)
Practical utility (grounding)	P+	11 (0.79%)
	P–	0 (0%)
Width of understanding (complete picture)	W+	16 (1.16%)
	W–	0 (0%)
Total		1,568 (100%)

In contrast, the categories of A+ (Accuracy) (n = 1) scarcely had any postings. This result indicates that the students did not use the references/literature or information/data collected to support that their positions are accurate and true. Furthermore, the lack of postings in categories P+ (Practical utility) (n = 11) and W+ (Width of understanding) (n = 16) also implies that the students were less likely to discuss the practical utility of proposed solutions or widen their perspective on the topic at hand.

On the other hand, the findings show that 150 messages regarding negative indicators were found in *Google Docs*. The highest of these messages were the J- (n = 107) postings. The result indicates that the students were most likely to agree, disagree, or provide alternative opinions without

supporting reasons, examples, or elaboration during the discussion. However, the discussion transcripts found no representation of a few negative indicators such as A– (Accuracy), P- (Practical utility) and W- (Critical Assessment). This result is reasonable because the contribution of the students towards categories A+ (Accuracy), P+ (Practical Utility), and W+ (Width of Understanding) was significantly low.

IX. DISCUSSION

The research findings indicate that most students' contributions to the project's online learning environment belong to the Relevance (R+) category. This category involves expressing and expanding a wide range of relevant ideas, opinions, or suggestions related to the topic. Expressing ideas is a crucial step towards higher-level thinking. It is particularly important because it helps students shape and refine their thoughts, ultimately leading to better decision-making and problem-solving.

Furthermore, the discussion in the project work online learning environment also encourages the development of communication skills among students because they need to reach a consensus to produce the e-book that conveys the information related to the principles and importance of co-curricular implementation. This is in line with the previous studies (Kovalyova et al., 2016; Putri & Hidayat, October 2019; Walters & Sirotiak, April 2011), which indicates that project-based learning creates a learning environment that encourages collaboration among students, where they can work together to address problems, develop solutions, contribute ideas, and reach a consensus on decisions.

In addition, most postings contributed by the students in the Novelty (N+) category indicated that students could generate new ideas or suggestions for the project being discussed. This is plausible because the project task required students to create the content or information presented in the e-book. At the same time, students must also consider and evaluate the different ideas and viewpoints contributed by their groupmates. Therefore, the project work helps develop students' critical thinking while producing the e-book that conveys information on the principles and importance of co-curricular implementation (GKKO1062). Besides, the findings are also consistent with the prior research (Anazifa & Djukri, 2017; Farindhani & Wangid, 2019; Sari & Prasetyo, 2021, Thomas & MacGregor, 2005; Umam et al., 2022, and Yustina et al., 2020), which indicates that project-based learning can help to develop students' critical thinking abilities by considering different ideas and evaluating opposing viewpoints.

Also, the project task that allows students to decide their project topics or themes based on the concept of Triple E while designing the e-book using different thinking tools (GKEB1072) by applying appropriate digital resources (GAPD1032) is important for developing students' creativity and innovative thinking. For example, the students were given the freedom to apply a variety of elements (such as graphics, text, different shapes, diagrams, and colours) provided in *Canva* to attract the attention or interest (Engagement) audiences, facilitate the target audience's understanding (Enhancement), and transform the e-book into a shareable link (Extension) to receive comments, suggestions, or other positive/ constructive feedback via social media such as *Facebook*, *YouTube*, and *Telegram* to help students improve the content and design of the e-book. These are aligned with the prior studies (Birgili, 2015; Munakata & Vaidya, 2015; Ulger, 2018), which indicate that project-based learning that empowers students to have ownership and authority over their assignments can lead to increased creativity in their work and a deeper understanding of the subject matter.

However, based on the analysis of the discussion postings, it was found that the categories of Accuracy (A+), Practical Utility (P+), and Width of Understanding (W+) had very few postings. This suggests that the students mostly expressed their agreement, disagreement, or alternative opinions without providing any supporting reasons, examples, or explanations. On the other hand, the students were less likely to discuss the practical utility of the proposed solutions or broaden their perspective on the topic being discussed. Two main reasons can be attributed to the obtained results. Firstly, students may not always use references or collected information to support their project work in the online learning environment. This could be due to a lack of time, as they prioritise completing the project quickly over conducting thorough research. Additionally, unclear instructions or guidance on the importance of using references and how to integrate them into the project can lead to oversight.

X. CONCLUSION

It can be concluded that most students could provide substantive responses in the online learning environment of the assigned project work. This is supported by the students having an average critical thinking ratio of 0.81 and a positive-to-negative indicator ratio of approximately 1:0.1. The findings further indicate that the responses contributed by students tended to aggregate in the categories of R+ (Relevance) and N+ (Novelty). This reveals that the students could articulate a wide range of relevant ideas, opinions or suggestions to the topic discussed and generate new suggestions or solutions to the situation or issue. Therefore, it can be concluded that the designed project work in the online learning environment can encourage the development of students' critical thinking and communication skills when they must reach a consensus in creating the e-book. Besides critical thinking, the project task encourages students' creativity when given freedom, ownership, and authority to design the project.

Finally, it is important to note that integrating assessment into the three courses (GAPD1032, GKKO1062, and GKEB1072) benefits both instructors and students. The benefits of incorporating integrated assessment are as follows:

1. Integrated assessment allows students to apply their knowledge of co-curriculum and personal health, as well as their learning and digital skills, across multiple domains.
2. Interdisciplinary learning is encouraged through integrated assessments, as real-world issues often demand knowledge from multiple disciplines. By incorporating content from different courses, the integrated assessment

promotes interdisciplinary learning, which results in a more comprehensive understanding of the subject matter among students.

3. Integrated assessment develops students' critical thinking skills because it challenges them to think critically and make connections between different concepts. It encourages them to analyse information, synthesise ideas, and develop a deeper understanding of the material.

4. Integrated assessment can streamline the learning process by covering multiple learning objectives simultaneously. This efficiency can be particularly valuable when there are time constraints in the classroom.

5. Lastly, the integrated assessment as a project requires student collaboration, fostering teamwork and communication skills.

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APPENDIX

Course Synopsis

Course code	Name of course	Synopsis
GAPD1032	Basic Digital Education	This course introduces students to the introduction of digital learning, the role of digital era students, the role of digital era teachers, technology and digital resources for meaningful learning activities, the use of online learning management, the use of online digital technology, the concept of computational thinking and digital citizenship. Students will also gain knowledge on the concept of digital learning and utilisation in a meaningful way based on the latest digital tools and resources using problem-solving approaches for teaching and learning.
GKKO1062	Co-curriculum and Personal Health	This course focuses on students gaining knowledge and mastering co-curriculum and personal health skills. In addition, it is hoped that through this course, students will improve and strengthen their self-competence related to the concepts, goals and strategies of co-curriculum implementation and the importance of personal health aspects as well as health issues involving nutrition, infectious diseases, and substance abuse.
GKEB1072	Learning Skill	This course focuses on learning skills, self-management, social adaptation, reading and note-taking, thinking, information acquisition and management, information processing, and presentation skills. This course is offered to enable students to master and apply learning skills in learning management at the tertiary education level.

Newman, Webb, and Cochrane (1995) Critical Thinking Model

Category	Code	Indicator
R (Relevance)	*R+*	Relevant statements to the issue discussed
	R–	Irrelevant statements to the issue discussed
I (Importance/Significance)	*I+*	Important/significant points/ issues
	I-	Unimportant, trivial points/ issues
N (Novelty)	*N+*	Provide new information, ideas, or solutions that have never been mentioned (even if they are not essential or valuable); generate new data from the information collected.
	N-	Repeat what has already been said without any further exploration.
O (Referring)	*O+*	Refer to course material, use relevant outside material, use previous knowledge/ personal experience, course-related problems brought in (e.g., students identify problems from lectures and texts), and welcome outside knowledge.
	O-	Squashing attempts to bring experience in outside knowledge, Sticking to prejudice or assumptions
L (Linking)	*L+*	Linking facts, ideas, and notions
	L-	Offering an interpretation without making inferences
A (Accuracy)	*A+*	The references/ literature used, or information/ data collected to support the participant's position are accurate and true.
	A–	The references/ literature used, or information/ data collected to support the participant's position are false.
J (Justification)	*J+L+*	Provide a logical statement of opinion, agreement, or disagreement with supporting reasons/ examples/ justifications/ proof.
	J+L–	Provide an illogical statement of opinion, agreement, or disagreement with supporting reasons/ examples/ justifications /proof.
	J–	Statement with simple agreement, disagreement, or alternative opinions without elaboration
C (Critical Assessment)	*C+L+*	Critical assessment/ evaluation of one's own previous statements/ reflection or others' contributions toward the issue discussed with a logical thinking process
	C+L–	Critical assessment/ evaluation of one's own previous statements/ reflection or others' contributions toward the issue discussed with an illogical thinking process.
	C–	Uncritical or unreasoned acceptance/ reject
Practical utility (grounding)	P+	Relating possible solutions to familiar situations; discussing the practical utility of new ideas.
	P–	Discussing in a vacuum (treat as if on Mars), suggesting impractical solutions
Width of understanding (complete picture)	W+	Widening discussion (problem within a larger perspective; intervention strategies in a broader framework)
	W–	Narrowing discussion (address bits or fragments of a situation; suggest glib, partial interventions)