PLATFORM - A Journal of Science & Technology

Received: 24 September 2023, Accepted: 21 November 2023, Published: 29 December 2023, Publisher: UTP Press,

MIND MAP AS A TOOL FOR ENFORCING LEARNING DURING FLIPPED CLASS: APPLICATION TO PETROLEUM ENGINEERING

Mysara Eissa Mohyaldinn

Department of Petroleum Engineering, Universiti Teknologi PETRONAS, Malaysia

*Email: mysara.eissa@utp.edu.my

ABSTRACT

Flipped learning has been proven to be an efficient learning strategy that can enforce learning and improve many desirable skills and attributes for learners. To properly implement a flipped class, the educator must use appropriate tools to facilitate learning during the pre-class (i.e., self-study) and in-class (i.e., with the educator) stages. The pre-class stage of a complete flipped class process requires students to self-learn with the minimum educator guidance. However, educators should ensure they create a resourceful learning environment for students to learn properly. This environment should consider directing the students and supporting them with efficient learning tools and scaffolding instruments to minimise their endeavours and make them more learning-focused. Mind maps are examples of tools that students may use to summarise lecturing notes, digest the learning contents easily, discuss the concepts with peers and groups, share the contents with lecturers and class, and finally get constructive feedback from lecturers and peers. In this work, the mind map was used to enforce students' learning during a flipped class of two petroleum engineering core subjects at a Malaysian university. Two batches of students simultaneously taking two core subjects in the January 2022 semester were guided to use mind maps for learning during the pre-class step of implemented flipped classes. Students were directed to reading material and asked to use mind maps during pre-class to summarise and digest the contents before presenting in hybrid (physical-online) classes, during which the lecturer gives instantaneous feedback. After the flipped class, data was collected to assess the impact of the implemented mind map-inclusive flipped class framework on learning performance. Two data sources were used, students' responses to an online survey and student marks of two coursework components related to the intended course learning outcome (Quiz 2 and Test 2). The responses to the survey revealed that using mind maps has substantially improved all four indicators. The student marks in the two coursework components indicated satisfactory learning performance.

Keywords: *cognitive domain, engagement, flipped class, mind maps, soft skills.*

INTRODUCTION

There is a continuous search for effective techniques and strategies for enhancing learning, simplifying the teaching/learning process, improving learner's skills, and ensuring retaining taught knowledge for learners [1]. The flipped class is a strategy that has proven to achieve effective learning outputs by creating an engaging and active learning environment [2]. Previous studies revealed that flipped classes can substantially improve many features related to teaching and learning, such as cognitive capabilities, soft skills, and lifelong learning. An efficient flipped class implementation mainly depends on using effective activities and tools used during pre-class and in-class steps and giving clear instructions and guidance to the students throughout the whole flipped class cycle [3].

The mind map is a technique used to summarise learning materials and present the content more clearly. The mind map was defined as the graphical representation of radiant thinking. Radiant thinking is a technique that helps the brain to develop ideas through radiation from a central point [4].

The technique allows a learner to summarise and present tasks, concepts, or items as separated pieces of text but systematically connected to the main subject matter. The experience was then evaluated by assessing four indicators, i. evaluation of lecturing and mind maps, ii. improvement of cognitive skills, iii. improvement of psychomotor and soft skills, and iv. engagement and lifelong learning. Using mind maps as a tool to improve learning has been proposed and implemented in many education disciplines, including engineering-related fields. Yeong [5] has used mind maps as a "simple but useful tool" to improve the students' learning of Cell Biology. He concluded that the mind map is a good tool for him to "represent the contents" he taught and for students who responded positively about their experience of using the mind map. Wette [6] pointed out that a mind map is a good tool for "revealing students' prior knowledge and schema, as well as any changes that occur through instruction and practice."

This work will discuss using the mind map to facilitate students' learning during a flipped class activity for two Petroleum Engineering core subjects at Universiti Teknologi PETRONAS, Malaysia.

OBJECTIVES

The general objective of this work is to evaluate using mind maps as a technique for enforcing students' learning during flipped class implementation. The specific objectives of the work are to:

1. Propose a flipped class framework that incorporates using mind maps during pre-class learning.

2. Implement the flipped class framework and reflect on students through online group presentations.

3. Evaluate the effect of mind maps on improving four indicators related to students' learning (i.e., lecturer instructions, psychomotor and soft skills, cognitive domain, and engagement and lifelong learning).

The following parts of this paper consist of Section 2, the literature review, where updated and relevant literature related to flipped learning and mind maps is presented. Section 3 discusses the methodology adopted to achieve this work and explains the proposed framework and evaluation procedure. Section 4 presents the evaluation results, including the impact of implementing the proposed framework on different indicators related to learning improvement.

LITERATURE REVIEW

The descriptions of mind maps in teaching and learning, as well as prior and current studies pertaining to the given subject, are investigated through a literature review. A mind map is an overview in which main categories radiate outward from a central image, and minor categories are shown as branches of bigger branches [7]-[8]. The nonlinear learning method of mind mapping is one teaching and learning tool that has lately surfaced in higher education as a way to assist students in critical thinking [9]-[10]. Creating educational materials with the aid of technology was a terrific way to engage students in a proactive learning process [11]-[12]. An explicit mind map's radiant structure encourages associations. Additionally, more potent associations can be made using distinct colours for specific categories [13]-[14]. Because the maps include specific meta-cognitive models with precise structures, it has been found that when students are given control over how they construct them, the maps have a favourable effect on student accomplishment [14]-[15].

Hanewald [16] saw how undergraduate students' lifelong learning abilities were developed through the collaborative production of digital knowledge maps. The author claims that mind maps' flexibility has offered pupils more autonomy while fostering abilities for lifetime learning [16]-[17]. Information retention can also be aided by applying emphasis in a mind map, such as thicker major branches and larger printing [18]-[19]. Focusing on utilising just one or two keywords can promote connections with broader scopes, and keeping the Mind Map to just one sheet of paper makes it possible to see the full picture at once and perhaps inspire more correlations [20]-[21]. This technique is one of the information processing techniques that uses advanced processing to preserve information in memory permanently. Similar to how Thinking Maps push students to write down their thought processes, increasing links between content and experience, they also help students feel more engaged with the material [22].

Recently, Beal and Hontvedt [23] have introduced a video-based mind map where junior students have utilised self-created videos to develop a mind map structure in collaboration with their peers. They concluded that the video-based mind map can substantially enhance the cooperative learning between students inside the class and can create "material and social structures" for in-class collaboration. Although there are many attempts to use the mind map as a tool for enforcing and improving learning, most of the previous work was applied to conventional learning. Therefore, the main contribution of the study is the implementation and evaluation of the mind map as a learning facilitation tool during flipped learning, where students are more self-dependent as compared to conventional learning.

METHODS

The framework of this activity is shown in Figure 1. The flipped class consists of two steps, pre-class and in-class. The pre-class activities by the students are conducted based on clear instructions given during week one after the grouping of the students by the course lecturer. The same activities are assigned to different classes, taking two different courses taught simultaneously by the same lecturer in January semester 2022. The first class is students in semester 5 taking Production Engineering 1 (PEI), while the second class is students in semester 6 taking Production Engineering 2 (PEII). The activity covers one-course learning outcome (CLO) for each course, i.e., CLO1 for PE1 and CLO4 for PE2. Students were asked to review and understand the materials provided before summarising the contents in the form of mind maps and making them ready for sharing with colleagues and the lecturer. The materials provided to students include lecture notes, watch pre-recorded videos and lectures on MS Teams, and scaffolding materials (e.g., references, webpages, … etc.). During the in-class step of the flipped class, the students presented their mind map contents in groups as per the parts assigned to them by the lecturer. The lecturer manages the class to ensure the concepts are shared and discussed properly in an engaging class environment. Meanwhile, he evaluates the presentation and corrects any misconceptions and wrong contents.

Following the flipped class, an assessment survey was sent to students through Google Forms to get their perception of the experience. The survey was prepared to assess four categories, as follows:

1. Evaluation of lecturing and mind maps lecturer instructions on using the mind maps, the contents given to create the mind maps, mind maps benefits and challenges.
2. Improvement of cognitive skills: ability to achieve the goals (i.e., intended CLO), content coverage, and level of understanding
3. Improvement of psychomotor and soft skills: communication skills, presentation skills, and research skills.
4. Engagement and lifelong learning: motivation, engagement, cooperative learning, and lifelong learning.

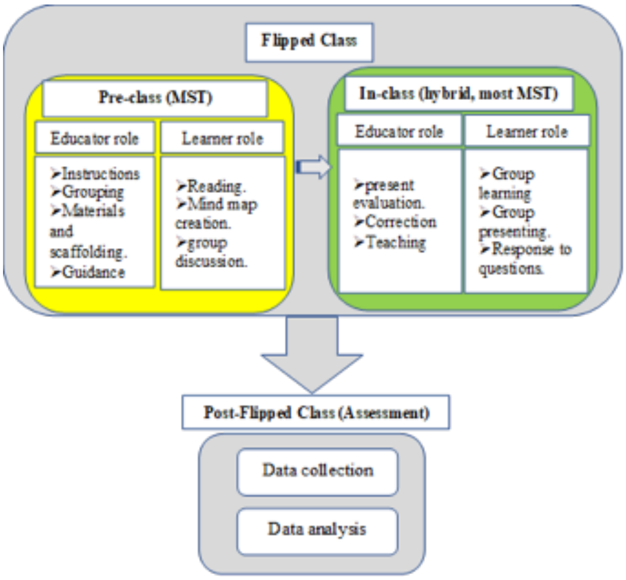


Figure 1 The activity framework

PARTICIPANTS AND DATA COLLECTION

59 students were taking PEI, and 18 students taking PEII. All the students participated in the activity itself but not in the response to the assessment survey. Table 1 shows the respondents of the survey from each batch. However, the results presented in this paper are mainly for the first batch (those taking PE1).

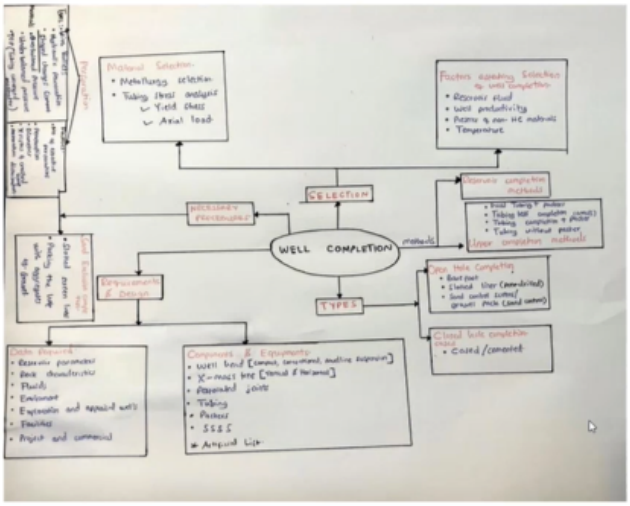
Table 1 Participants in the activity

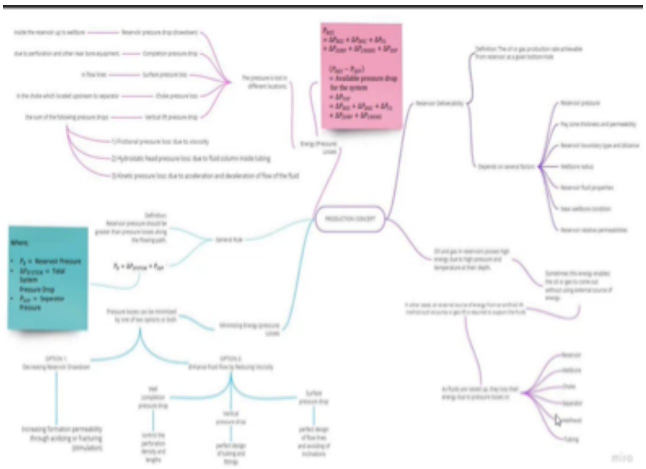
Course	CLO#	#of students	#of respondents
PEI	CLO4	59	25
PEII	CLO1	4	4

There are two main data sources used in this study. The first data source (DS#1) is the student's response to a Google form survey, whereas the second data source (DS#2) is the student marks to two coursework components related to the covered CLO (i.e., Test 2 and Quiz 2). The Google form survey consists of 20 questions, 16 Linkert scale-based and four short text answers.

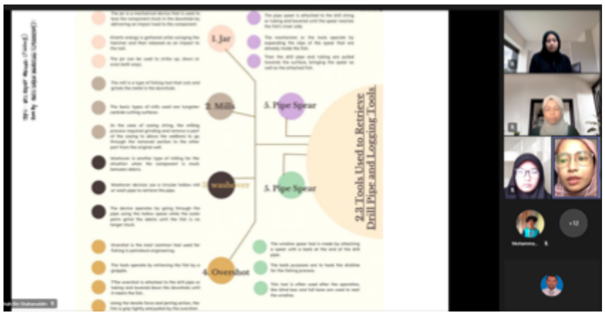
RESULTS AND DISCUSSION

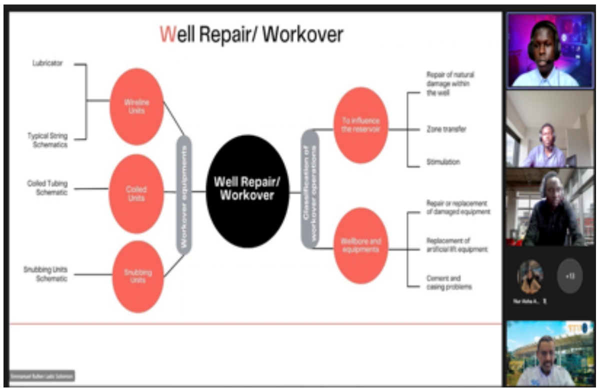
Figure 2 shows examples of mind maps generated by some groups of students. The images on top show examples of hand-written mind maps, while the images at the bottom show the mind maps presented by the students.





(a) Example of mind maps generated by PE1 students.





(b) Example of mind map presentations by PE2 students.

Figure 2 Examples of mind maps and presentations

Evaluation of Lecturing and Mind Maps

Figure 3 shows the student ratings on four questions related to the evaluation of lecturing and mind maps. The original questions (as asked to the students) are shown as legends at the bottom. It can be noted that the ratings of the questions by some students overlapped, as indicated by less than four legends (e.g., student 1 rated all the questions at three). Most student ratings to the first question (i.e., the lecturer's instructions on using mind maps are quite clear) are between three and five, but there are three students rated the question at two. This result indicates that most of the students have a positive perception of the clarity of the instructions given by the lecturer. Almost similar perception is also given to the other three questions (i.e., "using mind maps is quite beneficial," "the contents given for using mind maps are quite enough to achieve the requirements," and "I will recommend mind maps for other students and educators to practice").

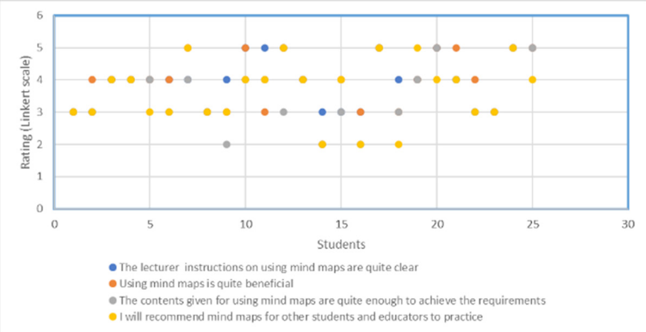


Figure 3 Student ratings of lecturing and mind maps

Students' Perception of Psychomotor and Soft Skills Improvement

The improvement of students' psychomotor and soft skills was also measured by four indicators, as indicated by the legends in Figure 4. The soft skills considered here are communication skills measured by the question "The activity gave me greater opportunities to communicate with other students", research skills (measured by the question "The activity has enhanced my research skills (searching skills, technical writing skills, citations and referencing)"), presentation skills (measured by the question "the activity has enhanced my presentation skills") and psychomotor skills (measure by the question "the activity enabled me to know more supporting tools (computational tools, editing/drawing tools, ..etc.)"). Except for two students, all students responded positively on the psychomotor and soft skills with ratings between three and five.

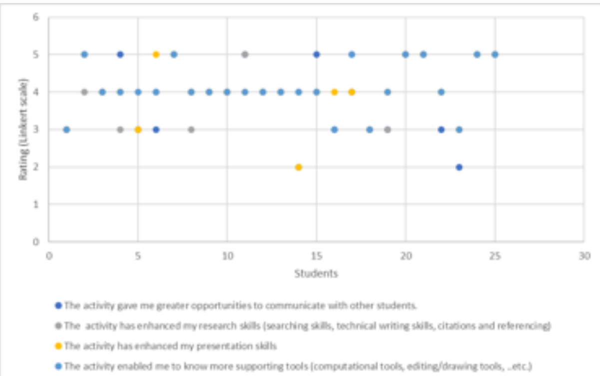


Figure 4 Students' rating on soft skills improvement

Students' Perception of Engagement and Lifelong Learning

Engagement and lifelong learning are measured using four indicators, and the result is shown in Figure 5. The first indicator is motivation, measured by students' responses to the question, "I was more motivated to learn by using mind maps." The second indicator is cooperative learning, measured by students' responses to the question, "The activity has enhanced my cooperative learning skills." The third indicator is lifelong learning, measured by students' responses to the question, "The activity has enhanced my lifelong learning skills (it made me more able to study by myself in future)". The fourth indicator is engagement, measured by students' responses to the question, "Using a mind map made the class more engaging than traditional classroom instruction.". Figure 5 shows that more students (eight students) are not satisfied with the level of active learning and engagement as compared to their perception of lecture instructions, quality of materials, and soft skills presented in Figure 3 and Figure 4. However, most of the students responded positively on all four indicators, with many ratings of four and five. The result may also be affected by the mode of teaching, which was online-dominated, and we believe that a more satisfactory perception will be achieved in physical classes. The results may also be affected by the index of learning style, in particular, the active/reflective category.

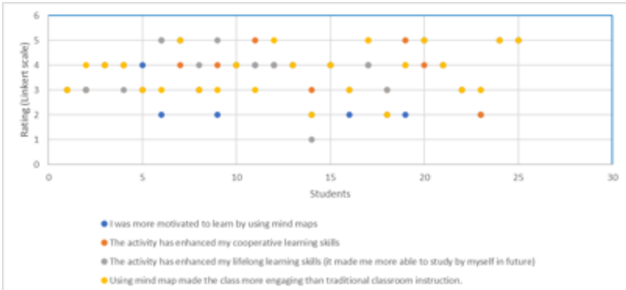


Figure 5 Rating of active learning and engagement

Cognitive Development of Students

The improvement of the cognitive domain for students is measured by three indicators, as shown in Figure 6. The first indicator is the objective or CLO achievement measured by students' response to the question "the requirements by the end of using the mind maps are achievable." The second indicator is the content coverage measured by students' responses to the question, "The activity enabled me to cover more content than traditional class." The third indicator is the level of understanding measured by students' responses to the question, "I understand more concepts through mind map than traditional class." The results indicate that six students were not satisfied with their understanding of using mind maps as compared to traditional teaching as compared to 19 students who responded somewhat positively. Only three students have rated "5," indicating strong satisfaction on the level of understanding. Comparatively, better ratings are given to the other two indicators; for example, seven students have rated "5," indicating strong satisfaction, on the objective achievements, and only two students responded below satisfaction (>3 ratings) on the contents coverage. The variation in students' response to the improvement in their cognitive domain may also be attributed to the variation in their learning styles.

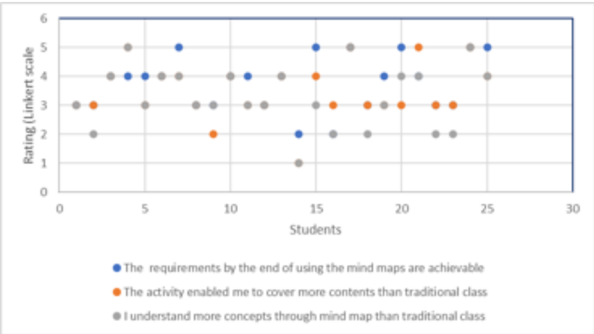


Figure 6 Rating of cognitive improvement

Further assessment of the impact of the activity on the student's cognitive domain is presented in Figure 7. The academic performance of the students on the intended course learning outcome related to the contents covered by the activity (i.e., CLO4) is presented by plotting their marks on two main coursework components related to the CLO (Test 2 and Quiz 2). The result shows that all students have passed the two components, with most of the students attaining between "B" and "A" grades. This result can be regarded as an indirect indicator of the cognition domain improvement for the students.

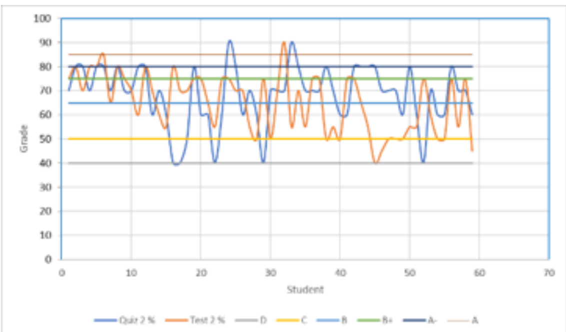


Figure 7 Students' performance on the intended CLO presented by their marks of related coursework components

Overall Impression

In addition to students' rating on a 5-point Linkert scale, the students' comments on their perception of the activity are presented using word clouds shown in Figure 8. The Figure is generated using a free online word cloud tool (https://classic.wordclouds.com/). Figure 8 is the word clouds image for the student's response to the question (What are the advantages of using mind maps?). From Figure 8, we can recognise some keywords that can be interpreted to conclude what advantages of using mind maps by students. For example, words like "easy", "skills", and "good" can be interpreted as positive attributes of mind maps, such as easy to cover and understand, improve students' skills, and is a good method for learning.

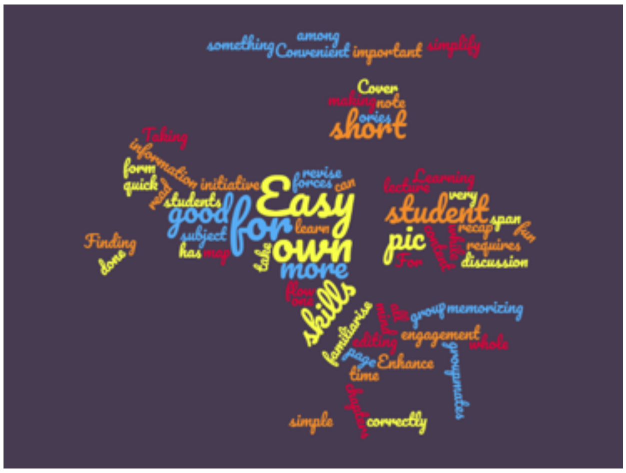


Figure 8 Words cloud based on students' responses about the advantages of mind maps

CONCLUSION

The mind map was used as a tool for enforcing learning of two Petroleum Engineering core subjects as part of an implemented flipped class. It can be concluded that using mind maps has substantially enhanced student's learning as proven by conclusions such as (i) As an evaluation of lecturing and mind maps, most of the students have a positive perception of the clarity of the instructions given by the lecturer, the beneficial of the mind map, and the ability of mind maps to assist in covering the material contents. (ii) Mind maps can significantly improve students' psychomotor and soft skills, as indicated by the positive response of students on the impact of mind maps on improving communication skills, presentation skills, research skills, and psychomotor skills. (iii) Mind maps can improve student's academic performance and cognitive domain. Students believed that they understood better by using mind maps, and the CLO was better attained. Also, the students have attained satisfactory academic performance reflected by all passing coursework with most of them getting above "B" grade. (iv) Mind maps can also improve the students' engagement and lifelong learning. The students responded positively on the class engagement, motivation, cooperative learning, and lifelong learning.

ACKNOWLEDGEMENT

The author would like to thank the Center for Excellence in Teaching and Learning (CETaL) at Universiti Teknologi PETRONAS for providing financial support through the Scholarship of Teaching and Learning (SoTL) fund (Cost Center 015LF0-057).

REFERENCES

[1] M.L. Hasan, M.E. Mohyaldinn, N.A.H. Aziz, and M.A. Mohamed, "Improving Students' Motivation to Learn through Gamification. Proceedings - 2017 7th World Engineering Education Forum, WEEF 2017," *In Conjunction with: 7th Regional Conference on Engineering Education and Research in Higher Education 2017, RCEE and RHEd 2017, 1st International STEAM Education Conference, STEAMEC 2017*. 2018, doi: 10.1109/WEEF.2017.8467059

[2] M.E. Mohyaldinn, A. Kaur, H.S. Alhassan, D. Kansan, M.L. Hasan, A. Yousif, and M.A. Ayoub, "Students' Perception Toward the Involvement in Developing Instructional Videos Using Powtoon Tool," Platform A Journal of Engineering, vol 4, no. 1, pp. 64–72, 2020.

[3] M.E. Mohyaldinn, "Analysis of students' perception on online-based flipped class using repertory grid technique (rgt)," *International symposium on Innovative Engineering 2021 Proceeding*, 2022.

[4] M. Noonan, "Mind maps: Enhancing midwifery education," *Nurse Education Today*, vol. 33, no. 8, pp. 847–852, 2013, doi: 10.1016/j.nedt.2012.02.003.

[5] F.M. Yeong, "Incorporating Mind-maps in Cell Biology Lectures – A Reflection on the Advantages and Potential Drawback," *Procedia - Social and Behavioral Sciences*, vol. 103, pp. 485–491, 2013. doi: 10.1016/j.sbspro.2013.10.364

[6] R. Wette, "Using mind maps to reveal and develop genre knowledge in a graduate writing course," *Journal of Second Language Writing*, nol. 38, no. November, pp. 58–71, 2017. doi: 10.1016/j.jslw.2017.09.005

[7] R.A. Karim, "Technology-assisted mind mapping technique in writing classrooms: An innovative approach," *International Journal of Academic Research in Business and Social Sciences*, vol. 8, no. 4, 2018.

[8] J.W. Budd, " Mind maps as classroom exercises," *The Journal of Economic Education*, vol. 35, no. 1, pp. 35-46, 2004.

[9] Y. Dong, S. Zhu, and W. Li, "Promoting sustainable creativity: an empirical study on the application of mind mapping tools in graphic design education," *Sustainability*, vol. 13, no. 10, p. 5373, 2021.

[10] B. Pudelko, M. Young, P. Vincent-Lamarre, and B. Charlin, "Mapping as a learning strategy in health professions education: a critical analysis," *Medical education*, vol. 46, no. 12, pp. 1215-1225, 2012.

[11] M.A.A Mamun, G. Lawrie, and T. Wright, "Instructional design of scaffolded online learning modules for self-directed and inquiry-based learning environments," *Computers & Education*, vol. 144, p. 103695, 2020.

[12] A. Paniagua, and D. Istance, "Teachers as designers of learning environments," *Educational Research and Innovation*, OECD: Paris, France, 2018.

[13] M.R. Kendall, and R.H. Crawford, "Use of Concept Generation Techniques in Different Cultural Settings," Paper presented at the *2013 ASEE Annual Conference & Exposition*, 2013.

[14] C. Şentürk, and G. Baş, "An overview of learning and teaching from the past to the present: New learning and teaching paradigms in the 21st century, (pp. 1-19), in Şenol Orakcı (ed). *Paradigm Shifts in 21st Century Teaching and Learning, IGI Global*, 2020. pp. 1-19, 2020.

[15] S.R. Wininger, J.L. Redifer, A.D. Norman, and M.K. Ryle, "Prevalence of learning styles in educational psychology and introduction to education textbooks: A content analysis," *Psychology Learning & Teaching*, vol. 18, no. 3, pp. 221-243, 2019.

[16] R. Hanewald, "Cultivating life-long learning skills in undergraduate students through the collaborative creation of digital knowledge maps," *Procedia-Social and Behavioral Sciences*, vol. 69, pp. 847-853, 2012.

[17] J.A. Wang, A. Zhang, and X. Zhao, "Development and application of the multi-dimensional integrated geography curricula from the perspective of regional remote sensing," *Journal of Geography in Higher Education*, vol. 44, no. 3, pp. 350-369, 2020.

[18] T. Bates, *How to Mind Map: 7 Easy Steps to Master Mind Mapping Techniques, Note-taking, Creative Thinking & Brainstorming Skills, Morrisville*, North Carolina: Lulu Press, 2019.

[19] M. Davies, " Concept mapping, mind mapping and argument mapping: what are the differences and do they matter?" *Higher education*, vol. 62, no. 3, pp. 279-301, 2011.

[20] S. Hariyadi, A.D. Corebima, and S. Zubaidah, "Contribution of mind mapping, summarizing, and questioning in the RQA learning model to genetic learning outcomes," *Journal of Turkish Science Education*, vol. 1, no. 1, pp. 80-88, 2018.

[21] J.S. Rhodes, *Mind Maps*. Prescott Valley, AZ: JJ Fast Publishing, LLC, 2021.

[22] R.C. Pianta, B.K. Hamre, and J.P. Allen, "Teacher-student relationships and engagement: Conceptualizing, measuring, and improving the capacity of classroom interactions," *In Handbook of research on student engagement* (pp. 365-386): Springer, 2012.

[23] C. Beal and B. Hontvedt, "Video-based mind maps in higher education: A design-based research study of pre-service teachers' co-construction of shared knowledge," *Learning, Culture and Social Interaction*, vol. 41, p. 100720, 2023.