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Learning Transformation: The Impact of Problem Based Learning with Mind Mapping on Learning Outcomes in Environmental Conservation Lesson

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Abstract: Schools should introduce environmental conservation and change awareness centered on local issues, encouraging students to share their insights and perspectives. For this reason, this study aims to determine the effect of applying the problem-based learning model assisted by mind mapping on student learning outcomes in environmental conservation lesson. This study used a quasi-experimental design with the Pretest-Posttest Non-Equivalent Control Group Design consisting of control and experimental classes. The research population was all class X SMA Negeri 3 Banda Aceh students. Furthermore, purposive sampling produced a sample consisting of four classes with a total of 121 students. The learning outcomes data were obtained from the test instrument using 30 multiple-choice questions. Data analysis was performed using the Mann-Whitney test with a significance level 0.05. The data analysis results show that applying the problem-based learning model assisted by mind mapping has a significant effect on learning outcomes with a significance value of $p < 0.05$ ($0.000 < 0.05$). Thus, applying the problem-based learning model assisted by mind mapping positively affects learning outcomes. The results of this study provide information that problem-based learning assisted by mind mapping can be applied to conservation-based lessons.

Keywords: Environmental conservation; Learning outcomes; Mind-mapping; Problem-based learning.

Introduction

Humans are deeply interconnected with the environment, interacting seamlessly with plants, animals, and microorganisms. Environmental sustainability is crucial, with environmental management being pivotal in the wise use of natural resources (Huda, 2020). In SMA Negeri 3 Banda Aceh, biology education is student-centered with teachers playing a facilitating role. However, observations and interviews reveal that some students remain passive in their learning activities, presenting a significant concern that requires attention.

Learning material for environmental change and conservation is one that students must master because this material is closely related to the conservation of living things, including humans. The massive landscape degradation due to human activities has resulted in reduced and fragmented forest habitats for wildlife. Such habitat fragmentation has led to an increase in the frequency of human-wildlife conflicts, such as elephants (Abdullah et al., 2019). For this reason, a learning model is needed to increase students' understanding of this material, stimulate students to care about environmental conservation, and train students to have skills in solving problems.

Problem-Based Learning (PBL) is a teaching model that equips students with problem-solving skills (Günter & Alpat, 2017). This method not only enhances learning outcomes and critical thinking but also bolsters self-regulation abilities, as evidenced by various studies (Sharma, 2023; Khatiban, 2014; Kong, 2014; Sungur,

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2010). It is versatile, applicable across various topics, and has seen successful implementation in diverse educational settings (Loyens et al., 2015). When paired with mind mapping, PBL becomes even more effective, simplifying conceptual understanding for students. This combined approach notably boosts mastery of theoretical knowledge, fosters independent learning, and hones practical skills (Gao et al., 2022).

Mind mapping is a visual tool that organizes information, aiding students in summarizing extensive lessons and promoting engagement and peer communication, thus reinforcing scientific theories and concepts (Wilson et al., 2016). This technique not only facilitates the identification of student misconceptions, allowing for immediate instructor feedback, but also enhances student responsiveness and motivation as they actively contribute to their learning environment. Constructing a mind map entail placing the primary topic at the center of the page, with radiating lines forming subtopic branches connected to the central idea. These branches can be color-coded, further elaborated with sub-branches, and embellished with pictures and diagrams to deepen understanding (Wilson et al., 2016).

Research on the application of mind mapping has been conducted to increase student motivation, and learning outcomes have been carried out (Jones et al., 2012; Rasmuin & Nafisah, 2019). In addition, mind mapping is also used as an active learning strategy, learning tool, information search and can improve metacognitive skills (Rosciano, 2015; Erdem, 2017; D'Antoni et al., 2010; Astriani et al., 2020). Critical thinking and professional self-concept can also be improved through reflective learning based on visual mind mapping (Yang et al., 2022).

The PBL learning model can enhance student learning outcomes; furthermore, PBL has a greater positive impact on critical thinking, analysis, and evaluation than traditional learning (Sharma et al., 2023). PBL is an effective method of teaching and learning, particularly for long-term retention and implementation (Yew & Goh, 2016). According to Khatiban & Sangestani (2014), the implementation of PBL can increase student competence, foster a more positive attitude towards learning experiences, and enhance student performance. The PBL model combined with flashcards, according to Khairunnisa et al. (2022), affects students' creative thinking because it requires students to solve commonplace problems. PBL classes were more engaging than traditional classes in this investigation

Based on the description above, this study aims to identify the effect of applying the problem-based learning model assisted by mind mapping on student learning outcomes in environmental change and conservation lesson. The results of this study will provide an overview for teachers, students, and environmentalists about the impact of combined learning on problem-based learning and mind mapping on student learning outcomes in lessons related to the environment.

Method

The research method used was experimental with a Quasi-Experimental Design, namely a type of research consisting of a control class and an experimental class. The experimental group was given treatment by applying the problem-based learning model assisted by mind mapping while the control group used conventional methods. Pretest-Posttest Quasi-Experimental Design Non-Equivalent Control Group Design in this study can be seen in Table 1

Table1. Research Design

Class	Pretest	Treatment	Postest
E	O_1	X	O_2
C	O_3		O_4

Description:
E : Experiment
K : Control
O_1 : Pretest score (before the application of problem-based learning assisted by mind mapping)
O_2 : Posttest score (before the application of problem-based learning assisted by mind mapping)
O_3 : Pretest score (before the application of problem based learning)
O_4 : Posttest score (before the application of problem based learning)
X : Treatment

The research took place at SMA Negeri 3 Banda Aceh from February to June 2023 during the Even Semester of the 2022/2023 Academic Year, focusing on class X. The study's population encompassed 361 students from 10 class X sections of SMAN 3 Banda Aceh (Table 2).

Tabel 2. Research population

Class	N	The average students' initial score
X-IPAS-1	37	83
X-IPAS-2	36	83
X-IPAS-3	36	82
X-IPAS-4	35	85
X-IPAS-5	30	87
X-IPAS-6	27	88
X-IPAS-7	32	89
X-IPAS-8	32	88
X-IPAS-9	36	88
X-IPAS-10	36	87
Total number of students	361	

The sample selection technique used purposive sampling by taking classes with the same or nearly identical initial average score. Then a new sample is randomized. The number of students sampled in this study was 121 (Table 3). The sample that has the same or nearly the same average initial ability score consists of six classes, but only four classes can be studied while PPG students are studying the other classes.

Table 3. Research sample

Class		N	The average students' initial score
Kontrol	X-IPAS-5	30	89
	X-IPAS-7	32	87
Eksperimen	X-IPAS-6	27	88
	X-IPAS-8	32	88
Total number of students		121	

The instrument used in this study is the written test instrument. Written tests are carried out to determine students' learning outcomes after participating in the learning process. The test given is an objective test in the form of pretest and posttest questions. Learning outcomes will be measured using posttest questions in the form of objective tests, and the test items consist of 30 multiple-choice questions with five alternative answers.

Data collection was carried out by providing pretest and posttest questions. Types of data collected, and methods of data collection are presented in Table 4.

Table 4. Data collection technique

Data type	Data source	Data collection method	Instrument	Data collection time
Initial score	Students	Objective test	Pretest	Before learning begins
Learning outcome	Students	Objective test	Posttest	After learning ends

Hypothesis testing was carried out using the Mann-Whitney U test analysis. The conclusion of whether Ho is accepted or rejected is obtained by interpreting the significance value from the analysis results through the SPSS version 26. The criteria used in making conclusions are if the Sig number > 0.05, then Ho is accepted, which means there is no effect of differences in treatment on the response variables.

Result and Discussion

The results and discussion are presented in two parts. First, the results of comparing pretest and posttest scores from the control and experimental classes (Figure 1). Second, the comparison of the scores of inferential statistical test results. Both activities aim to present a complete view of the impact of implementing problem-based learning assisted by mind mapping on environmental conservation lessons.

Figure 1 shows the average pretest scores of students in the control class, 49.92 and 50.03 in the experimental class. Those results mean that students in the control and experimental classes have the same initial score. The average posttest score in the experimental class was 63.42, higher than the posttest average score in the control class, which was 55.74.

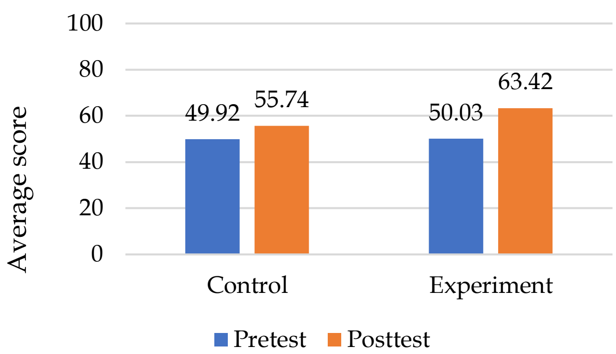

Figure 1. The comparison of pretest and posttest scores from both classes

Figure 1 does not show a significant difference in the pretest and posttest scores of the control and experimental classes. For this reason, it is necessary to conduct further analysis using statistical tests, starting with the normality test (Table 5) and the homogeneity test (Table 6).

Table 5. Results of the normality test of learning outcomes

Class		Mean	df	Normality test*
Control	Pretest	49.92	62	0.000
	Posttest	55.74	62	0.000
Experiment	Pretest	50.03	59	0.001
	Posttest	63.42	59	0.079

*Kolmogorov-Smirnov, sig > 0,05 then the distribution is normal

Table 5 show that the learning outcomes data are not normally distributed in the control class, while in the posttest experimental class, the distribution is normal, and the pretest is not normally distributed. Therefore, non-parametric data analysis was carried out with the Mann-Whitney test to test the learning outcomes hypothesis. The results of the Man-Whitney Test for the pretest are shown in Table 7, and for the posttest in Table 8.

Tabel 6. Homogeneity test results of learning outcomes

Aspect	Levene Statistic	df1	df2	Sig.
Learning outcome	1.54	3	238	0.20

*Levene, sig > 0,05 then the data is homogeneous

The Levene test results in Table 6 show a sig value of 0.204 > 0.05 which means the average score of homogeneous learning outcomes. Even though this data is homogeneous, the normality test results show that there are data that are not normally distributed, so further analysis is continued with non-parametric tests.

Table 7. Mann-Whitney U Test results for pretest scores

Class	N	Mean	Mann-Whitney Test
Control	62	61.74	Asymp Sig 0.81
Experiment	59	60.22	

*Sig < 0.05 maka berbeda nyata

The results of the Mann-Whitney test in Table 7 for the average pretest score showed a significant value of 0.810 > 0.05, which means that the average pretest score in the control and experimental classes was not significantly different. This result proves that the initial scores of students in control and experimental classes are the same.

Students in the control and experimental classes have the same initial abilities. This reason is proven by the results of the pretest data analysis, which showed that the results were not significantly different between the control and experimental classes. Then the problem-based learning (PBL) model was applied to the control class, and mind-mapping-based PBL to the experimental class. Furthermore, at the end of the lesson, a post-test was carried out to determine the effect of applying mind mapping-based PBL on their learning outcomes

Table 8. Mann-Whitney U Test results for posttest scores

Class	N	Mean	Mann-Whitney Test
Control	62	47.85	Asymp Sig 0.00
Experiment	59	74.81	

Sig < 0.05 maka berbeda nyata

Table 8 shows a significant value of 0.000 <0.05, meaning that the posttest scores in the control and experimental classes are significantly different. This result proves that applying the mind mapping-based PBL model to affect change and conservation of the environment lesson influences student learning outcomes so that the hypothesis is accepted (Ho is rejected).

The results of the post-test data analysis showed a significant value of 0.000 > 0.05, which means that the average post-test scores in the control and experimental classes were significantly different. This result proves that applying the problem-based learning model assisted by mind mapping affects student learning outcomes. The average post-test score in the class that applied the problem-based model learning assisted by mind mapping was significantly higher than in the control class. This result is because mind mapping is an effective method for remembering and helps significantly in storing information for a long time, according to the results of research by Kalyanasundaram et al. (2017).

Applying the problem-based learning model assisted by mind mapping has an impact on improving student performance. This result can be seen from the involvement of students in groups. Students actively discuss to find solutions to problem-solving. In addition, students also actively seek information from various sources, both books and the Internet. The discussion results are outlined in the form of a mind map. This condition follows the research results from Adodo (2013), which show that mind mapping can improve student performance. In addition, mind mapping is also effective in teaching and learning (Liu, 2014).

The research findings of Wang (2021) indicate that the use of PBL teaching approaches and the practical implementation of PBL improves the professional knowledge, learning engagement, reflective ability, and teamwork of pre-service teachers. In addition, PBL is more effective than traditional methods at enhancing social and communication skills, problem-solving abilities, and independent learning, and it does not produce worse academic outcomes (Trullas et al., 2022). The implementation of a problem-based learning model in conjunction with animation media can enhance students' science process abilities (Salfina et al., 2021). In addition, implementing PBL can increase student motivation to learn (Fatimahwati et al., 2021).

According to Eppler (2006) and Davies (2011), the implementation of mind mapping has advantages such as being easy to understand and use, encouraging creativity and self-expression, providing a concise hierarchical overview, being easy to expand and add additional content, having a free form and an unrestricted structure, having no limits on ideas and links, not maintaining an ideal structure or format, and being able to encourage and develop creative thinking and brainstorming. The research findings of Ristiliana (2022) indicate that mind mapping can increase student learning activities. Furthermore, Yang's (2022) research demonstrates that the combination of mind mapping and PBL instruction can assist students with integrated concept mapping and the development of a more comprehensive knowledge structure.

Applying the problem-based learning model assisted by mind mapping can also increase students' creativity. This result is because students are free to be creative in making mind maps with various shapes and colours, which can be seen in Figure 2. Apart from that, making mind maps can also increase students' learning motivation so that they affect learning outcomes. The research results of Areisty et al. (2020) show that PBL with mind mapping is effective in increasing students' learning motivation.

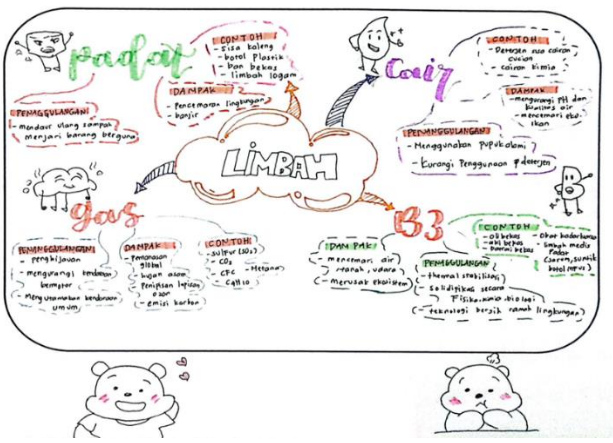

Figure 2. An example of Mind mapping created by students

According to Husna et al. (2013), the PBL learning model is significantly better at increasing environmental care attitudes. Therefore, this learning model is suitable for applying to environmental change and conservation lessons because it can foster students' awareness of preserving the environment. Applying the PBL model can improve student performance (Dolder et al., 2012). The research results of Günter and Alpat (2017) show a significant difference in the learning achievement of students who apply the PBL model compared to classes that do not apply the PBL model. In addition, students also understand concepts better in classes that apply the PBL model.

Conclusion

Based on the research and discussion results, applying the problem-based learning model assisted by mind mapping positively affects the learning outcomes of class X science students at SMA Negeri 3 Banda Aceh. Based on the results and discussion, the problem-based learning model assisted by mind mapping can be applied to material change and environmental preservation. The results of this article also inform teachers and schools that it is essential to provide freedom of learning for students so that they can explore their ideas optimally.

Author Contributions

Conceptualization, Yusniza, Cut Nurmaliah, and Abdullah; methodology, Yusniza; software, Yusniza; validation, Cut Nurmaliah, Abdullah, M. Ali S, and Safrida; formal analysis, Yusniza, Cut Nurmaliah, Abdullah; investigation, Yusniza; resources, Yusniza; data curation, Yusniza, Cut Nurmaliah, and Abdullah; writing—original draft preparation, Yusniza; writing—review and editing, Yusniza, Cut Nurmaliah, and Abdullah; visualization, Yusniza; supervision, M. Ali S and Safrida; project administration, Yusniza; funding acquisition, Yusniza. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Abdullah, A., Sayuti, A., Hasanuddin, H., Affan, M., & Wilson, G. (2019). People's perceptions of elephant conservation and the human-elephant conflict in Aceh Jaya, Sumatra, Indonesia. *European Journal of Wildlife Research*, *65*(5). https://doi.org/10.1007/s10344-019-1307-1

Adodo, S. O. (2013). Effect of Mind-Mapping as a Self-Regulated Learning Strategy on students' achievement in basic science and Technology. *Mediterranean Journal of Social Sciences*. https://doi.org/10.5901/mjss.2013.v4n6p163

Areeisty, K., Hasanuddin, & Sarong, M. A. (2020). The implementation of problem-based learning with mind mapping to improve students' learning motivation. *Journal of Physics*, *1460*, 012061. https://doi.org/10.1088/1742-6596/1460/1/012061

Astriani, D., Susilo, H., Suwono, H., Lukiati, B., & Purnomo, A. (2020). Mind mapping in Learning Models: a tool to improve student metacognitive skills. *International Journal of Emerging Technologies in Learning (Ijet)*, *15*(06), 4. https://doi.org/10.3991/ijet.v15i06.12657

D'Antoni, A. V., Zipp, G. P., Olson, V. G., & Cahill, T. (2010). Does the mind map learning strategy facilitate information retrieval and critical thinking in medical students? *BMC Medical Education*, *10*(1). https://doi.org/10.1186/1472-6920-10-61

Davies, M. (2011). Concept mapping, mind mapping and argument mapping: What are the differences and do they matter? *Higher Education*, *62*(3), 279–301. https://doi.org/10.1007/s10734-010-9387-6

Dolder, C. R., Olin, J. L., & Alston, G. L. (2012). Prospective measurement of a Problem-Based Learning Course sequence. *The American Journal of Pharmaceutical Education*, *76*(9), 179. https://doi.org/10.5688/ajpe769179

Eppler, M. J. (2006). Information Visualization A comparison between concept maps, mind maps, conceptual diagrams, and visual knowledge construction and sharing. *Information Visualization*, 5, (202 – 210). https://doi.org/10.1057/palgrave.ivs.9500131

Erdem, A. (2017). Mind Maps as a lifelong learning tool. *Universal Journal of Educational Research*, *5*(12A), 1–7. https://doi.org/10.13189/ujer.2017.051301

Fatimahwati, F., Yusrizal, Y., Fitri, Z., Rahmatan, H., & Khaldun, I. (2021). Application of Problem Based Learning Model with SETS Vision to Increase Students' Learning Motivation on Environmental Pollution Material. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 310–316. https://doi.org/10.29303/jppipa.v7i3.715

Gao, X., Wang, L., Deng, J., Wan, C., & Mu, D. (2022). The effect of the problem-based learning teaching model combined with mind mapping on nursing teaching: A meta-analysis. *Nurse Education Today*, *111*, 105306. https://doi.org/10.1016/j.nedt.2022.105306

Günter, T., & Alpat, S. K. (2017). The effects of problem-based learning (PBL) on the academic achievement of students studying 'Electrochemistry.' *Chemistry Education. Research and Practice*, *18*(1), 78–98. https://doi.org/10.1039/c6rp00176a

Huda, K. (2020). *Modul pembelajaran SMA biologi kelas X: perubahan lingkungan.* [Teaching Resource]. https://repositori.kemdikbud.go.id/22020/

Husna, S., Abdullah, A., & Nurmaliah, C. (2013). Penerapan model problem-based learning pada konsep perusakan dan pencemaran lingkungan untuk meningkatkan sikap peduli lingkungan siswa SMA Negeri 1 Sabang. *Jurnal Edubio Tropika*, *1*(2), 97–100. https://jurnal.usk.ac.id/JET/article/view/5231

Jones, B. D., Ruff, C., Snyder, J. D., Petrich, B., & Koonce, C. (2012). The effects of mind mapping activities on students' motivation. *International Journal for the Scholarship of Teaching and Learning*, *6*(1). https://doi.org/10.20429/ijsotl.2012.060105

Kalyanasundaram, M., Sb, A., Ramachandran, D., Jayaseelan, Bazroy, J., Singh, Z., & Purty, A. (2017). Effectiveness of mind mapping technique in information retrieval among medical college students in Puducherry-A pilot study. *Indian Journal of Community Medicine*, *42*(1), 19. https://doi.org/10.4103/0970-0218.199793

Khairunnisa, Abdullah, Kharil, Hasanuddin, & Rahmatan, H. (2022). The Influence of Problem Based Learning Models combined with Flashcard Media on Creative Thinking Skills of Students. *Jurnal Penelitian Pendidikan IPA*, *8*(1), 247–251. https://doi.org/10.29303/jppipa.v8i1.1154

Khatiban, M., & Sangestani, G. (2014). The effects of using problem-based learning in the clinical nursing education on the students' outcomes in Iran: A quasi-experimental study. *Nurse Education* *in Practice*, *14*(6), 698–703. https://doi.org/10.1016/j.nepr.2014.10.002

Liu, Y., Zhao,G., Ma, G., & Bo, Y.(2014). The effect of mind mapping on teaching and learning : A meta-analysis. *Standard Journal of Education and Essay*, *2*(2014), 17–31.

Loyens, S. M. M., Jones, S. H., Mikkers, J., & Van Gog, T. (2015). Problem-based learning as a facilitator of conceptual change. *Learning and Instruction*, *38*, 34–42. https://doi.org/10.1016/j.learninstruc.2015.03.002

Rasmuin, R., & Nafisah, D. (2019). The implementation of mind mapping in Tarkib learning to improve student learning outcomes. *Al-Ishlah*, *11*(2), 159. https://doi.org/10.35445/alishlah.v11i2.151

Ristiliana, R., Nurasmawi, N., Hartanto, D., Akhyar, A., & Yuliana, I. (2022). The Effect of Using Mind Mapping Strategy towards Students' Learning Activities. *AL-ISHLAH: Jurnal Pendidikan*,*14*(3), 3807–3812. https://doi.org/10.35445/alishlah.v14i3.1671

Rosciano, A. (2015). The effectiveness of mind mapping as an active learning strategy among associate degree nursing students. *Teaching and Learning in Nursing*, *10*(2), 93–99. https://doi.org/10.1016/j.teln.2015.01.003

Salfina, S., Nurmaliah, C., Pada, A. U. T., Hasanuddin, H., & Abdullah, A. (2021). Penerapan Model Pembelajaran Problem Based Learning dipadu Media Animasi untuk Meningkatkan Keterampilan Proses Sains, Motivasi dan Hasil Belajar Biologi di SMAN Aceh Utara. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 266–271. https://doi.org/10.29303/jppipa.v7ispecialissue.1072

Sharma, S., Daryanti, I., Elysabeth, D., Arna, T., Tarihoran, U., & Chou, F. (2023). Nurse Education Today Outcomes of problem-based learning in nurse education : A systematic review and meta-analysis. *Nurse Education Today*, *120* (October 2022), 105631. https://doi.org/10.1016/j.nedt.2022.105631

Trullàs, J. C., Blay, C., Sarri, E., & Pujol, R. (2022). Effectiveness of problem-based learning methodology in undergraduate medical education: a scoping review. *BMC Medical Education*, *22*(1), 1–12. https://doi.org/10.1186/s12909-022-03154-8

Tseng, H. C., Chou, F. H., Wang, H. H., Ko, H. K., Jian, S. Y., & Weng, W. C. (2011). The effectiveness of problem-based learning and concept mapping among Taiwanese registered nursing students. *Nurse Education Today*, *31*(8), e41–e46. https://doi.org/10.1016/j.nedt.2010.11.020

Wang, C. C. (2021). The process of implementing problem-based learning in a teacher education programme: an exploratory case study. *Cogent Education*, *8*(1). https://doi.org/10.1080/2331186X.2021.1996870

Wilson, K., Copeland-Solas, E., & Guthrie-Dixon, N. (2016). A Preliminary study on the use of Mind Mapping as a Visual-Learning Strategy, in General Education Science classes for Arabic speakers in the United Arab Emirates. *Journal of the Scholarship of Teaching and Learning*, *16*(1), 31–52. https://doi.org/10.14434/josotl.v16i1.19181

Yan, Y., Yuehong, W., Kun, L., Hongbo, Z., Hongyu, Z., Yingming, Y., & Zhili, Z. (2023). Implementation of mind mapping with problem-based learning in prosthodontics course for Chinese dental students. *BMC Medical Education*, *23*(1), 1–8. https://doi.org/10.1186/s12909-023-04479-8

Yang, K., Chen, H., Liu, C., Zhang, F., & Jiang, X. (2022). Effects of reflective learning based on visual mind mapping in the fundamentals of nursing course: A quasi-experimental study. *Nurse Education Today*, *119*, 105566. https://doi.org/10.1016/j.nedt.2022.105566

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning : An overview of its process and impact on learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004