The implementation of problem-based learning with mind mapping to improve students’ learning motivation

K Areeisty, Hasanuddin and M A Sarong
Department of Biology Education, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
E-mail: areeistyk@yahoo.com

Abstract. Students’ learning motivation is as low as indicated by the poor learning outcomes for the topic of environment pollution system. The current teaching and learning process of environmental pollution is lack of the use of innovative learning models. Their learners are merely listening and take notes and thus they are not interested in learning. This research was conducted to determine the impacts of the implementation of problem-based learning models with Mind mapping on the students’ motivation for the environmental pollution topic in Year 10 of two senior high school Banda Aceh, Indonesia. This research employed a quantitative approach, evaluation research. The method was quasi-experiment, with pretest-posttest factorial group design. The sample of this study were 253 students from SMAN 5 and SMAN 7 Banda Aceh, Indonesia. The instrument was a questionnaire to measure students’ motivation. Data analysis involved a non-parametric test, the Mann Whitney test, at a significant level of 0.05. The findings of this study indicated that the influence of the implementation of problem-based learning models with Mind mapping on the motivation-outcomes of the Year 10 students for the environmental pollution topic.

1. Introduction
Students require various skills in 21st-century life to prepare themselves to become successful individuals in the future. The 21st-century skills are relevant to the four pillars of life established by the United Nations, including learning to know, learning to do, learning to be and learning to live together. Each of the four principles consists of specialized skills that need to be promoted in learning activities, one of which is critical thinking skills.

The 21st-century skills can be achieved by updating the quality of learning and fostering students in developing their self-potential emphasizing the project-based learning/problems, encouraging collaboration, increasing engagement, motivating, and promoting student-centered learning. The observations on Biology Teachers and Year 10 students at two Senior High Schools in Banda Aceh showed that students were lack of learning motivation and critical thinking skills, as indicated by poor learning outcomes in the environmental pollution topic. The majority of students did not achieve the minimum criteria of mastery learning for the last three years. The minimum criteria of mastery learning at SMAN 5 and SMAN 7 Banda Aceh was 75. In addition, the teaching and learning process concerning the environmental pollution topic lacked the use of innovative learning models. The students merely listened and wrote, causing them to be bored in the learning. The students also had no experience of learning using problem-based learning with mind mapping to enhance their motivation.
Besides, the teaching and learning process on environmental pollution topic is the lack of use of innovative learning models. Students learn by listening and taking notes only, so they feel bored in learning. Therefore, an approach that can stimulate students’ critical thinking skills in biology learning is needed. Moreover, students also have never learned using problem-based learning models with mind map to increase their motivation and critical thinking skills. Thus, it will provide a better impact on students’ learning outcomes.

Problem-based learning (PBL) model is student-centred learning, indicated by interactive collaboration between students and the information is sourced independently [1]. Students work collaboratively with their peers to analyze complex problems [2]. Students also work independently to gather information and bring it to the group as they continue to solve their collective problems and further reflect on the problems. The role of teachers changes from delivering information to facilitating collaborative thinking, reflection, and inquiry, while the content is left for students to decide [3].

Mindmap is an application providing meaningful information to be understood easily. Mindmap technique prepares the mind in such a way that information can be used logically and imaginatively to create images in the brain. In mind map techniques, the main idea is determined, followed by the explanation of the linear view [4]. The mindmap is the easiest way to develop information in the human mind and retrieve information from outside the brain. It is a creative and effective way to map ideas [5]. Mindmaps can serve as a tool to facilitate students to plan ideas in the pre-writing process. Examples can be provided for students to prepare hierarchy steps in a that will help them maintain ideas. Mindmaps are best to apply at the pre-writing stage to explore ideas and generate thinking on the writing topics [6].

Mindmaps assist students in learning the information by making them organize it and add pictures and colours. Mindmaps reduce the extrinsic cognitive burden because students create a two-dimensional space to connect related ideas and concepts. Mindmaps enable students to create visual images to enhance their learning and can be used as a metacognitive tool that allows them to meaningfully connect. Mindmap is defined as visual representation, non-linear representation of their ideas and relationships [7].

Motivation explains what makes people do an action, keep them doing it, and help them complete tasks. The concept of motivation is used to describe the desire to behave, the direction of behaviour (choice), the intensity of behaviour (effort, ongoing), and the actual completion or achievement [8].

Based on the above explanation, students’ motivation in the environmental pollution system topic needs to be improved. One of the solutions is implementing a problem-based learning model with mindmap. The problem-based learning model with mindmap benefit the students to develop their skills to identify problems. Students are required to collaborate in solving problems related to daily life. Students realize that learning is necessary to address and understand crucial problems [9]. Mindmapping can facilitate students’ learning and promote the mind’s natural ability to think [10]. The use of mind mapping is to assist in the information retrieval and critical thinking [11].

Previous studies concerning the use of the PBL model have been conducted [12]. PBL model is one of the learning models that can improve student achievement and critical thinking skills. This activity in PBL shows the initial problem correctly so that students can understand what they have to do. PBL also creates an effective teaching and learning approach [13].

The previously mentioned circumstances show the need to improve students’ motivation. One of the solutions is to employ the problem-based learning model with Mindmapping. Mindmapping can assist students by facilitating the learning process and promoting the natural ability to think [13]. The problem-based learning model is one of the learning models that can improve student achievement and critical thinking skills. Based on the problems mentioned earlier, it is necessary to implement the problem-based learning model with Mindmapping to enhance Year 10 motivation both schools involved in this study. Based on these problems, the researchers conducted this study entitled “The Implementation of Problem-based learning with mind mapping for Student’s Motivation for Environmental Pollution at Senior High Schools in Banda Aceh.”
2. Research Aim and Question

2.1. The subject of the study
The subjects in this study were year 10 students from SMAN 5 (113 students) and SMAN 7 (140 students) in Banda Aceh, Indonesia

2.2. The instrument, data collection, and data analysis
The instrument was non-test, and data collection involved a questionnaire in determining the students’ learning motivation of the environmental pollution topic. The closed questionnaire consisted of 25 statements using Likert-scale with the responses including A = Agree (4), DA = Disagree a little (3), D = Disagree (2) and SD = Strongly Disagree (1). There were four indicators of the questionnaire items, including attention, relevance, confidence, and satisfaction [7]. The questionnaire score was obtained by calculating the students’ response to each item in the questionnaire. The data was then analyzed using a paired sample t-test.

3. Results and Discussion
In this section, we present results and discuss them as follows. First, we describe teachers’ internet accessibility at homes and schools. Second, we discuss about teachers’ acceptance to the online professional development course according to their internet accessibility.

The analysis results of students’ learner motivation in the experimental class implementing problem-based learning with Mindmapping and the control class are presented in Figure 1 below.

![Figure 1](image_url)

**Figure 1.** The mean score of pretest and posttest of students’ learning motivation in SMAN 5 Banda Aceh

Figure 1 indicates that students’ learning motivation in the experimental class employing problem-based learning with Mindmapping is higher than the problem-based learning class, the Mindmapping class, and the control class. Besides, the learning motivation of the students in the problem-based learning class is better than the Mindmapping class; the Mindmapping class is better than the control class. The analysis of students’ learning motivation in the experimental class employing problem-based learning with Mindmapping and the control class in SMAN 7 Banda Aceh are presented in Figure 2.
Figure 2. The mean score of pretest and posttest of students’ learning motivation in SMAN 7 Banda Aceh

Figure 2 shows that students’ learning motivation is better in the classroom employing problem-based learning with Mindmapping, compared to the problem-based learning class, the Mindmapping class, and the control class. The students’ learning motivation in the problem-based learning class is better than the Mindmapping class. Students in the Mindmapping class also have a higher motivation than the control class. The comparison is based on the average value of each class.

The normality test was undertaken using the Kolmogorov Smirnov test to determine whether the data were normally distributed or not. The significance level used was $\alpha = 0.05$. If the significance is greater than $\alpha$, the data is normally distributed. Inversely, if it is less than $\alpha$, the data is not normally distributed. If the data is normally distributed, the homogeneity and ANCOVA test will be conducted. However, if it is not normally distributed, the data will be analysed using a non-parametric test, the Mann Whitney test. The data in this study were not abnormally distributed, as indicated by the mean difference test. The data analysis results of the students at SMAN 5 Banda Aceh are presented in Table 1.

Table 1. The pretest and posttest mean difference tests of learning motivation at SMAN 5 Banda Aceh

| Learning Motivation | Class            | Normality | Homogenity | Hypothesis testing |
|---------------------|------------------|-----------|------------|--------------------|
| Pretest             | PBL+Mindmapping  | $p (0.021 < \alpha (0.05)$ (normal) | $p (0.13 > \alpha (0.05)$ (homogen) | $p (0.20 > \alpha (0.05)$ (not significant) |
|                     | PBL              | $p (0.20 > \alpha (0.05)$ (normal) | $p (0.00 > \alpha (0.05)$ (not normal) |                                                |
|                     | Mindmapping      | $p (0.00 > \alpha (0.05)$ (not normal) |                                                |                                                |
|                     | Control          | $p (0.04 > \alpha (0.05)$ (not normal) |                                                |                                                |
| Posttest            | PBL+Mindmapping  | $p (0.20 > \alpha (0.05)$ (normal) | $p (0.42 > \alpha (0.05)$ (homogen) | $p (0.00 < \alpha (0.05)$ (significant) |
|                     | PBL              | $p (0.02 < \alpha (0.05)$ (normal) |                                                |                                                |
|                     | Mindmapping      | $p (0.07 > \alpha (0.05)$ (normal) |                                                |                                                |
|                     | Control          | $p (0.03 < \alpha (0.05)$ (normal) |                                                |                                                |
The ANCOVA test results of the pretest presented in Table 1 shows that students had the same initial motivation. The posttest results of the learning motivation indicate that the p-value < α (0.00 <0.05). The analysis results of the students at SMAN 7 Banda Aceh are presented in Table 2.

### Table 2. The pretest and posttest mean difference tests of learning motivation at SMAN 7 Banda Aceh

| Learning motivation | Class          | Normality          | Homogenity          | Hypothesis testing          |
|---------------------|----------------|--------------------|---------------------|-----------------------------|
| Pretest             | PBL+Mindmapping| p (0.11 < α (0.05) | p (0.20 > α (0.05)  | p (0.30 > α (0.05) (Not significant) |
|                     | PBL            | p (0.20 > α (0.05) | (not normal)        |                             |
|                     | Mindmapping    | p (0.02 < α (0.05) | p (0.45 > α (0.05)  |                             |
|                     | (normal)       | p (0.00 > α (0.05) | (normal)            |                             |
|                     | (not normal)   | (normal)           | (normal)            |                             |
| Posttest            | PBL+Mindmapping| p (0.20 < α (0.05) | p (0.00 < α (0.05)  |                             |
|                     | PBL            | p (0.20 > α (0.05) | (normal)            |                             |
|                     | Mindmapping    | p (0.06 > α (0.05) | (normal)            |                             |
|                     | Control        | p (0.11 > α (0.05) | (normal)            |                             |

Table 2 displays that the results of the ANCOVA test of the pretest it shows that the initial motivation of the students was equal. The posttest results of the learning motivation indicate that the p-value is greater than α (0.00 <0.05). Thus, the research hypothesis is accepted, there is an influence of the implementation of problem-based learning model with Mindmapping on the students’ learning motivation of the environmental pollution topic in Year 10 of SMA Negeri 7 Banda Aceh.

The learning implementing the Problem Based Learning (PBL) model with Mindmapping enables the students to face real-world problems in the form of natural phenomena, and questions related to environmental pollution. The problem can be based on real-life involving facts and the natural environment (natural laboratories) so that students are motivated to learn. High learning motivation will then influence students’ learning outcomes. The PBL learning model allows students to associate the concepts learned with everyday life, and thus, it benefits the students and the educators only guide the students. The finding of this study is line with a study conducted by [14] reporting that there is the influence of the PBL model on student motivation and learning outcomes.

The results of hypothesis testing showed that there is a significant influence of motivation on critical thinking skills. Motivation significantly influences learning outcomes [15], including critical thinking skills. The lack of motivation will disrupt the effectiveness of learning.

The learning implementing the Problem-Based Learning (PBL) model with Mindmap enables students to face real-world problems related to natural phenomena, and questions concerning environmental pollution [14]. The problems can be taken from real life that involves facts and the natural environment (natural laboratory) so that students are motivated to learn. The high motivation will have an impact on students’ learning outcomes. PBL learning model enables students to relate the concepts to everyday life. There is an influence of the PBL model on students’ motivation and learning outcomes [16].

Motivation is the urge to act or the desire to do and fight for something. Motivation is the energy in each individual, indicated by the emergence of one’s feelings and affections, that will be stimulated by goals [17]. Students with high motivation will strive for optimal learning; thus, they can improve their
critical thinking skills. Motivation and critical thinking skills influence each other in its implementation [8].

4. Conclusions
The results of this study show that problem-based learning with Mindmapping is effective in enhancing students’ learning motivation for the environmental pollution topic. The evidence of the result is shown by the increasing of the average score and the significance of the t-tests.

5. References
[1] Neville A J 2008 Problem-based learning and medical education forty years on: A review of its effects on knowledge and clinical performance. Med. Princ. Pract. 18 1–9
[2] Hmelo-Silver C 2004 Knowledge recycling: Crisscrossing the landscape of educational psychology in a problem-based learning course for pre-service teachers Journal on Excellence in College Teaching 11 41–56
[3] Simone C D 2014 Problem-Based learning in teacher education: Trajectories of change. International Journal of Humanities and Social Science 4
[4] Parikh N D 2016 Effectiveness of teaching through mind mapping technique. The international Journal of Indian Psychology 3
[5] Buzan T 2002 How to Mind Map? (London: Thorsons)
[6] Bukhari S S F 2016 Mind mapping techniques to enhance EFL writing skill International Journal of Linguistics and Communication 4
[7] Keller J M 2012 Motivational design for learning and performance: The ARCS model approach (New York: Springer)
[8] Pintrich P R 2013 Motivation and Classroom Learning (New Jersey: John Wiley & Sons)
[9] Barrows H 200 Is it truly possible to have such a thing as dPBL? Distance Educ. 23 119–122
[10] Buzan T and Buzan B 1996 Radiant thinking. The mindmap book: How to use radiant thinking to maximize your brain’s untapped potential (New York: Penguin)
[11] D’Antoni A V, Pinto Zipp P G and Olsen V G 2010 Does the mind map learning strategy facilitate information retrieval and critical thinking medical students? BioMed Central Medical Education 10 61–71
[12] Mundilart and Helmiyanto I 2017 Effect of problem-based learning on improvement physics achievement and critical thinking of senior high school student Journal of Baltic Science Education 16
[13] Alrahlah 2016 How effective the problem-based learning (PBL) in dental education: A critical review The Saudi Dental Journal 28 155–161
[14] Allen D E, Donham R S and Bernhardt S A 2011 Problem-based learning. In: New Directions for Teaching and Learning 128 pp 21–29
[15] Trianto 2011 Mendesaian Model-Model Pembelajaran Inovatif/Progresif (Jakarta: Predana Media Group)
[16] Ramlawati R and Yunus S R 2017 Pengaruh model PBL (Problem Based Learning) terhadap motivasi dan hasil belajar IPA peserta didik Sainsmat 6 1-14
[17] Usman S, Punaji S, Utami W and Gazali L 2015 Pengaruh metode group work berbantuan media video dan motivasi berprestasi terhadap hasil belajar menulis paragraf deskriptif dalam Bahasa Inggris Jurnal Pendidikan Humaniora 3 22-30