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Wimba learning strategy with PjBL model: How the effect student in excretory system concept?

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ABSTRACT

This research aims to determine the effect of wimba learning strategies with PjBL (project-based learning) models toward student learning outcomes on the excretory system material. This research was conducted in September 2018 until September 2019. The research method used a true experiment with a population of all class XI in one of the State High School of Tasikmalaya City Indonesia, with eight classes with 288 students. The samples used were two classes taken by random cluster sampling, namely XI mathematics and science 1 (XIMS-1) class with 36 students (M=18, F=18) as a controller class and XI mathematics and science 4 class with 36 students (18 student male and 18 student female) as an experimental class. The research instrument was in the form of a multiple-choice written test totaling 30 questions. Based on the study results, data analysis using the ANCOVA test showed that the wimba learning strategy with the project-based learning model significantly improves students' understanding and analyzing concepts of the excretory system with p-value 0,002. These results are viewed from indicators of learning outcomes. The average score of N-Gain learning outcomes of students in the experimental class on the cognitive aspects of C1, C2, C4, and C5 have N-Gain better than the control class. This learning strategy was appropriate for learning biology that can make students more active in the learning process.

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INTRODUCTION

In the 2013 Curriculum, students are no longer the learning object, but students are the central learning (Djamahar, Ristanto, Sartono, Ichsan, & Muhlisin, 2018; Hairida, 2016). The 2013 curriculum emphasized exercising the students to their three core competencies, covering cognitive, affective, and psychomotor competence. Students work together to conduct research, apply logic and reasoning, and devise solutions to complex problems (Leasa, Sanabuky, Batlolona, & Enriquez, 2019; Öztürk & Korkmaz, 2019). The 2013 curriculum requires students to be active in the learning process, and the project-based learning (PjBL) model is one of them.

Project-Based Learning (PjBL) can increase students' learning motivation, increase student activity, improve student skills, develop and practice communication skills in cooperative working groups, and give students opportunities to organize projects (Permana & Chamisijatin, 2018; Tsai, Shen, & Lin, 2014). The 2013 curriculum in implementation uses the scientific method; the scientific method emphasizes students' activeness in constructing a concept in the learning process (Djamahar et al., 2018; Wahyu, 2017). In addition to choosing the right learning model, applying learning strategies applied by a teacher is very influential for their students.

Learning strategy is a learning activity that must be done by teachers and students so that learning objectives can be achieved effectively and efficiently (Rusman, 2016; Chiang, Fan, Liu, & Chen, 2016; Oghenevwede, 2019). A learning strategy is a learning activity that needs to be carried out by teachers and students to achieve learning objectives. Learning strategies are the methods chosen to convey subject matter in a particular learning environment, including the nature, scope, and sequence of activities that can provide learning experiences to students. Learning strategies can be interpreted as each activity chosen, which can provide students with facilities or assistance to achieve individual learning goals (Lai & Hwang, 2016; Özsevgeç, Artun, & Ünal, 2012). One of the learning strategies suitable to be combined with PjBL is the wimba learning strategy because, in the learning process, through material and practicum delivery.

Wimba model learning strategies implemented in two stages, namely face to face learning and practicum. The approach used is deductive and inductive (Suprapto, Chaidir & Ali, 2019). Wimba model learning strategies are very suitable for using the scientific method. The scientific method itself is closely related to science. It is studied so that humans can understand the natural processes associated with life, besides science, require facts, and combine logic with imagination. The example is Biology (Suprapto et al., 2012). Wimba itself in the learning process is based on visuospatial. They are starting with making concept maps, making 2D drawings, 3D drawings, and then making concrete 3D. It can develop mastery of the material while presenting from 2D images, 3D images, and then to 3D Congkret (Suprapto et al., 2019; Suprapto, 2018).

Biology as a science has its uniqueness compared to other sciences (Ormancı & Ören, 2011; Ristanto, Zubaidah, Amin, & Rohman, 2018; Styers, Van Zandt, & Hayden, 2018). Biological science products are a tangible collection of facts and concepts resulting from scientific processes (Goode & Halbritter, 2019; Inayah, Ristanto, Sigit, & Miarsyah, 2020; Sudjoko, 2001). In biology, imagination is necessary. Without imagination, it will be challenging to link each organ's structure and function in the system. The imagination can then be presented by constructing a 3D image based on visuospatial (Ibrahim & Achmad, 2013). Spatial intelligence or visual-spatial intelligence is the ability that allows visualizing information and synthesizing data and concepts into visual or picture metavor (Suprapto et al., 2012).

The ability of visuospatial representation is a person's ability to understand and comprehend concepts through visual representation related to spatial learning and doing tasks (Dewiyanti & Kommers, 2005; Markowitz, Laha, Perone, Pea, & Bailenson, 2018; Suprapto, 2016). Therefore, during the learning process, visuospatial abilities are needed by students to be able to help the process of absorbing material related to the system that occurs in the human body. In contrast, the process of imagination requires visuospatial abilities. To facilitate students to engage their visuospatial abilities to create their imagination when learning (Atikah et al., 2018; Dewiyanti & Kommers, 2005).

Based on an interview with a Biology teacher from one of the State High Schools in Tasikmalaya City, Indonesia, on 21 September 2018, the problem that arose in students in the learning process was the lack of students' ability to imagine the material presented. For example, in the excretory system material in the formation of urine, students' ability to imagine it so that more leverage needs to be assisted with pictures or videos will certainly reduce the students' understanding of the material. Misunderstanding about the material will undoubtedly have an impact on the learning outcomes of students themselves (Yunanda, Susilo, & Ghofur, 2019; Zulfia, Susilo, & Listyorini, 2019). This research aimed to analyze the influence of the wimba learning strategy with the PjBL model in excretory system concepts.

METHODS

Research Design

The research method used is a real experiment. This method is considered promising because of the control class and the experimental class (Arikunto, 2013). The research method used a real experiment because it can control all external variables that affect the experiment (Sugiyono, 2017). The research design used in this study was the pre-test post-test control group design (Sugiyono, 2017). There are two groups chosen randomly in this design. Then, given a pre-test to determine the initial conditions, there is a difference between the experimental and control groups. Good pre-test results if the value of the experimental group is not significantly different. The arrangement of research patterns in a real experiment by Sugiyono (2017) can be seen in Table 1.

Table 1
Pretest-postest control group design

Classes	Pretest	Treatment	Posttest
Experiment	0_1	X_1	0_2
Control	0_3	X_2	0_4

Description:
X_1: Wimba Learning Strategy with PjBL Model
X_2: Cooperative Learning Strategy with PjBL Model
0_1: Pre-test of the experimental group
0_2: Post-test of the experimental group
0_3: Pre-test of the control group
0_4: Post-test of the contol group

Population and Sample

This study's population was 288 eleven grade students in one of the state high schools relatively far from the center of Tasikmalaya City, Indonesia, in the 2018/2019 academic year. The sample in this study was taken using cluster random sampling technique. The steps taken by the author in sampling are doing the randomization process from eight population class (Table 2).

Table 2
Number of samples, each class

Treatment Class	Class	Number of Students
Experiment	XI mathematics and science 1 (XIMS-1)	36
Control	XI mathematics and science 1 (XIMS-4)	36
	Total	**72**

Instrument

Based on the validity test results using Anates application, the research instruments used in this study were 30 multiple choice questions from 50 questions validated using Anates apps ver 4.0.9. Furthermore, the reliability test measured using Alpha Cronbach obtained a value of 0.89, which meant that the instruments were reliable. These instruments used to measure student learning outcomes based on Revised Bloom's Taxonomy indicators, namely remembering, understanding, applying, analyzing, and evaluating. (Table 3).

Table 3

Learning output indicators in excretory system concept.

Indicator	Description	Number of questions	Sample of Question
Remembering	Explain factual answers, test memory, and recognition	12	The process of removing metabolic waste substances that are not useful for the body and excreted with urine, sweat, and respiratory air is called. a. Secretion b. Respiration c. Excretion d. Expiration e. Reabsorption
Understanding	Translate, describe, interpret, or simplify.	6	The following statements that are not related to the human excretory system are a. The kidneys excrete urine b. The lungs excrete water c. The lungs secrete bile d. The skin sweats e. The liver secretes bile
Applying	Understanding when to apply, why to apply, and recognizing patterns of application to new, unusual and different situations.	8	If the urine has just been issued, the physical form that should be shown is... a. Odorless and colorless b. Colorless and odorless c. Odorless and colorless d. Smells and colors e. Everything is correct
Analyzing	Breaking down into sections, shapes and patterns	20	The statement below which does not correspond to the above organs is... a. Emits residual gases such as CO2 and H2O b. Located in the abdominal cavity to the right under the diaphragm c. Protected by a thin membrane called the hepatic capsuled. d. Excreting bile, residual substances from the breakdown of damaged red blood cells e. Antidote
Evaluating	Based on the	39	When our body temperature increases,

	criteria and stating why	the blood vessels in the skin will widen, the statement is a. Urine formation process b. Metabolic process c. Sweat formation process d. Osmoregulation process e. Augmentation Process

Procedures

Before excretory system learning was conducted, students in the experimental and control classes were given a pre-test to measure their initial ability. The experimental class was then taught using Wimba learning strategy with the PjBL model in the first, second, and third meetings. Students are assigned to make groups and design projects in the first meeting. Then students are assigned to present the progress of the project they made in the second meeting. And then, students present the final product they made in the third meeting. The application steps refer to Suprapto (2016), as indicated in Figure 1. On the other hand, the control class was taught using a cooperative learning strategy with a project-based learning model. The post-test of learning outcomes was then given to the experimental and control classes.

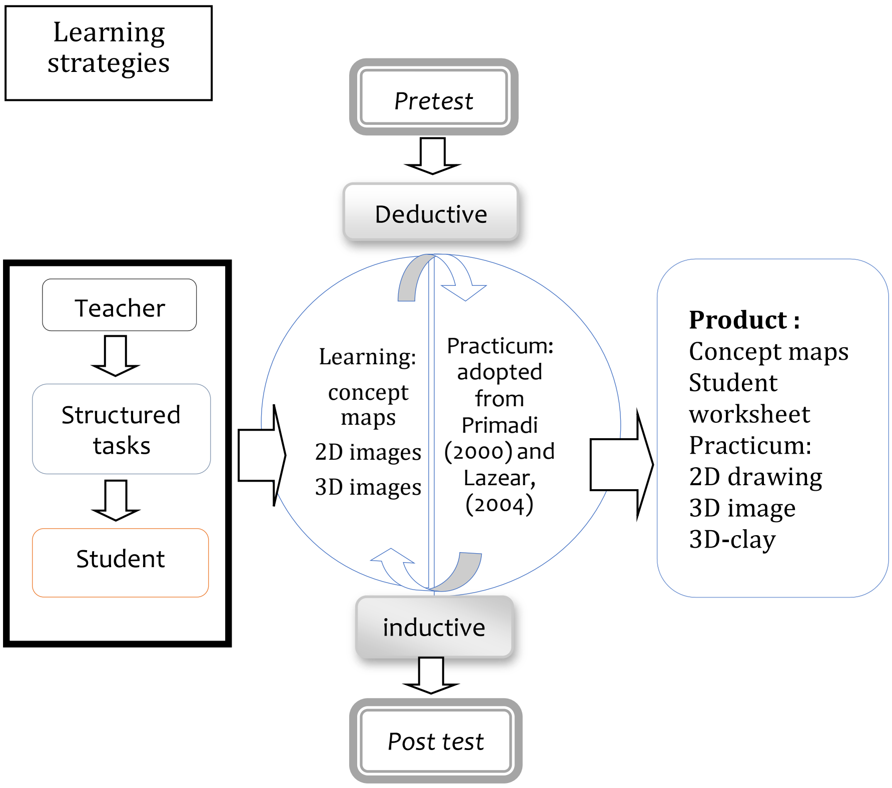

Figure 1. Wimba learning strategy.

Data Analysis

Data were analyzed using the prerequisite analysis and hypothesis test. The normality test was analyzed by the Kolmogorov-Smirnov test with a significance level of 5% or 0.05, and then for homogeneity test was analyzed by the Levene test with a significant level of 5% or 0.05, and then for hypothesis were analyzed using ANCOVA and showed that the significance level in the corrected model.

Table 4
The result of normality test

Data	Asymp.Sig (2-tailed)	Distribution
Pretest Experiment Class	0,200	Normal
Posttest Experiment Class	0,076	Normal
Pretest Control Class	0,060	Normal
Posttest Control Class	0,066	Normal

The normality test was analyzed by the Kolmogorov-Smirnov test with a significance level of 5% or 0.05. Data is normally distributed if the significant value or Asymp.Sig (2-tailed) value is more than 5% or 0.05. The data obtained in the experimental class (Table 4) that Asymp.Sig (2-tailed) values 0,200 (Pretest) and 0.076 (Posttest). While in the control class, the Asymp.Sig (2-tailed) values of 0.060 (Pretest) and 0.066 (Posttest) were obtained. Each data value in both classes is normally distributed because both classes' data values have Asymp. Sig (2-tailed) is greater than the significance level of 5% or 0.05.

Table 5
The result of homogenity test

F	df1	df2	Sig.
,054	1	70	,818

Furthermore, the homogeneity test was analyzed by the Levene test with a significant level of 5% or 0.05. Data is said to be homogeneity if the significance value or Asymp.Sig (2-tailed) value is more than 5% or 0.05. They tested the homogeneity of the data to measure the ability to think critically using SPSS version 23. Based on the results of the homogeneity test (Table 5), it can be concluded that the two data group which from the post-test score is homogeny.

RESULTS AND DISCUSSION

The teacher gives a pre-test to measure how students understand the material to be learned in the first experimental class's lesson. Then the teacher gives a video about the excretion system material that aims to stimulate students to find problems from the video that has been shown. After that teacher divides students into four groups and divides the width of student work and explains how the student worksheets are done, and at the end of the lesson, the teacher assigns students to make a concept map that will be presented at the next meeting.

At the second meeting, the teacher asked student representatives to present their concept maps in front of their friends. Then the teacher gives his comments on the concept map student has made. Besides that, the teacher also asked each group to present their product. Each group was assigned to make four products, namely 2D drawings and 3D drawings of excretory organs, and 3D from the 2D and 3D drawings they had made. Furthermore, at the third meeting, each group presented the products made by them and discussed each other's products about the products made between groups. Moreover, at the end of the lesson teacher gives conclusions about their products and ends with implementing the post-test.

Based on the results of the learning process of the experimental class using wimba learning strategies with project-based learning models, the output obtained in the form of 3D organs of the excretory system made by students (Figure 1). The teacher gives a pre-test to measure how students understand the material to be learned in the first experimental class's lesson. Then the teacher gives a video about the excretion system material that aims to stimulate students to find problems from the video that has been shown. After that teacher divides students into four groups and divides the width of student work and explains how the student worksheets are done, and at the end of the lesson, the teacher assigns students to make a concept map that will be presented at the next meeting.

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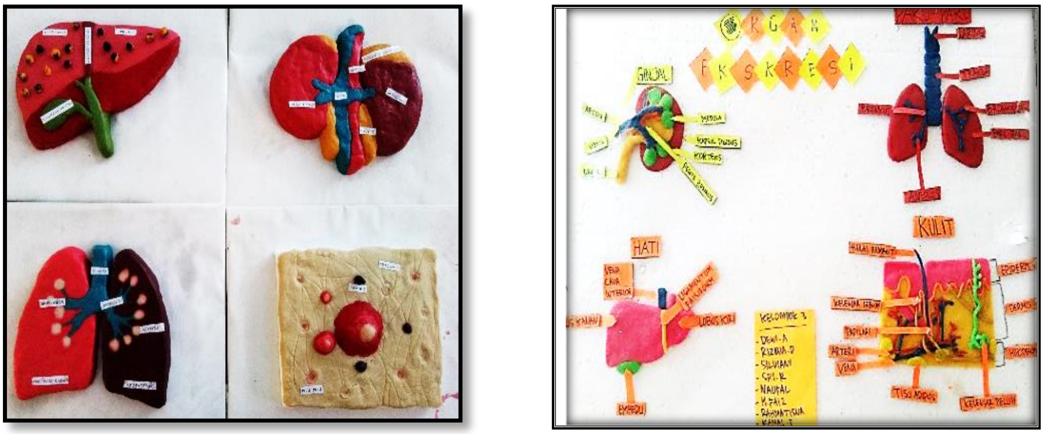

a b

Figure 2. Concrete 3D made by students regarding the excretory system organ;(a) liver, kidney, lung and skin organs made by groups 1, (b) liver, kidney, lung and skin organs made by groups 2.

Concrete 3D formation using wax is used to improve understanding of concepts and train students' spatial-visual abilities. Making 3D Concrete using wax can stimulate students to examine the extent of mastery of the concept, judging by the exact structure, shape, and location of the organ. Based on students' 3D Concrete results, there are still less delineated parts, such as lobes found in the lungs, kidney organs appear from within, and parts of the skin layer (Figure 2.a). Also, giving color to the organ's kidney and liver is still not quite right (Figure 2.b). However, based on the hypothesis test analysis, differences in students' learning outcomes before and after being given treatment using the wimba learning strategy with the project-based learning model.

Table 6

The result of hypothesis test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	44,703[a]	2	22,352	6,625	,002
Intercept	948,186	1	948,186	281,038	,000
Postest	17,814	1	17,814	5,280	,025
Strategi	40,242	1	40,242	11,928	,001
Error	232,797	69	3,374		
Total	39198,000	72			
Corrected Total	277,500	71			

a. R Squared = ,161 (Adjusted R Squared = ,137)

The hypothesis was analyzed using ANCOVA. All data analyzes were performed using SPSS for Windows version 23. The ANCOVA Test summary data analysis (Table 6) showed that the significance level in the corrected model was 0.002. Because the significance value is far below 0.05, then Ho is rejected. Based on this result, the Wimba Learning Strategy with Project-Based Learning Models significantly influences learning outcomes. Based on the next ANCOVA test (Table 6) obtained a significant value of 0.004 on learning outcomes, the conclusion of the hypothesis that can be rejected is Ho because of the results of a significant value of less than 0.005. This result shows that the wimba learning strategy with the project-based learning model can improve student learning outcomes in the material excretion system. The statement can be observed descriptively in the comparison of the average score of the pre-test, post-test, and N-gain learning outcomes of students in the experimental class and the control class (Figure 3).

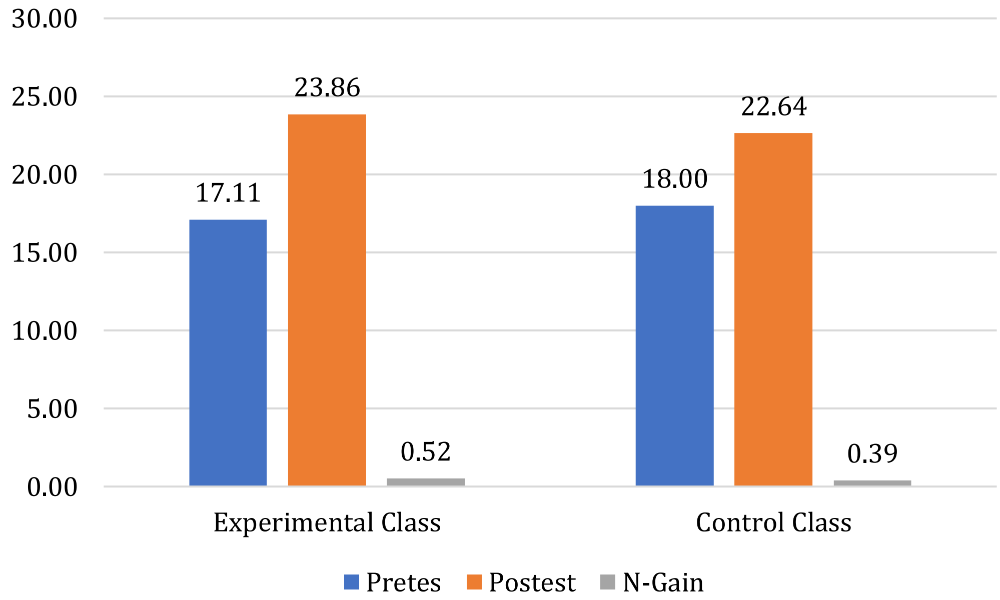

Figure 3. The difference in increase Learning Outcomes of Students in Experiment and Control Classes

In comparing the average scores, the experimental class obtained learning outcomes of 0.52 using the Wimba learning strategy with a project-based learning model looks better than the control class that obtained learning outcomes of 0.39 using the cooperative learning strategy with the project-based model learning. These influences are due to the wimba learning strategy related to the ability to imagine information or knowledge that can then be presented by constructing visuospatial-based 3D images. One of the visuospatial abilities is obtained through groups (Dewiyanti & Kommers, 2005; Markowitz et al., 2018), so students can more actively discuss drawing 2D and 3D organs.

Visuospatial representation has a role in increasing students' conceptual (Valai, Schmidt-Crawford, & Moore, 2019; Atikah et al, 2018). This development is due to the influence of PjBL. Students who are facilitated by Project Based Learning display better mastery of concepts compared to students who are facilitated by conventional learning, so the results learning of students who are facilitated by Project Based Learning is more improved than those not facilitated by Project Based Learning (Mahanal, 2010)

Wimba learning strategy with the PjBL model begins with observation through practical activities and the assignment of concept maps by compiling information about the material to be studied. The step of making concept maps aims to compile the information received about the excretion system's material to be studied so that students already understand the concept through the concept map they are making. Concept maps are two-dimensional hierarchy diagrams that reflect how knowledge is organized (Chiang et al., 2016; Davies, 2011; Kostova & Radoynovska, 2010). The concept map aims to get prior knowledge while strengthening students' concepts or knowledge (Akyol, Sungur, & Tekkaya, 2010; Großmann & Wilde, 2019; Hadjichambis, Georgiou, Paraskeva-Hadjichambi, Kyza, & Mappouras, 2016; Suprapto, 2012). Concept maps are often used to assist in the clarification, consolidation, and strengthening of knowledge (Akyol et al., 2010; Hadjichambis et al., 2016). The concept map that has been made is then presented to check the extent of the reinforcement of the concept of knowledge and clarify the wrong concepts to students in the excretion system material. Based on the results of the concept map presentation, there are still misconceptions among students. Furthermore, to see the improvement of each Indicator of learning outcomes. The average N-Gain of students in the experimental class using the Wimba learning strategy with the project-based learning model and the control class using the cooperative learning strategy with the model PjBL is seen in Figure 4.

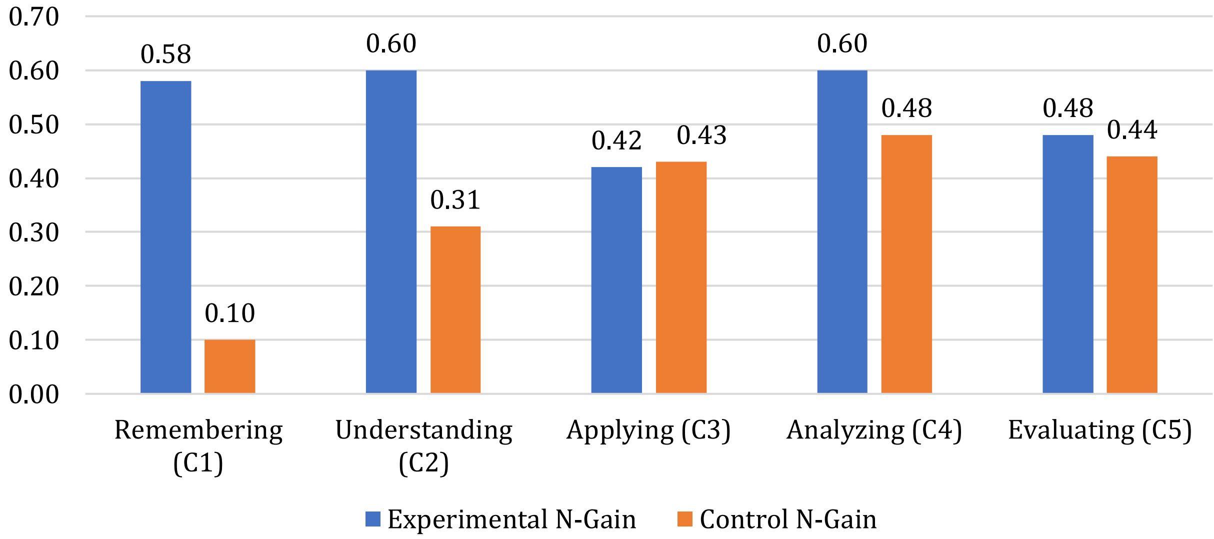

Figure 4. The difference in the increase in indicators Learning Outcomes pre-test and postest

From comparing the average N-Gain on the aspect of indicators of student learning outcomes, Based on these pictures above, it can be concluded that the average score of N-Gain learning outcomes of students in the experimental class (the cognitive aspects of C1, C2, C4, and C5) better than the control class.

Model-VS with Inductive-Image (IG) treatment can develop Understanding (C2), in addition to the ability to remember (C1) and evaluate (C5) developed very well in the Inductive-Playdoh (IP) treatment. In contrast, the ability to apply develops from Deductive-Image (DG). The highest average N-Gain score in the experimental class is in the cognitive aspects of understanding (C2) and analyzing (C4). This aspect due to the assignment of a concept map that can improve students' understanding of the concept (Lampert, Müllner, Pany, Scheuch, & Kiehn, 2020; Lancor, 2014). The initial learning process begins with practical activities by observing 2D images and 3D images of the excretory system or becomes one of the things that can improve students' understanding. Moreover, the learning process that starts with practical activities will be easier to remember (Duda, Susilo, & Newcombe, 2019). Visual illustrating is involving the ability of information analysis and processing (Akyol et al., 2010; Hadjichambis et al., 2016). Thus, this learning model better improves in the higher level of the cognitive domain. It proved that the visuospatial representation support student to higher thinking ability as analyzing

(Atikah, 2018; Hadjichambis et al., 2016).

The average N-Gain score in the experimental class has the lowest average score on the cognitive aspect of C3 that is applying. The control class has the lowest average score on the cognitive aspect of C1 that is remembering. The experimental class that uses Cooperative Learning Strategies with Project-Based Learning models gets the lowest N-Gain scores in C1 because students cannot remember the learning material in the learning process. Whereas in the experimental class, the low cognitive aspect of C3 is because students still lack in applying, applying concepts, and developing concepts. So, when drawing organs and forming organs with candles, there is still a wrong concept. From this, it can be concluded that with the Wimba Learning Strategy with PjBL, the results are significant and influential in improving the cognitive aspects of learning outcomes.

CONCLUSION

This study concludes that the Wimba Learning Strategy with PjBL Model influences students' learning outcomes in the excretion system material in class XI, one of the State High Schools in the City of Tasikmalaya Indonesia Academic Year 2018/2019. The findings in this study indicate that the Wimba learning strategy with the PjBL Model significantly improves students' ability to understand and analyze concepts. These findings are viewed from indicators of learning outcomes. The average score of N-Gain learning outcomes of students in the experimental class on the cognitive aspects of C1, C2, C4, and C5 have N-Gain better than the control class N-Gain. Nevertheless, it needs to be prepared to implement Wimba Learning Strategy with PjBL models so that teachers and students can maximize the learning steps to achieve the objectives in implementation.

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REFERENCES

Arikunto, S. (2013). *Prosedur Penelitian.* Jakarta: PT. Asdi Mahasatya.

Atikah, A., Sanjaya, Y., & Rustaman, N. (2018). The role of visuospatial representation to improve student's conceptual mastery based on gender in learning human urinary system. *Journal of Science Learning, 1*(3), 95-103. https://files.eric.ed.gov/fulltext/EJ1226342.pdf

Akyol, G., Sungur, S., & Tekkaya, C. (2010). The contribution of cognitive and metacognitive strategy use to students' science achievement. *Educational Research and Evaluation*, *16*(1), 1–21. https://doi.org/10.1080/13803611003672348

Chiang, K. H., Fan, C. Y., Liu, H. H., & Chen, G. D. (2016). Effects of a computer-assisted argument map learning strategy on sixth-grade students' argumentative essay reading comprehension. *Multimedia Tools and Applications*, *75*, 9973–9990. https://doi.org/10.1007/s11042-015-2904-y

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

Dewiyanti, S., & Kommers, P. (2005). Virtual reality for spatial topics in biology. *International Journal of Continuing Engineering Education and Lifelong Learning*. https://doi.org/10.1504/ijceell.2004.004577

Djamahar, R., Ristanto, R. H., Sartono, N., Ichsan, I. Z., & Muhlisin, A. (2018). Cirsa: designing instructional kits to empower 21st century skill. *Educational Process: International Journal*, *7*(3), 200–208. https://doi.org/10.22521/edupij.2018.73.4

Dole, S., Bloom, L., & Doss, K. K. (2017). Engaged learning: Impact of PBL and PjBL with elementary and middle grade students. *Interdisciplinary Journal of Problem-Based Learning*,*11*(2), 9. https://doi.org/10.7771/1541-5015.1685

Duda, H. J., Susilo, H., & Newcombe, P. (2019). Enhancing different ethnicity science process skills: Problem-based learning through practicum and authentic assessment. *International Journal of Instruction*, *12*(1), 1207–1222. https://doi.org/10.29333/iji.2019.12177a

English, M. C., & Kitsantas, A. (2013). Supporting student self-regulated learning in problem- and project-based learning. *Interdisciplinary journal of problem-based learning*, *7*(2), 6. https://doi.org/10.7771/1541-5015.1339

Großmann, N., & Wilde, M. (2019). Experimentation in biology lessons: guided discovery through incremental scaffolds. *International Journal of Science Education*, *41*(6), 759–781. https://doi.org/10.1080/09500693.2019.1579392

Goode, A. B. C., & Halbritter, D. (2019). Entomological research in the classroom: the dispersal of biological control agents. *The American Biology Teacher*, *81*(4), 242–247. https://doi.org/https://doi.org/10.1525/abt.2019.81.4.242

Hadjichambis, A. C., Georgiou, Y., Paraskeva-Hadjichambi, D., Kyza, E. A., & Mappouras, D. (2016). Investigating the effectiveness of an inquiry-based intervention on human reproduction in relation to students' gender, prior knowledge and motivation for learning in biology. *Journal of Biological Education*, *50*(3), 261–274. https://doi.org/10.1080/00219266.2015.1067241

Hadratullah, H., Martono, T., & Purwaningsih, Y. (2016). Pengembangan strategi pembelajaran melalui model kooperatif tipe group investigation berbantuan flip chart dalam upaya meningkatkan hasil belajar ekonomi siswa kelas x ma nurul iman dasan makam Lombok Timur. *Jurnal Pendidikan Insan Mandiri,* *1*(1), 120120. https://media.neliti.com/media/publications/120120-ID-pengembangan-strategi-pembelajaran-melal.pdf

Hairida, H. (2016). The effectiveness using inquiry based natural science module with authentic assessment to improve the critical thinking and inquiry skills of junior high school students. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 209–215. https://doi.org/10.15294/jpii.v5i2.7681

Hartati, R. (2016). Peningkatan aspek sikap literasi sains siswa smp melalui penerapan model problem based learning pada pembelajaran ipa terpadu. *Edusains*, *8*(1), 90-97. http://dx.doi.org/10.15408/es.v8i1.1796

Ibrahim, A. (2013). *Penerapan Learning Log Class untuk Mendiagnostik Kesulitan Belajar Siswa SMA Pada Materi Sistem Ekskresi* (Doctoral dissertation, Universitas Pendidikan Indonesia). http://repository.upi.edu/id/eprint/2405

Inayah, A. D., Ristanto, R. H., Sigit, D. V., & Miarsyah, M. (2020). Analysis of science process skills in senior high school students. *Universal Journal of Educational Research, 8*(4A), 15–22. https://doi.org/10.13189/ujer.2020.081803

Insyasiska, D., Zubaidah, S., & Susilo, H. (2015). Pengaruh project-based learning terhadap motivasi belajar, kreativitas, kemampuan berpikir kritis, dan kemampuan kognitif siswa pada pembelajaran biologi. *Jurnal Pendidikan Biologi*, *7*(1). Retrieved from http://journal2.um.ac.id/index.php/jpb/article/view/713

Jihad, A & Abdul, H. (2013). *Evaluasi Pembelajaran*. Yogyakarta: Multi Presindo.

Krathwohl, D. R., & Anderson, L. W. (2009). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

Kostova, Z., & Radoynovska, B. (2010). Motivating students' learning using word association test and concept maps. *Bulgarian Journal of Science & Education Policy*, *4*(1), 62–98. Retrieved from http://proxy.libraries.smu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=eue&AN=51301136&site=ehost-live&scope=site

Lai, C. L., & Hwang, G. J. (2016). A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers and Education*, *100*, 126–140. https://doi.org/10.1016/j.compedu.2016.05.006

Lampert, P., Müllner, B., Pany, P., Scheuch, M., & Kiehn, M. (2020). Students' conceptions of plant reproduction processes. *Journal of Biological Education*, *54*(2), 213–223. https://doi.org/10.1080/00219266.2020.1739424

Lancor, R. A. (2014). Using student-generated analogies to investigate conceptions of energy: a multidisciplinary study. *International Journal of Science Education*, *36*(1), 1–23. https://doi.org/10.1080/09500693.2012.714512

Leasa, M., Sanabuky, Y. L., Batlolona, J. R., & Enriquez, J. J. (2019). Jigsaw in teaching circulatory system: a learning activity on elementary science classroom. *Biosfer: Jurnal Pendidikan Biologi*, *12*(2), 122–134. https://doi.org/10.21009/biosferjpb.v12n2.122-134

Maba, W. (2017). Teacher's perception on the implementation of the assessment process in 2013 curriculum. *International journal of social sciences and humanities, 1*(2), 1-9 https://doi.org/10.29332/ijssh.v1n2.26

Maba, W., & Mantra, I. B. N. (2018). The primary school teachers' competence in implementing the 2013 curriculum. In *SHS Web of Conferences 42*, 00035. EDP Sciences. https://doi.org/10.1051/shsconf/20184200035

Mahanal, S., Darmawan, E., Corebima, A. D., & Zubaidah, S. (2010). Pengaruh pembelajaran project based learning (pjbl) pada materi ekosistem terhadap sikap dan hasil belajar siswa sman 2 Malang. *Bioedukasi (Jurnal Pendidikan Biologi)*, *1*(1). http://dx.doi.org/10.24127/bioedukasi.v1i1.179

Markowitz, D. M., Laha, R., Perone, B. P., Pea, R. D., & Bailenson, J. N. (2018). Immersive virtual reality field trips facilitate learning about climate change. *Frontiers in Psychology*, *9*, 1–20. https://doi.org/10.3389/fpsyg.2018.02364

Mayangsari, P. W., Suratno, S., & Wahono, B. (2015). Pengaruh strategi pembelajaran murder (mood, understand, recall, digest, expand, review) berbasis media interaktif flash terhadap kemampuan berpikir kritis, metakognisi dan pencapaian hasil belajar siswa (mata pelajaran biologi kelas xi materi sistem ekskresi). *Jurnal Edukasi*, *2*(2), 7-11. Retrieved from https://jurnal.unej.ac.id/index.php/JEUJ/article/view/3503

Muhardi, M. (2004). Kontribusi pendidikan dalam meningkatkan kualitas bangsa Indonesia. *Mimbar: Jurnal Sosial dan Pembangunan*, *20*(4), 478-492. Retrieved from https://ejournal.unisba.ac.id/index.php/mimbar/article/view/153

Musa, F., Mufti, N., Latiff, R. A., & Amin, M. M. (2012). Project-based learning (PjBL): inculcating soft skills in 21st century workplace. *Procedia-Social and Behavioral Sciences*, *59*, 565-573. https://doi.org/10.1016/j.sbspro.2012.09.315

Musfiqon &Nurdyansyah. (2015). *Pendekatan Pembelajaran Saintifik*. Nizamia Learning Center: Sidoarjo.

Oghenevwede, O. E. (2019). Enhancing biology students' academic achievement and attitude through self-regulated learning strategy in senior secondary schools in delta central senatorial district. *Journal of Educational and Social Research*, *9*(4), 149–156. https://doi.org/10.2478/jesr-2019-0064

Ormancı, Ü., & Ören, F. Ş. (2011). An analysis of pre-service teachers' drawings about the digestive system in terms of their gender, grade levels, and opinions about the method and subject. *International Journal of Biology Education*, *1*(1), 1–22. Retrieved from https://www.researchgate.net/publication/303881794_An_Analysis_of_Pre-Service_Teachers%27_Drawings_about_the_Digestive_System_in_terms_of_Their_Gender_Grade_Levels_and_Opinions_about_the_Method_and_Subject

Özsevgeç, L. C., Artun, H., & Ünal, M. (2012). The effects of swedish knife model on students' understanding of the digestive system. *Asia-Pacific Forum on Science Learning and Teaching*, *13*(2), Article 5. Retrieved from https://www.eduhk.hk/apfslt/v13_issue2/artun/page2.htm

Öztürk, Ç., & Korkmaz, Ö. (2019). The effect of gamification activities on students' academic achievements in social studies course, attitudes towards the course and cooperative learning skills. *Participatory Educational Research*, *7*(1), 1–15. https://doi.org/10.17275/per.20.1.7.1

Permana, F. H., & Chamisijatin, L. (2018). Project-based learning through edmodo: improving critical thinking and histology concepts. *Biosfer: Jurnal Pendidikan Biologi, 11*(1), 58–69. https://doi.org/10.21009/biosferjpb.v11n2.90-100

Ristanto, R. H., Zubaidah, S., Amin, M., & Rohman, F. (2018). From a reader to a scientist: developing cirgi learning to empower scientific literacy and mastery of biology concept. *Biosfer: Jurnal Pendidikan Biologi*, *11*(2), 90–100. https://doi.org/10.21009/biosferjpb.v11n2.90-100

Rusman. (2016). Model-Model Pembelajaran Mengembangkan Profesionalisme Guru. Jakarta: PT Raja Grafindo Persada.

Saragih, A. H. (2008). Kompetensi minimal seorang guru dalam mengajar. *Jurnal Tabularasa,5*(1),23-34. Retrieved from http://digilib.unimed.ac.id/715/1/Kompetensi%20minimal%20seorang%20guru%20dalam%20mengajar.pdf

Slameto. (2015). *Belajar dan Faktor-Faktor yang Mempengaruhi*. Jakarta: Rineka Cipta.

Sudjana, N. (2017). *Penilaian Hasil Proses Belajar Mengajar.* Bandung: Remaja Rosdakarya Offset.

Sudjoko, 2001. *Pengantar Seni Rupa.* Bandung: Direktorat Jendral Pendidikan Tinggi Departemen Pendidikan Nasional.

Sugiyono. (2017). *Metode Penelitian: Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta.

Suharsono, & Kamil, P. M. (2015). *Buku Ajar Biologi Umum*. Tasikmalaya.

Suprapto, P. K., Chaidir, D. M., & Ali, M. (2019). Development of wimba 3 dimension interactive animation media on plant anatomy. *Journal of Physics: Conference Series (1233)*1, 012002. https://doi.org/10.1088/1742-6596/1233/1/012002

Suprapto, P. K. (2016). Implementasi Model pembelajaran visuospatial (3d) untuk mengembangkan kemampuan kognitif calon guru biologi pada konsep anatomi tumbuhan. *Bioedusiana: Jurnal Pendidikan Biologi, 1*(01). http://jurnal.unsil.ac.id/index.php/bioed/article/view/74

Suprapto, P. K. (2016). *Model Pembelajaran Wimba (Berbasis Visuospasial)*. Bandung.

Suprapto, P. K., Ardiansyah, R., Diella, D., & Chaidir, D. M. (2018). Kreativitas mahasiswa dengan pendekatan deduktif dan induktif pada model pembelajaran wimba. *Jurnal Pelita Pendidikan*, *5*(4). https://jurnal.unimed.ac.id/2012/index.php/pelita/article/view/8879

Suprapto, P. K. (2012). Pengembangan program perkuliahan anatomi tumbuhan berbasis visuospasial melalui repr esentasi mikroskopis sistem jaringan tumbuhan untuk meningkatkan penalaran dan penguasaan konsep calon guru biologi. eprint_fieldopt_thesis_type_phd thesis, Universitas Pendidikan Indonesia, Bandung. http://repository.upi.edu/8563/

Susilowati, I., Iswari, R. S., & Sukaesih, S. (2013). Pengaruh pembelajaran berbasis proyek terhadap hasil belajar siswa materi sistem pencernaan manusia. *Journal of Biology Education*, *2*(1). https://journal.unnes.ac.id/sju/index.php/ujbe/article/view/2618

Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active learning in flipped life science courses promotes development of critical thinking skills. *CBE Life Sciences Education*, *17*(3), 1–13. https://doi.org/10.1187/cbe.16-11-0332

Tawil, M., & Liliasari. (2013). *Berpikir Kompleks dan Implementasinya dalam Pembelajaran IPA.* Makasar: Universitas Negeri Makasar.

Tsai, C.-W., Shen, P.-D., & Lin, R.-A. (2014). Exploring the Effects of Student-Centered Project-Based Learning with Initiation on Students' Computing Skills. *International Journal of Information and Communication Technology Education*, *11*(1), 27–43. https://doi.org/10.4018/ijicte.2015010102

Tung, K. Y. (2002). *Simphoni Sedih Pendidikan Nasional.* Jakarta: Abdi Tandur.

UFMCS. (2015). *The Applied Critical Thinking Handbook*. Leavenworth.

Valai, A., Schmidt-Crawford, D. A., & Moore, K. J. (2019). Quality indicators for distance learning: A literature review in learners' perceptions. *International Journal on E-Learning*, *18*(1), 103–124. Retrieved from https://www.learntechlib.org/primary/p/171392

Wahyu, R. (2017). Implementasi model project based learning (pjbl) ditinjau dari penerapan kurikulum 2013. *Jurnal Tecnoscienza*, *1*(1), 49-62. Retrieved from http://www.ejournal.kahuripan.ac.id/index.php/TECNOSCIENZA/article/view/18

Wekesa, N. W., & Ongunya, R. O. (2016). Project based learning on students' performance in the concept of classification of organisms among secondary schools in kenya. *Journal of Education and Practice, 7*(16), 25-31. https://eric.ed.gov/?id=EJ1105278

Widodo, A. (2005). Taksonomi Tujuan Pembelajaran. *Didaktis*, *4*(2), 61-69. Retrieved from http://file.upi.edu/Direktori/FPMIPA/JUR._PEND._BIOLOGI/196705271992031-ARI_WIDODO/2005-Revisi_Taksonomi_Bloom-Didaktis.pdf

Yunanda, I., Susilo, H., & Ghofur, A. (2019). Misconceptions identification on biodiversity and protist using multiple choice open reason (mcor). *Biosfer: Jurnal Pendidikan Biologi*, *12*(2), 170–181. https://doi.org/10.21009/biosferjpb.v12n2.170-181

Zulfia, F. A., Susilo, H., & Listyorini, D. (2019). Virus-bacteria diagnostic test (vbd-test) in identifying biology teacher's misconception. *Biosfer: Jurnal Pendidikan Biologi*, *12*(2), 144–156. https://doi.org/10.21009/biosferjpb.v12n2.144-156