

## **Effect of learning models on biology learning outcomes in terms of student spatial intelligence**

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### ***Abstract***

This study aims to learn the effect of learning models on biology learning outcomes in terms of spatial intelligence. This research was conducted at Public High School 4 Kendari, from September to December 2017. This type of research is experimental, with measured variables, namely independent variables consisting of: (1) treatment variables: project-based learning and discovery learning models, and (2) moderator variables: high and low spatial intelligence, while the dependent variables are the learning outcomes in biology. The analysis technique used includes analysis of data descriptive and inferential analysis, done through independent sample t-test. The results of the t-test for Equality of Means test obtained  $t_{\text{count}} = 3.368$ , and the sig value was  $0.0015 < 0.05$  at  $\alpha$  of 0.05. This shows that the average biology students' learning outcome, that learned with project-based learning models, is higher when compared with the model of discovery learning in students who have high spatial intelligence. The results of t-test for Equality of Means obtained  $t_{\text{count}} = -0.858$  and sig  $0.2015 > 0.05$  at  $\alpha$  of 0.05. The shows that there is no difference in the average biology learning outcomes of students, taught by project-based learning models compared to discovery learning models, in students who have low spatial intelligence.

**Keyword:** *learning models, biology learning outcomes, spatial intelligence*

## Introduction

One resolution that can be done to prepare excellent and capable human resources in this global era is to improve the quality of education. Improving the quality of education can mainly be achieved through learning change. The reformation in the subject is a change in the learning paradigm, namely the orientation of the learning model, that initially centred on the teacher switching to student-centred classroom activities, with the teacher's primary role, as an expert, turned to the role of students as experts. The emphasis on teaching, that originally recalled the facts, has turned towards the relationship between information and findings concept of knowledge; accumulated facts quantitatively turned to the transformation of facts. The use of technology has turned towards communication, access, collaboration, and expression (Arends, 2012)

Contemporary research on classroom learning models shows that teaching models that use active learning strategies produces effective learning and create student ownership of the learning process. This in turn results in improved student performance and creates concrete student attitudes towards the learning process (A Raja Mohammed, 2008). One of the learning models referred to in this study is the project-based learning and discovery model. The model selection was based on observations and interviews, with teachers of biology, conducted by researchers at Public High School 4 Kendari. One of the learning models referred to in this study is the project-based learning and discovery learning model. The implementation of the discovery learning model can gradually increase and concern of students towards continuing to learn to find the answer to the problems given by a teacher.

But in its implementation in class, several problems are faced by the teachers. Specifically, students have difficulty connecting the concepts they have learnt with the problems faced by students. In learning, sometimes students have not been able to find concepts and

learning objectives have not been achieved. Students have difficulty analyzing, integrating, reorganizing materials, and making conclusions. Further, a lack of creativity of students during the learning process takes place and has implications for student learning outcomes, namely the value rate of student learning outcomes is still below 75.

To solve the problems mentioned, one of the learning models is Project-Based Learning. This learning model emphasizes learning activities; students explore, assess, interpret, and synthesize information to obtain various learning outcomes (knowledge, skills, and attitudes). In project-based learning, students actively create by utilizing their own experiences and abilities to do activities and produce works that they consider useful for themselves or others. Then after completing the project, students remember what they have learned for longer periods, and students also learn how to take responsibility and build self-confidence, solve problems, work collaboratively, communicate ideas, and become innovators (Păvăloiu, Petrescu, & Dragomirescu, 2015).

Some studies have shown that project-based learning can improve learning outcomes in biology. (Jagantara, Adnyana, & Widiyanti, 2014) states that there are differences between the learning outcome of students studying biology, with the model of project-based learning and the direct learning model. Later studies conducted (Chiang & Lee H, 2016) showed that the learning model, project-based learning, has a positive effect on student motivation, and can facilitate students' skills in problem-solving. Likewise, the study conducted by (Wafula & Ongunya, 2016) states that the use of project-based learning can improve students' knowledge of the concept of classification of organisms. This leads to an increase in academic achievement and can positively change student attitudes, which can also contribute to increased academic achievement.

In addition to learning models that influence learning outcomes, more essential factors that need attention in the learning process are intelligence factors possessed by students, and



knowledge related to subjects and academic skills (Mieke Lunenberg, Korthagen, & Swennen, 2007). Next, (Anjarsari, Hobri, Irvan, & Sunardi, 2017) stated that individual intelligence is one of the characteristics that needs to be understood by teachers in the learning process. Teachers, who do not understand the intelligence of students well, will have difficulty in facilitating the process of developing students' potential, so students do not have sufficient opportunities to develop their potential. So that teachers can understand the intelligence possessed by students, the teacher needs to understand multiple intelligences. Gardner reports that an individual has multiple intelligences, consisting of verbal intelligence, logical intelligence, spatial intelligence, kinaesthetic intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence and natural intelligence, and existential intelligence (H Gardner, 2011).

In this study, one of the multiple intelligences that will be studied is spatial intelligence, where someone who has spatial intelligence can see visual images right around them and pay attention to small things that most other people do not pay attention to. Spatial intelligence is related to learning biology in schools because many biological materials present images, schemes, graphics, and diagrams that emphasize students to perceive images, classify images and analyze images both internally and externally, then interprets or communicate information that students understand from the image (Armstrong, 2009).

Biology, as one of the fields of science, provides a variety of experiences to understand the concepts and processes of science. The skills of this process include the skill of observing, offering hypotheses, using tools and materials well, always considering work safety and security, asking questions, making hypotheses, classifying and interpreting data, communicating findings orally or in writing, and exploring and sorting factual information which is relevant to testing ideas or solving problems in everyday life.

To find out the phenomena of the two types of learning models (project-based learning and discovery learning models) on biology subjects, and the effects of students' spatial intelligence, the authors are interested in researching with the goal of understanding the effect of learning models on biology learning outcomes, in terms of student spatial intelligence.

## Method

This research was conducted at Public High School 4 Kendari from September to December 2017. This research is an experimental study, with measured variables, namely, the dependent variable is the learning outcomes of biology and the independent variables consists of (1) treatment variable, namely the project-based learning model and the discovery learning model, and (2) moderator variable; students' spatial intelligence (high spatial intelligence and low spatial intelligence). The population in this research comprised all students of class XI specialization of MIPA, in the 2017/2018 Academic Year, consisting of 9 parallel classes. The sample is students of class XI MIA 1 and class XI MIA 4.

Students were first given spatial intelligence tests to obtain data on the spatial intelligence scores of students. The scores obtained by students on the spatial intelligence test, were sorted from the lowest score to the highest score. Determination of groups of students, in the group of high spatial intelligence and low spatial intelligence groups, used a division of 27% for the high group and 27% for the low group, as the study sample (Anastasi & Urbina, 2007; Sugiyono, 2006).

The design of this study was the Quasi-Experimental design, the Post-Test Only Control Group Design. The study design is showed in Figure 1.

Where, E is the experimental group, taught by project-based learning model, K is the control group, taught by the discovery learning model.  $O_2$  and  $O_1$  are learning outcomes between

the two learning models Data, from study of biology, and the spatial intelligence is obtained by providing a test. Data analysis techniques include (1) descriptive analysis, used to find the mean, median, standard deviation, maximum value, and minimum value; (2) testing of analysis prerequisites; normality testing using the Liliefors test (Sudjana, 2005). If the test results show that  $L_0 < L_{table}$  then the data tested comes from the population with normal distribution with a significant level  $\alpha = 0.05$  and the homogeneity test with the Levene's test. If  $sig > \alpha$  at  $\alpha = 0.05$ , the other data variance homogeneous group; (3) The inferential analysis, conducted through the independent sample t-test.

## **Result and Discussion**

### ***Result***

Descriptive analysis, data from this study presented in Table 1.

Table 1 represents the average biology learning outcome of students taught with a project-based learning model. These results are higher (79.77) when compared to the discovery learning model (70.93) in students who have high spatial intelligence. While for students who have low spatial intelligence, the average learning outcomes is 73.49; lower than students who are taught by the discovery learning, with an average learning outcome of 75.81.

Data of biology learning outcomes, of students taught using the learning model of project-based learning and discovery learning in students who have high spatial intelligence, can be viewed in Figures 2.

Furthermore, to be more explicit about the differences in biology learning outcomes between the project-based learning model and the discovery model, learning in low spatial intelligence is represented in Figure 3.

The subsequent analysis is to use the independent T-test sample, which aims to determine the differences in the average biology learning outcomes of students who learned using the project-based learning model and discovery learning model. The results of this study is presented in Table 2 and Table 3.

The calculation results in table 2 shows that for the Levene's test, the sig value is  $0.334 > 0.05$  on  $\alpha$  of 0.05, which means that both groups have homogeneous variances and the results of the t-test for Equality of Means are  $t_{\text{count}} = 3.368$  and the sig value  $0.0015 < 0.05$  on  $\alpha$  of 0.05. This shows that the average biology learning outcomes of students, taught by the project-based learning model, is higher, when compared to the discovery learning, in students with high spatial intelligence.

The results in Table 3 show that, for the Levene's test, the sig value is  $0.912 > 0.05$  on  $\alpha$  of 0.05, which means the two groups have homogeneous variances and the results of the t-test for Equality of Means obtained  $t\text{-test} = -0.885$  and the value sig  $0.2015 > 0.05$  on  $\alpha$  of 0.05. This explains that there is no difference between the learning outcomes of students, that learned by project-based learning model compared to the discovery learning model, with low spatial intelligence.

## Discussion

The calculation results in Table 2 explain that the project-based learning model, carried out in this study, can improve the biology learning outcomes better for students have high spatial intelligence. The results are consistent with the opinion of (Tiantong & Siksen, 2013), that the Project-based learning model is more suitable for students with high spatial intelligence. This is because project-based learning can improve students' metacognitive skills, so students can do proper planning and can evaluate and find solutions. This contributes to student academic

achievement by creating an equal learning environment. These results reinforce the results of (Salam, Ibrahim, & Sukardjo, 2019), revealing that multiple intelligences have an impact on student learning outcomes in mathematics learning. Furthermore, (Suprpto, Ahmad, Chaidir, Ardiansyah, & Diella, 2018) suggested the results of a simultaneous correlation test calculations showed that there was a significant connection between spatial intelligence and learning outcomes on creativity with a correlation coefficient of  $(R) = 0.474$ . Students who have high spatial intelligence can quickly understand what they see and hear. Students can immediately understand what is happening or what is being explained. Students have a basic intelligence, and each has a unique combination of this multiple intelligence that produces a particular set of skills (P Kaushik, 2017).

Furthermore, students who have high spatial intelligence, manage to think in or with pictures and tend to quickly learn through visual contributions such as films, video images, and demonstrations that use models (Jasmine, 2016). Students can improve their levels of learning when introduced to specific assignments. Students who have high spatial intelligence can see spatial connections between objects and conceptual spatial abilities; the ability to create and manage thinking models of the environment. If there is a child who has visual-spatial abilities, then he/she will be responsive and efficient in carrying out various complicated activities (H S Hindal, 2014).

Spatial abilities are influenced by several factors, including genetics, nutrition, and the environment in which a person grows (Gaundare & Yeole, 2014; Ginnis, 2002; Santrock, 2011). Genetic factors did provide the potential for the improvement of a person's intelligence, but other factors such as nutrition and environment also affect the development of intelligence. According to (Ginnis, 2002; Santrock, 2011), environments enriched with challenges and stimulation affect memory connections, which in turn effects intelligence.

The results of calculations in Table 3 shows that there is no significant difference in the biology learning outcomes of students who have low spatial intelligence, taught by project-based learning and discovery learning models. (Winarti, Yuanita, & Nur, 2019) reported that learning strategies contributed 20.6% to the development of multiple intelligence students. There is no difference because students who have low spatial intelligence tend to be passive in learning; students cannot understand, process, and think in a visual form and translate it. Students cannot translate images in their minds in two or three-dimensional forms. As a result, students who have low spatial intelligence have difficulty understanding biological material, especially those related to the physical structure and function of organisms.

Three factors make up the main dimensions of spatial ability, namely: (1) Spatial Relation (spatial relations): This factor consists of tasks that require mental rotation of an object in both (2D) or (3-D), (2) Spatial Orientation: This factor includes the ability to imagine how an object will look from a different perspective, from the observer's reorientation; and (3) Visualization: This factor consists of tasks that have spatial figural components, such as movement or displacement of parts of an image, and are more complex than spatial relationships or orientations (Harle, Towns, Lafayette, & States, 2011).

Therefore, Multiple Intelligence has a profound impact in the learning process. The results of multiple intelligence have an impact on the learning process in the class that correlates with learning outcomes in individual students. As such, this study contributes to the optimization of learning in the classroom by measuring the potential of each student. Consequently, Biology lessons not only aim to improve academic abilities but also evolve the potential of student intelligence.

## **Conclusion**

This study has successfully analysed the effect of the learning model on learning outcomes by reviewing spatial intelligence, with the following conclusions: (1) The average biology learning outcomes of students, taught by project-based learning, are higher when compared to the discovery learning model, in students who have high spatial intelligence; (2) There is no difference in the average biology learning outcomes of students, taught with the project-based learning model and the discovery learning model, who have low spatial intelligence.

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**Table 1.** Descriptive analysis of research data

Treatment	Statistics					
	Amount of data	Average	Median	Min	Max	Sd
Project-based learning × high spatial intelligence	10	79,77	80,24	69,77	88,37	5,26
Discovery learning × high spatial intelligence	10	70,93	72,1	60,47	79,07	6,41
Project-based learning × low spatial intelligence	10	73,49	70,93	67,44	83,72	5,5
Discovery learning × low spatial intelligence	10	75,81	75,58	65,12	88,37	6,6

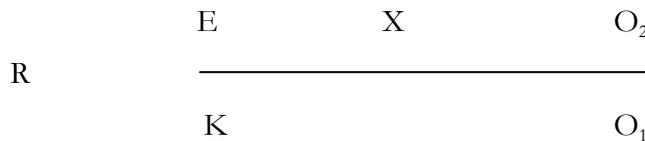
**Table 2.** Test results of an independent sample T-test for groups high spatial intelligence

Independent sample test		Learning outcomes	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F Sig	0,985	0,334
T-test for Equality of Means	t df	3,368 18	3,368 17,339

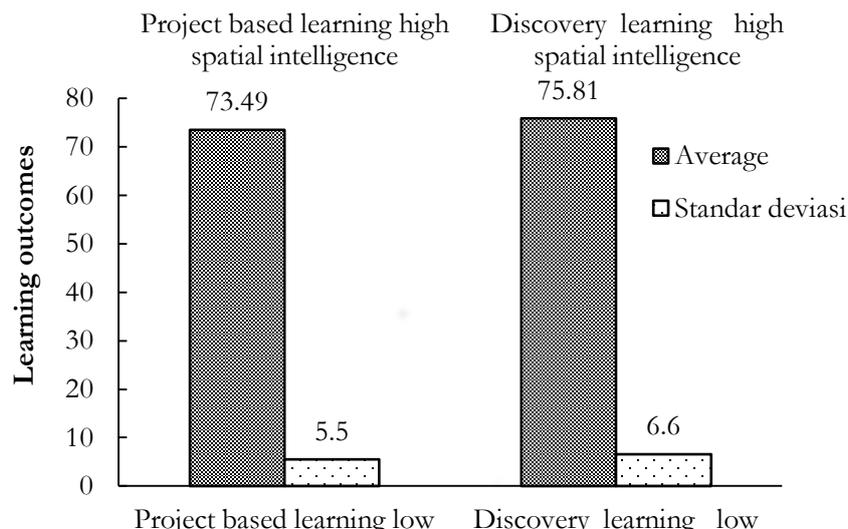
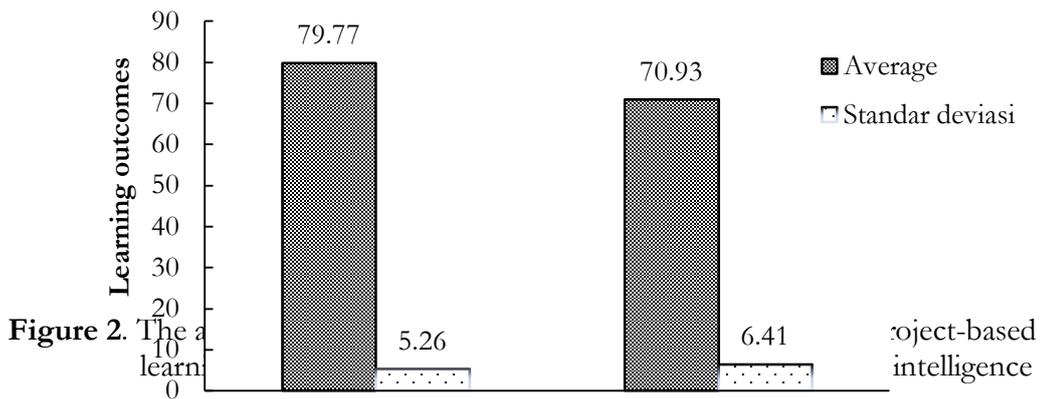
Sig. (2-tailed)		0,003	0,004
Mean Difference		8,83700	8,83700
Std. Error Difference		2,62363	2,62363
95 % confidence interval of the Difference	Lower	3,32494	3,30983
	Upper	14,34906	14,36417

**Table 3.** Test results of an independent sample T-test for groups low spatial intelligence

		Learning outcomes	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	0,012	
	Sig	0,912	
T-test for Equality of Means	t	-0,856	-0,856
	df	18	17,441
	Sig. (2-tailed)	0,403	0,404
	Mean Difference	-2,32500	-2,32500
	Std. Error Difference	2,71631	2,71631
95 % confidence interval of the Difference	Lower	-8,031176	-8,04491
	Upper	3,38176	3,39491



**Figure 1.** Post-test only control group design



**Figure 3.** The average Biology learning outcomes of students taught project-based learning and discovery learning in students have low spatial intelligence

## References

- A Raja Mohammed. (2008). Effects of Active Learning Variants on Student Performance and Learning Perceptions. *International Journal for the Scholarship of Teaching and Learning*, 2(2), 1–15. <https://doi.org/10.20429/ijstl.2008.020211>
- Anastasi, A., & Urbina, S. (2007). *Psychological Testing* (7th edition). Jakarta: PT. Indeks.
- Anjarsari, E., Hobri, Irvan, M., & Sunardi. (2017). Spatial Intelligence on Solving Three Dimensional Geometry Object Through Project Based Learning. *Journal of Social Sciences and Humanities Invention*, 4(8), 3817–3822. <https://doi.org/10.18535/ijsshi/v4i8.20>
- Arends, R. I. (2012). *Learning to Teach* (9th Edition). New York: The McGraw-Hill Companies, Inc.
- Armstrong, T. (2009). *Multiple Intelligences in the Classroom*. Alexandria: ASCD (3rd Edition). Alexandria, Virginia USA: ASCD Publications Press.
- Chiang, C. L., & Lee H. (2016). The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students. *International Journal of Information and Education Technology*, 6(9), 709–712. <https://doi.org/10.7763/IJIET.2016.V6.779>
- Gaundare, V. S., & Arun D Yeole. (2014). An Experimental Study on Factors Affecting The Multiple Intelligences of MBA Students With The Help of Informational Technology. *IBMRD's Journal of Management and Research*, 3(1), 94–103.
- Ginnis, P. (2002). *The Teacher's Toolkit: Raise Classroom Achievement with Strategies for Every Learner* (Fourth). UK: Crown House Publishing Ltd.
- H Gardner. (2011). *Howard Gardner Theory Multiple Intelligences* (Tent-anni). New York: Basic



Books.

- H S Hindal. (2014). Visual-Spatial Learning: A Characteristic of Gifted Students. *European Scientific Journal*, 10(13), 557–574.
- Harle, M., Towns, M., Lafayette, W., & States, U. (2011). A Review of Spatial Ability Literature, Its Connection to Chemistry, and Implications for Instruction. *Chemical Education Reserach*, 88(3), 351–360. <https://doi.org/10.1021/ed900003n>
- Jagantara, I. M. W., Adnyana, P. B., & Widiyanti, N. (2014). Pengaruh Model Pembelajaran Berbasis Proyek Terhadap Hasil Belajar Biologi Ditinjau dari Gaya Belajar Siswa SMA. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi IPA. Program Pascasarjana Universitas Pendidikan Ganesha*, 8(1), 1–8.
- Jasmine, J. (2016). *Metode Mengajar Multiple Intellengences* (Agus Salim). Bandung: Nuansa Cendekia.
- Mieke Lunenberg, Korthagen, F., & Swennen, A. (2007). The Teacher Educator as A Role Model. *Teaching and Teacher Education*, 23, 586–601. <https://doi.org/10.1016/j.tate.2006.11.001>
- P Kaushik. (2017). Redefining Learning: Kolb's Theory of Learning Styles with Gardner's Multiple Intelligences. *International Journal of Learning and Teaching*, 9(1), 330–339. <https://doi.org/10.18844/ijlt.v8i5.1889>
- Păvăloiu, I.-B., Petrescu, I., & Dragomirescu, C. (2015). Interdisciplinary Project-Based Laboratory Works. *Procedia - Social and Behavioral Sciences*, 180(November), 1145–1151. <https://doi.org/10.1016/j.sbspro.2015.02.230>
- Salam, M., Ibrahim, N., & Sukardjo, M. (2019). The Effect of Learning Model and Spatial Intelligence on Learning Outcome. *Advances in Social Science, Education and Humanities Research*, 227(ISAMR 2018), 307–310. <https://doi.org/10.2991/icamr-18.2019.76>
- Santrock, J. W. (2011). *Educational Psychology* (5th edition). New York: McGraw-Hill Companies.



- Sugiyono, D. (2006). *Statistika untuk Penelitian*. Bandung: CV. Alfabeta.
- Suprpto, P. K., Ahmad, M. Z., Chaidir, D. M., Ardiansyah, R., & Diella, D. (2018). Spatial Intelligence And Students' Achievement to Support Creativity on Visuospatial-Based Learning. *Jurnal Pendidikan IPA Indonesia*, 7(2), 224–231. <https://doi.org/10.15294/jpii.v7i2.14322>
- Tiantong, M., & Siksen, S. (2013). The Online Project-based Learning Model Based on Student Multiple Intelligence. *International Journal of Humanities and Social Science*, 3(7), 204–211.
- Wafula, W. N., & 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.
- Winarti, A., Yuanita, L., & Nur, M. (2019). Effectiveness of Multiple Intelligences Based Intelligences And Science Process Skills of Junior High. *Journal of Technology and Science Education*, 9(2), 122–135. <https://doi.org/10.3926/jotse.404>