The Effect of Spatial Intelligence and Learning Management on the Learning Outcomes of Mechanical Engineering Students in the Mechanical Drawing Course

Ali Hasbi Ramadani, Universitas Negeri Surabaya, Indonesia
Ekohariadi, Universitas Negeri Surabaya, Indonesia
Lilik Anifah, Universitas Negeri Surabaya, Indonesia
Bambang Suprianto, Universitas Negeri Surabaya, Indonesia
I Gusti Putu Asto Buditjahjanto, Universitas Negeri Surabaya, Indonesia
Heru Arizal, Universitas Negeri Surabaya, Indonesia

The Southeast Asian Conference on Education 2023
Official Conference Proceedings

Abstract
The workforce needed in the industrial revolution era 4.0 is not only skilled at operating machines (machine operators), more than that it is required to have a better understanding of AI (Artificial Intelligence) which includes the latest machines. backed by skills. design, the achievement of student design competence from the learning process must be supported by innate intelligence and good learning implementation. This innate intelligence is related to spatial intelligence while the implementation of learning must be supported by good learning management. So it is necessary to do research related to the factors that can support student design learning outcomes. This study aims to analyze the effect of spatial intelligence and learning management on the learning outcomes of students majoring in mechanical engineering who program a machine drawing course, which consists of 2 independent variables (Spatial Intelligence and Learning Management), and 1 dependent variable (Learning Outcomes). This study involved 61 students who programmed a machine drawing course for the 2022 school year. Data analysis used multiple linear regression using the SmartPLS application. The results showed that: 1) Student spatial intelligence has an influence on changes in student drawing learning outcomes, while the contribution of spatial intelligence to image learning outcomes is 59%. 20 Good learning management by educators has an influence on changes in student drawing learning outcomes, while the management contribution learning on image learning outcomes by 26.8%. 3) Spatial intelligence and learning management affect picture learning outcomes by 58.3% and 41.7% are influenced by other variables.

Keywords: Spatial Intelligence, Learning Management, Learning Outcomes

INTRODUCTION

Vocational school students have the goal of producing graduates who are ready to work. The problem that occurs is the high rate of open unemployment (TPT) for vocational school (SMK) graduates. Based on data from the national statistical center (BPS) for vocational graduates, TPT ranks second after SMA, namely 2,111,338 in August 2021. TPT for SMK graduates in East Java Province occupies the top position, namely 11.89% in 2020. This is This can happen because of the gap between school and industry in the 21st century (Fildzah et al., 2021).

The 21st century is called the information century, the century of information technology, globalization, industrial revolution 4.0, etc. This century will see changes that are very fast and difficult to predict in all areas of life, including education (Lövdén et al., 2020). Changes that take place very quickly can provide opportunities if they can be put to good use, but they can also be disastrous if they are not anticipated in a systematic, structured and measurable manner.

This change triggers changes in the areas of skills needed by the world of work. To predict the skills needed will be very difficult because it depends on the field and sub-occupation that is the focus of the skill. The 21st century is the era of the industrial revolution 4.0 which raises the need for new types of skills that did not exist before, as well as eliminating skills that are no longer relevant (Wijaya et al., 2016).

The industrial revolution 4.0 no longer requires a workforce that is only skilled at operating machines (machine operators), more than that, of course, they are required to have a better understanding of AI (Artificial Intelligence) which includes the latest machines. In addition, (1) Production processes no longer use pure mechanisms (2) Manual production machines have been abandoned and are no longer produced, (3) All manufacturing technologies have begun to use numerical control (4) Numerical control has been adopted from the design. which is very closely related to this, especially the Mechanical Engineering (manufacturing) department, is students' design skills, this is because design is the initial stage of the manufacturing process before the production process. So that this design skill must be owned by everyone (labor) in the business world and the industrial world who concentrate in the field of production (manufacturing).

Each workforce (person) has its own intelligence according to passion, (Gardner, 1983) formulates eight types of intelligence, which humans possess, namely: (1) linguistic intelligence, (2) logical-mathematical intelligence, (3) spatial intelligence, (4) musical intelligence (5) kinesthetic intelligence (6) interpersonal intelligence (7) intrapersonal intelligence (8) natural intelligence (Rahma Elvira Tanjung, 2019).

Based on several theories and initial observations that have been carried out, the intelligence that most supports students in producing good drawing skills is: Spatial Intelligence. Spatial intelligence can be defined as the ability to recognize and describe objects or patterns perceived by the brain (Xie et al., 2020). Yanuarita (Yanuarita, 2014), explained that regarding the spatial visual ability test in general it aims to measure the power of visual logic, spatial imagination, accuracy and thoroughness of a person presented in the form or abstract symbols. There are three dimensional aspects in spatial intelligence, namely spatial relation, spatial orientation, and spatial visualization (Harle & Towns, 2011). In addition, Lohman also suggested the dimensions of spatial intelligence with three aspects, namely spatial

orientation, spatial relations, and spatial visualization (Lohman, 1993). An explanation of the dimensions of spatial intelligence, namely as follows. 1) Image Orientation (Spatial Orientation), 2) Image Relationship (Spatial Relation), 3) Image Visualization (Spatial Visualization).

In the learning process of drawing courses in certain situations students are required to be able to solve problems and complete assignments or projects, so that good learning management support is needed. The essence of learning management is the effective and efficient management and implementation of learning tasks through the process of planning, organizing, implementing, assessing and evaluating to achieve the desired learning objectives (Gemnafle & Batlolona, 2021), and this opinion is supported by opinion (Austin & Rust, 2015; Lohman, 1993).

The goal of learning is to induce changes in the behavior or competence of students after participating in learning activities, to achieve changes in the behavior or competence of students after participating in learning activities, these goals are formulated in the form of special statements. or descriptions. This means that every curriculum must be prepared in writing (written plan) so that everything can be carried out properly with regard to the planning, implementation and evaluation of learning which will result in student learning outcomes as expected.

Learning management is very important to improve teaching and learning. Therefore, there is a need for a teacher's role in leading or directing learning, starting with planning, organizing, implementing and evaluating (Saifulloh & Darwis, 2020). With good learning management and adapted to the character of students who will take part in the learning process will improve learning outcomes from students.

Learning outcomes are changes in people's behavior that can be observed and measured in the form of knowledge, attitudes and skills. These changes can be interpreted as better growth and development than before, and the subconscious becomes conscious (Lian et al., 2018). Understanding learning outcomes is the process of determining the value of student learning through assessment activities or measuring learning outcomes. Based on the above understanding, the learning outcomes can indicate that the main goal is to determine the success of students after participating in learning activities, where the level of success is indicated by letters or words according to a scale or symbols, (Mashuri & Hasanah, 2021). Learning outcomes in machine drawing courses are the level of students' changes obtained both cognitively, affectively, and psychomotorically, which are grouped into a single unit in drawing skills. The drawing skills possessed by students in the machine drawing class vary, this is due to the different potential and basic intelligence possessed by students.

Objects that need to be considered to support future development are Drawing Skills, so in this case the researcher will describe how the Influence of Spatial Intelligence, Learning Management, on the Drawing Skills of students of the Department of Mechanical Engineering Education, State University of Surabaya in machine drawing courses.

METHOD

Types of Research

In this study, an ex post facto quantitative approach was used survey method (Kunrath et al., 2020). Furthermore, data and facts collected from the constructs of spatial intelligence, learning management, and learning outcome will be tested according to the design below.

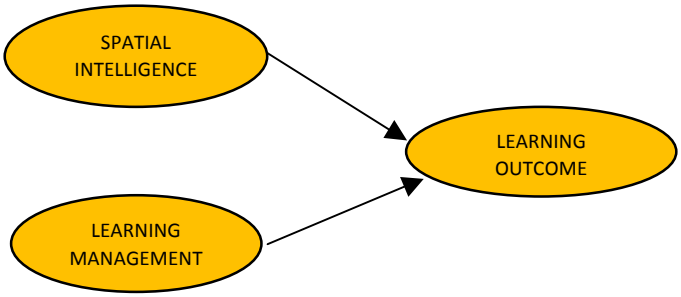

Figure 1. Conceptual Framework

Participants

The population in this study were all mechanical engineering education students who programmed production machine drawing courses, totaling 61. Because the population is small, the sampling technique used in this study is a census type, so that the entire population is the sample of this study.

Research Instrument

To obtain data regarding the constructs to be tested, data collection instruments were prepared in the form of questionnaires and tests. For the efficiency of questionnaires and tests distributed with the help of applications such as Google Forms. The test was used to measure students' constructs of spatial intelligence and drawing skills while the questionnaire was used to measure students' constructs of creativity, design interest, and spatial intelligence.

The instruments to be used will be prepared in advance according to the rules of instrument preparation, namely: construct validity, content validity, face validity, and followed by item validity to see the validity and reliability of the instruments to be compiled. For more details regarding the description of the instrument in each construct, it can be seen in the following table:

Table 1. Instrument grid

No	Variable	Indicator	Data Collection
1	Spatial Intelligence	1. Image classification. 2. Object rotation 3. Relationship and logical consistency 4. Test arbitrary build 5. Symbolic reasoning	Test
2	Learning Management	1. Learning Planning 2. Implementation of Learning 3. Learning Evaluation	Questionnaire
3	Drawing learning outcomes	1. Psychomotor 2. Cognitive 3. Affective	Test

Data Analysis Techniques

This study is a quantitative study, the analysis is SEM (Structural Equation Modeling), which is suitable for multivariate statistical analysis. SEM data processing is built on measurement models and structural models. SEM has three functions at the same time, namely to check the validity and reliability of the instrument (confirmatory factor analysis), to test the model of the relationship between variables (path analysis) and to obtain an appropriate model for prediction (structural model analysis and regression analysis). A general model basically consists of a measurement model and a structural or causal model. A measurement model is used to construct an estimate of validity and discriminant validity, while a structural model is a model that describes hypothesized relationships.

This analysis is used to determine the effect of spatial intelligence, Learning Management, on student learning outcomes in the machining engineering expertise program. In testing the hypothesis of the construct above, it will be analyzed how the influence of each construct is directly or indirectly influenced by each construct. The analysis test tool used uses SmartPLS assistance.

RESULT

Measurement Model Analysis

The results of the descriptive data processing showed that all of the research respondents were 100% male who were vocational school students. The instruments used in this study were tested for validity first. Analysis of the test results was carried out using Aiken'(Aiken, 1980). The results of the analysis of each instrument are declared valid where the value of V is above 0.4. All respondents were asked to fill out instruments that had been prepared previously. The results show data like the table below.

Table 2. Discriminant Validity Results Average Variance Extracted

	Average Variance Extracted (AVE)
Spatial Intelligence	0,692
Learning Management	0,808
Learning Outcome	1,000

Based on the table above, the AVE of each construct/variable has a value above >0.5. These results explain that the contract is able to explain more than half of the indicator variance for each construct.

Table 3. Discriminant Validity Results Loading Factor

	Spatial Intelligence	Adversity Intelligence	Creativity
S1	0,866		
S2	0,715		
S3	0,869		
S4	0,798		
S5	0,898		
MP1		0,917	
MP2		0,925	
MP3		0,853	
HB			1

All indicators for each construct show a loading factor value above 0.7. These results state that these indicators can represent each construct. From the two determinant validity, both AVE and factor loading, it can be concluded that the data is valid.

After checking the validity, the next step is to check the data for reliability. The reliability test in this study used Cronbach Alpha reliability. The data is said to be reliable if the Cronbach Alpha value ≥ 0.5.

Table 4. Reliability Results Cronbach Alpha

	Cronbach's Alpha
Spatial Intelligence	0,889
Learning Management	0,882
Learning Outcome	1,000

The value of each construct has a Cronbach Alpha value above 0.5. Spatial intelligence has a value of 0.889, Learning Management of 0.882, and Learning Outcome of 1,000. This indicates that the instruments in all research constructs are reliable. After the data has been said to be valid and reliable, the data is analyzed to determine the effect of each research construct, namely: spatial intelligence, Learning Management, and Learning Outcome. The test results obtained data as shown in the following figure.

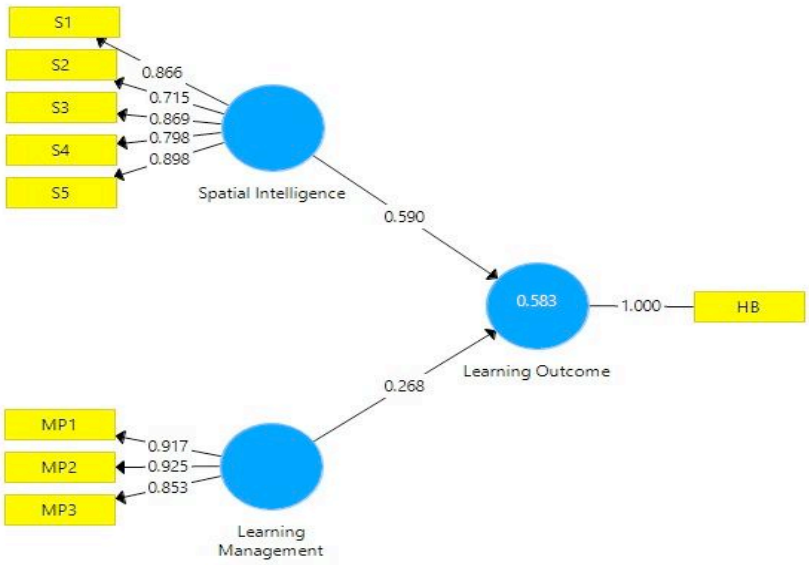

Figure 2. Model of the relationship between variables with each Loading Factor

The results of data analysis obtained the influence of the variables of spatial intelligence and learning management on learning outcome and the joint effect of the two independent variables on the dependent variable. The results of the path analysis can be seen in Table 5 and the R square value in Table 6.

Table 5. Influence values between variables

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Spatial Intelligence -> Learning Outcome	0,590	0,588	0,096	6,130	0,000
Learning Management -> Learning Outcome	0,268	0,276	0,108	2,482	0,013

Table 6. R Square Values

	R Square	R Square Adjusted
Learning Outcome	0,583	0,569

Based on the table, the P value shows less than 0.05, so the influence between the variables is significant. Each influence has a positive value. The following is an explanation of each variable.

Based on Table 6 it is found that spatial intelligence has a positive effect of 0.590 on learning outcomes. P value of 0.000 <0.05 means significant. So it can be concluded that there is a positive and significant influence of spatial intelligence on the learning outcomes of students majoring in mechanical engineering in machine drawing courses.

Based on Table 5 it is found that Learning Management has a positive influence of 0.268 on learning outcomes. P value of 0.013 <0.05 means significant. So it can be concluded that there is a positive and significant influence of learning management on the learning outcomes of students majoring in mechanical engineering in machine drawing courses.

Based on Table 6, the R Square value is 0.583 or 58.3%. So that Spatial Intelligence and Learning Management explain the learning outcomes of 58.3% and 41.7% are influenced by other variables. From these results indicate that the greatest influence is spatial intelligence. So it can be concluded that good student image learning outcomes are owned by students who have good spatial intelligence with the implementation of good learning management.

DISCUSSION

From the results of the research that has been carried out, the discussion will consist of 3 discussions, namely: 1) the relationship between spatial intelligence and learning outcomes, 2) the relationship between learning management and learning outcomes, 3) spatial intelligence and learning management and learning outcomes.

First, for the relationship between visual-spatial intelligence and student learning outcomes in machine drawing courses. Based on Table 6 it is found that spatial intelligence has a positive effect of 0.590 on learning outcomes. P value of 0.000 <0.05 means significant. So it can be concluded that there is a positive and significant influence of spatial intelligence on the learning outcomes of students majoring in mechanical engineering in machine drawing courses.

These results provide information that the higher the spatial intelligence possessed by students, the higher the student learning outcomes in machine drawing courses. So it is expected that students will have high spatial intelligence which will be marked by the increased ability of students in drawing which supports their learning outcomes, especially in machine drawing courses.

Research by (Wahyudi et al., 2018) shows that visual spatial intelligence can improve student learning outcomes. Every aspect of integrated assessment complements each other so that students can grow according to the skills they have. Activities undertaken to improve spatial intelligence can be selected according to the level of students. While analyzing the influence of an object, it can be noted from the personal characteristics of students, their perceptions come from individual differences and their tendencies (Yulfianti & Dewi, 2021). So it can be concluded that spatial intelligence can be said to be well developed if students have the capacity to manage images, shapes, and three-dimensional space with the main activity of recognizing shapes, colors, and spaces and creating images mentally and realistically so that with their spatial intelligence, students will exert ability and effort to achieve the maximum expected machine drawing results. The relationship between spatial intelligence and student learning outcomes in the machine drawing course has a positive and significant relationship, as well as in the high category, so that spatial intelligence can be used as a determinant of the high achievement of student learning outcomes in the machine drawing course.

Second, Learning Management has a positive influence of 0.268 on learning outcomes. P value of 0.013 <0.05 means significant. So it can be concluded that there is a positive and significant influence of learning management on the learning outcomes of students majoring in mechanical engineering in machine drawing courses. Education management experts argue that every activity in a formal educational organization, of course, requires management activities, including structuring, compiling and developing activities as well as implementation of curriculum and learning in a school (Hardy et al., 2021). Therefore in relation to learning management and learning programs, it includes activities that include planning, implementation, and evaluation and follow-up (Al-Mamary, 2022) and teachers as executors of learning management.

Different activities related to learning management that teachers do are planning learning materials, formulating learning objectives, organizing and developing learning materials, creating harmonious communication with school leaders, directing lessons, presenting learning materials, creating and maintaining constructive learning relationships and communicating with students, encourages and increases students' desire to learn and the evaluation and monitoring of students' learning outcomes. The aforementioned tasks and management tasks must be performed by professional and experienced trainers. The success of the teacher in the optimal development of the cognitive, affective and psychomotor development of students is also influenced by the quality and consistency of the performance of learning management activities. It also requires trainers who are professional and have a high and consistent commitment to service. The relationship between learning management

carried out by educators and student learning outcomes in the machine drawing course has a positive and significant relationship, as well as in the high category, so that learning management can be used as a determinant of high student learning outcomes in the machine drawing course.

Third, based on Table 7, the R Square value is 0.583. So that spatial intelligence and learning management affect learning outcomes by 58.3% and 41.7% are influenced by other variables. From these results indicate that the greatest influence is spatial intelligence. So it can be concluded that good student image learning outcomes are owned by students who have good spatial intelligence with the implementation of good learning management. This data provides information that the higher the visual-spatial intelligence and the implementation of learning with good management by educators, the higher the student learning outcomes in machine drawing courses. However, table 6 shows that the student's spatial intelligence variable has a higher contribution compared to the learning management variable.

CONCLUSION

From the results of the research that has been done regarding the hypotheses tested on each construct, it can be concluded as follows:

- Spatial Intelligence has a positive and significant direct effect on the learning outcomes of images. This shows that the level of students' spatial intelligence has an influence on changes in student drawing learning outcomes, while the contribution of spatial intelligence to drawing learning outcomes is 59%.
- Learning Management has a direct positive and significant influence on student learning outcomes. This shows that good learning management by educators has an influence on changes in student image learning outcomes, while the contribution of learning management to image learning outcomes is 26.8%.
- Spatial intelligence and learning management affect picture learning outcomes by 58.3% and 41.7% are influenced by other variables, these other variables can be internal or external influences.

ACKNOWLEDGEMENT

Alhamdulillah, praise be to Allah SWT, because thanks to the grace of Allah the researcher was able to complete this article. On this occasion, the researcher would like to thank the parties who have supported and helped in the preparation of this research.

REFERENCES

Aiken, L. R. (1980). Content Validity and Reliability of Single Items or Questionnaires. *Educational and Psychological Measurement*, *40*(4), 955–959. https://doi.org/10.1177/001316448004000419

Al-Mamary, Y. H. S. (2022). Why do students adopt and use Learning Management Systems?: Insights from Saudi Arabia. *International Journal of Information Management Data Insights*, *2*(2), 100088. https://doi.org/10.1016/j.jjimei.2022.100088

Austin, M. J., & Rust, D. Z. (2015). Developing an Experiential Learning Program: Milestones and Challenges. *International Journal of Teaching and Learning in Higher Education*, *27*(1), 143–153. http://www.isetl.org/ijtlhe/

Fildzah, L. A., Ardiningrum, R., & Muhammad, R. (2021). Pengaruh Industri Kecil Terhadap Pertumbuhan Ekonomi di Kabupaten Sidoarjo (2010-2020). *Jurnal Ekombis*, *7*(2), 59–66.

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books.

Gemnafle, M., & Batlolona, J. R. (2021). Manajemen Pembelajaran. *Jurnal Pendidikan Profesi Guru Indonesia (Jppgi)*, *1*(1), 28–42. https://doi.org/10.30598/jppgivol1issue1page28-42

Hardy, J. G., Sdepanian, S., Stowell, A. F., Aljohani, A. D., Allen, M. J., Anwar, A., Barton, D., Baum, J. V., Bird, D., Blaney, A., Brewster, L., Cheneler, D., Efremova, O., Entwistle, M., Esfahani, R. N., Firlak, M., Foito, A., Forciniti, L., Geissler, S. A., … Wright, K. L. (2021). Potential for Chemistry in Multidisciplinary, Interdisciplinary, and Transdisciplinary Teaching Activities in Higher Education. *Journal of Chemical Education*, *98*(4), 1124–1145. https://doi.org/10.1021/acs.jchemed.0c01363

Harle, M., & Towns, M. (2011). A Review of Spatial Ability Literature, Its Connection to Chemistry, and Implications for Instruction. *Journal of Chemical Education*, *88*(3), 351–360. https://doi.org/10.1021/ed900003n

Kunrath, K., Cash, P., & Kleinsmann, M. (2020). Designers' professional identity: personal attributes and design skills. *Journal of Engineering Design*, *31*(6), 297–330. https://doi.org/10.1080/09544828.2020.1743244

Lian, B., Kristiawan, M., & Fitriya, R. (2018). Giving creativity room to students through the friendly school's program. *International Journal of Scientific and Technology Research*, *7*(7), 1–7.

Lohman, D. F. (1993). *Spatial Ability and Paper Presented at the First Spearman Seminar*. University of Plymouth.

Lövdén, M., Fratiglioni, L., Glymour, M. M., Lindenberger, U., & Tucker-Drob, E. M. (2020). Education and Cognitive Functioning Across the Life Span. *Psychological Science in the Public Interest*, *21*(1), 6–41. https://doi.org/10.1177/1529100620920576

Mashuri, M., & Hasanah, E. (2021). Manajemen Pembelajaran Bahasa Inggris dalam Meningkatkan Hasil Belajar Siswa saat Pandemi Covid-19 di SMA Muhammadiyah 3 Yogyakarta. *Diglosia: Jurnal Kajian Bahasa, Sastra, Dan Pengajarannya*, *4*(2), 227–234. https://doi.org/10.30872/diglosia.v4i2.174

Rahma Elvira Tanjung, D. F. (2019). CANVA SEBAGAI MEDIA PEMBELAJARAN PADA MATA PELAJARAN DASAR LISTRIK DAN ELEKTRONIKA Rahma Elvira Tanjung 1) , Delsina Faiza 2) 1. *Jurnal Vokasional Teknik Elektronika Dan Informatika*, *7*(2), 79–85.

Saifulloh, A. M., & Darwis, M. (2020). Manajemen Pembelajaran dalam Meningkatkan Efektivitas Proses Belajar Mengajar di Masa Pandemi Covid-19. *Bidayatuna: Jurnal Pendidikan Guru Mandrasah Ibtidaiyah*, *3*(2), 285. https://doi.org/10.36835/bidayatuna.v3i2.638

Wahyudi, M. A., Widiyanti, W., & Nurhadi, D. (2018). Kecerdasan Visual Spasial Dan Kemandirian Belajar Pada Hasil Belajar Mata Pelajaran Gambar Teknik Di Smk. *Teknologi Dan Kejuruan: Jurnal Teknologi, Kejuruan, Dan Pengajarannya*, *41*(2), 101–109. https://doi.org/10.17977/um031v42i22018p101

Wijaya, E. Y., Sudjimat, D. A., & Nyoto, A. (2016). Transformasi pendidikan abad 21 sebagai tuntutan pengembangan sumber daya manusia di era global [The transformation of 21st century education as a demand for human resource development in the global era]. *Prosiding Seminar Nasional Pendidikan Matematika 2016*, *1*, 263–278.

Xie, F., Zhang, L., Chen, X., & Xin, Z. (2020). Is Spatial Ability Related to Mathematical Ability: a Meta-analysis. *Educational Psychology Review*, *32*(1), 113–155. https://doi.org/10.1007/s10648-019-09496-y

Yanuarita, A. (2014). *Rahasia Otak dan Kecerdasan Anak*. Teranova Books.

Yulfianti, S. Y., & Dewi, R. M. (2021). Efek Learning Management System Berbasis Google Classroom dan Minat Belajar Terhadap Hasil Belajar Ekonomi Siswa. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *7*(2), 491. https://doi.org/10.33394/jk.v7i2.3717

Contact email: ali21007mhs@unesa.ac.id