Hybridization of Local fruit flies in experimental-based genetic learning

by Mokosuli Yeremia

Submission date: 27-Mar-2023 10:42AM (UTC+0700)
Submission ID: 2047579755
File name: document_16.pdf (712.77K)
Word count: 3890
Character count: 22050

Journal of Positive Psychology & Wellbeing
2022, Vol. 6, No. 3, 35 – 42
http://journalppw.com
ISSN 2587-0130

Hybridization of Local fruit flies in experimental-based genetic learning

Masje Wurarah[1], Deitje Adolfien Katuuk[2], Mokosuli Yermia Semuel[3*], Herry Maurits Sumampouw[1]

[1]*Departement of Education Biology, Faculty of Matematics Natural Science and Earth, Universitas Negeri Manado, Tondano, Sulawesi Utara, Indonesia.*
Email: masjewurarah@unima.ac.id
[2]*Doctoral Program in Educational Management, Postgraduate Program, Manado State University, Tomohon, North Sulawesi, Indonesia.*
[3]*Biology Study Program, Faculty of Mathematics Natural Science and Earth, Manado State University, Tondano, North Sulawesi, Indonesia.*
Email: yermiamokosuli@unima.ac.id
Corresponding author: Mokosuli Yermia Semuel, email: yermiamokosuli@unima.ac.id

Abstract

Genetics is one of the most challenging subjects to study in biology. Biology learning through local fruit flies' hybridization experiments, training life skills, and science process skills also concrete abstract genetic concepts. Research has been carried out to analyze the learning outcomes of students who study genetics through the hybridization of local fruit flies. In conducting experiments, students are assisted by the results of research laboratory researchers packaged in audio-visual media. The research consists of a laboratory research stage for phenotypic analysis of local fruit flies at the Biology Laboratory of the State University of Manado (Figure 1a), packaging the results of laboratory analysis in audio-visual media using Camtasia (Figure 1b). and the application of audio-visual media in learning hybridization of local fruit flies by students in schools. The application of audio-visual media in schools in learning genetic concepts through the hybridization of local fruit flies applies to classroom action research methods. Classroom action research subjects in this study were students of class XII MIA 1 SMA N 1 Ratahan, Indonesia. The results showed that Biology learning with the hybridization experiment of local isolate fruit flies, in addition to improving high school students' learning outcomes on the subject of inheritance, can also improve students' scientific process skills. The hybridization experiment of local isolate fruit flies provides a meaningful learning experience for students, training the life skills needed in the current era of the industrial revolution 4.0.

Keywords: local fruit flies, hybridization, experiment, genetics learning

Introduction

Drosophila sp. is a type of winged insect that is a member of the order Diptera. Fruit flies became the most widely used model organisms in research into genetics, physiology, evolution, medicine and even biophysics (Irion and Volhard, 2022; Bellen et al., 2021; Cheng et al., 2022). Female Drosophila melanogaster can produce 50-75 eggs per day and a maximum of 400-500 eggs for ten days (Akhund-Zade et al., 2021; Koval et al., 2021). The cultivation of fruit flies is relatively easy to maintain because it can use rotten fruit as a food source, does not require sterile conditions and fruit fly isolates are easily obtained from nature (Kolesnyk et al. 2020; Sumampouw et al. 2017). The use of fruit flies in genetic studies is partly because fruit flies have many variations in phenotypic characteristics. Variations of phenotypic characteristics include eye colour, abdomen colour, wing colour, wing shape and length, legs colour, thoracic structure etc. (Rolandi et al., 2018; Mokosuli et al., 2020; Sumampouw et al., 2019). However, phenotypic variations can be

observed directly using a lup or a simple microscope. Furthermore, the life cycle of fruit flies is completed in a relatively short time of 14 days (Flatt, 2020; Semuel et al., 2021).

Learning the abstract concept of genetics will be very appropriate if experimental methods teach it. Experimental methods will be able to concrete abstract genetic concepts that cannot be seen with the naked eye (Orcos et al. 2018), including the principle of inheritance of traits through hybridization. Furthermore, experimental learning through local fruit fly crosses provides opportunities for students to develop problem-solving skills, design experiments, determine methods and analyze experimental results (Baken et al., 2022). Many experts believe that experimental learning improves students' creativity and critical thinking skills (Sumampouw and Mokosuli, 2017). However, students' creativity and creative thinking skills were needed in the current era of the industrial revolution 4.0. However, teacher assistance is vital for students to conduct experiments. By using information computer technology, teachers can design learning media that help students plan, execute and analyze the results of their experiments.

Media is a presentation tool that can process text, discourse, images and animations that can be processed by the creativity of its users (Savov et al., 2022). From so many learning media based on information computer technology, learning using Camtasia Studio media which is currently being developed, has begun to be widely developed. This media is classified as audio-visual, which can increase students' interest in seeing, hearing and knowing the material presented. Camtasia Studio is a software that can record everything that is going on on the monitor screen. Therefore, this software is usually used to make video tutorials or presentations (Handayani et al., 2021). This media also makes it easier for students if they want to learn independently. The media is in the form of video tutorials containing material and explanations so that students can easily repeat the lesson and do it independently (Wurarah and Mokosuli, 2019).

One alternative to increase the effectiveness of the learning process is to apply appropriate learning media, which can provide space for students to learn directly, communicate and experiment to solve the problems they face. Educational media by the Commission On Instructional Technology (COIT) were defined as media that were born as a result of the communication revolution that can be used for learning purposes in addition to teachers, textbooks, and whiteboards (Williamson and Piattieva, 2019; Permanasari, 2019). Gagne states that educational media are various components in the student and student environment that can stimulate students and students to learn. In addition, learning media is a means to provide incentives for the learner so that the learning process occurs (Abdulkarim et al., 2018).

Sulawesi, known as Celebes, has a very high endemism of flora and fauna species (Mokosuli et al., 2019). Sulawesi is located in the biogeographical area of the Wallacea zone, which has a diversity of flora and fauna species that differ from the western and eastern regions of Indonesia. The local fruit flies used in this study came from North Sulawesi, namely Southeast Minahasa Regency. Local fruit flies were isolated and phenotypically analyzed in the laboratory and packaged in Camtasia media. The learning media becomes a tool for students at the school in conducting hybridization experiments of local fruit flies. Research has been carried out to analyze the learning outcomes of students who study genetics through the hybridization of local fruit flies. In conducting experiments, students are assisted by the results of research laboratory researchers packaged in audio-visual media.

Method

The research consisted of a laboratory research stage for phenotypic analysis of local fruit flies at the Biology Laboratory of the State University of Manado (Figure 1a), packaging the results of laboratory analysis in audio-visual media using Camtasia (Figure 1b). and the application of audio-visual media in learning hybridization of local fruit flies by students in schools. The application of audio-visual media in schools in learning genetic concepts through the hybridization of local fruit flies applies classroom action research methods. Classroom action

research subjects in this study were students of class XII MIA 1 SMA N 1 Ratahan. The research design used went through 4 stages, namely planning, action, observation, and reflection (Amaliah et al., 2019)

(a)

(b)

Figure 1. Development of Audio Visual Media Phenotypic Analysis of Fruit flies

.

Data Collection Techniques

The type of data in this classroom action research is quantitative data. Quantitative data in the form of test results of students' abilities in working on the questions given and data from teacher observations (Sugiyo[22], 2013). The process of collecting data using test and non-test techniques. The test technique in question is to use a[22] written test and a performance test, while the non-test technique is used to observe student activities in the form of questionnaires and observations

Data Processing Techniques

Learning process data obtained from observation sheets, questionnaire data and learning outcomes data were analyzed using the percentage technique, namely by calculating the percentage of student learning completeness based on the criteria, namely for individual absorption, declared complete if the level of mastery of the material was at least 75% or 7.5 (according to KKM set at SMA Negeri 1 Ratahan in the 2016/2017 academic year). Analyzed using the formula:

$$DSI = \frac{X}{Y} \times 100\%$$

Description : X: Scores earned by students; Y: Maximum score; DSI: Individual absorbency of students (Arikunto, 2006)

Students are complete in classical learning when they obtain a percentage of absorption of 70% of all students of class XII MIA 2 at SMA N 1 Ratahan, which is analyzed using the formula:

$$KBK = \frac{\Sigma N}{\Sigma S} \; x \; 100\%$$

Information:

ΣN: The number of students completed
ΣS: The number of students entirely
KBK: Completeness of classical learning (Arikunto, 2006)

RESULTS AND DISCUSSION

Research Results

Cycle I

The implementation of the first cycle of action refers to the implementation plan of the first cycle of learning which includes two learning meetings. At the first meeting, the teacher explained the learning process and showed a learning video compiled using the Camtasia program. At the first meeting, each group was given an experimental project to isolate local fruit flies. The procedure and planning of the experimental project were prepared by a group of students referring to the audio-visual media provided as a reference. The experimental project aims to isolate fruit flies from nature by using rotten fruit media and to reproduce fruit flies from scratch by isolating male and female flies and placing them in new media. The results of experimental projects carried out by students are then made into reports to be presented. At the second meeting, the teacher guides the students to sit in groups where each group consists of 5 members. The group's task is to present the results of their experiments and discussions. At this meeting, the teacher gave the students an evaluation of cycle one. On the sidelines and at the end of the lesson, the teacher explains the learning material by linking the learning material with the real world and the surrounding environment.
In the first cycle, the overall score was 1.705, and the average value of student learning outcomes was 68.2, so classical student learning completeness reached 40%. However, complete learning of students as a whole, namely, 15 students have not achieved complete learning while only ten students have completed it. From these results, it can be stated that the implementation of this first cycle has not achieved classical learning completeness.

Cycle II

In the second cycle, based on the reflection of the first cycle, the researcher, as the teacher, conducted a brief question-and-answer process about the previous material while paying attention to where the shortcomings were in the evaluation of the first cycle. After completing the question and answer session, the teacher continued the learning process based on the second cycle learning implementation plan. In the second cycle at the third meeting, the teacher showed a learning video compiled using the Camtasia program. The project group of students continued the experiment and observation of fruit fly hybridization, where the initial stage was carried out in cycle 1. The crossing was carried out for 14 days, and students made observations every day. Observations were recorded for group analysis and discussion.

Groups of students then compile the results of observations. At the fourth meeting, the teacher guides students to sit in groups and present the results of group discussions. And continued with the evaluation of cycle II. In this second cycle, the overall score was 2,321, and the average value of student learning outcomes was 82.25, so classical student learning completeness reached 98%. This means that students have completed their learning outcomes. However, individually there is still one student who has not reached the criteria for completeness, namely 12%; thus, researchers do not need to proceed to the next stage, and those who have not reached the criteria for completeness are remedial. The evaluation results of a cycle I and cycle II have a reasonably large comparison between the average value and completeness of

student learning outcomes classically. The average value of the first cycle is 68, while the second cycle is 82.25. The classical completeness of the first cycle is 40%, while the second cycle is 98 % (Figure 2). More details can be seen in Figure 1.

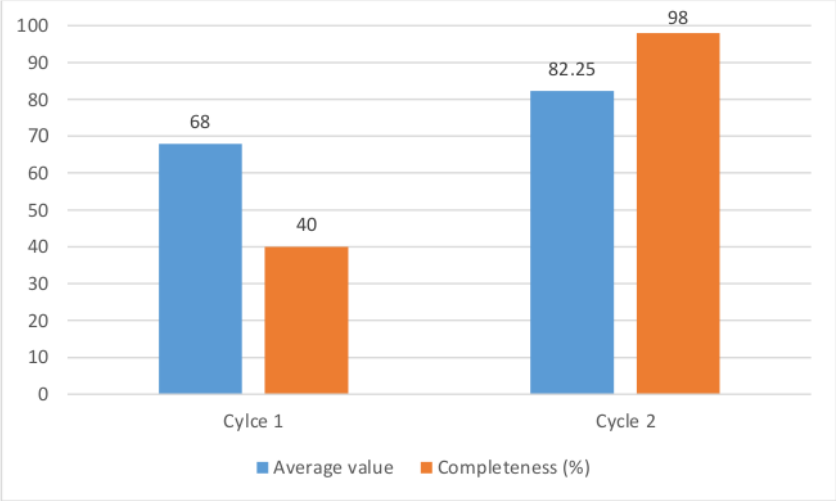

Figure 2. Comparison of the average learning outcomes and student learning completeness

Discussion

Cycle I

In the implementation stage of the first cycle, students did not get optimal results because when researchers applied audio-visual learning media using the Camtasia program, some students were less severe and not active in the learning process. However, students have demonstrated group cooperation and the ability to plan, prepare experimental materials and conduct experiments on isolating fruit flies from nature. In cycle 1, the group has not worked solidly because some students are less willing to accept the opinions of other friends and work as a team. The data obtained in the first cycle, the researcher and the observer (biology study teacher) reflect by analyzing the implementation of the contextual stages and the achievement of indicators in the first cycle. Is it following the plan that has been made or still needs improvements as equipment for predetermined action criteria? The data from the analysis in the first cycle is used as a reference for planning the next cycle.

27
The results of the written evaluation in cycle one have not shown an average that follows the minimum completeness criteria for high school biology subjects because students have not been able to work together to analyze experimental results and data and compile reports. There has not been a good discussion in the analysis and preparation of the report. The analysis of the experimental results is based on the heredity concept learning material, which is the material for preparing the test questions. Based on observations, some students did not understand the material presented by their group but did not ask or discuss it with their group friends.

Cycle II

In the implementation phase of cycle II, the researchers applied the same learning model, namely audio-visual learning media using the Camtasia program with the material still on heredity (inheritance of traits) where the written test was in the form of a description (essay) and made improvements based on the results of these reflections. After reflecting on the results of the

first cycle of research, the researchers approached and supervised students who were less active and who were not serious in the learning process and provided motivation and encouragement that could attract students' interest in learning for class XII MIA 1 students at SMA N 1 Ratahan, Southeast Minahasa Regency, North Sulawesi, Indonesia. Students are rewarded with stars when they are active in discussions. The teacher asks for a video report of the analysis process and reports prepared for the presentation. The percentage of mastery learning outcomes obtained classically is 98%, and only one student has not achieved mastery learning outcomes. Students who have not achieved completeness learn assignments with the same material and are remedial. Completeness of student learning outcomes based on percentages and achievements classically; the learni[21] outcomes are declared complete. There is an increase in the value of mastery of student learning outcomes.

The use of audio-visual media for the Camtasia program by utilizing fruit fly crosses as a medium for learning heredity material can provide seriousness in learning from students, teaching and learning activities are more attractive, encouraging students to think critically, making students active and easy to understand the material being taught. This is also in line with the research of Sumampouw et al. (2017; Tumbel et. al. 2022), learning using audio-visual learning media can stimulate students to think critically.

Students can also carry out practicum or fruit fly cross-research independently, according to what has been done by researchers. Experiments and practicum activities can increase students' motivation and interest (Blumer et al., 2019; Wartono, 2003). Because of the problems, they can quickly find out, and also they get to see the truth of their conclusions quickly and show an increase in value at the end of each cycle. In the end, they were learning using Camtasia program audio-visual media and local fruit fly hybridization experiments for learning Mendel's Law material improved student learning outcomes in class XII MIA 1 at SMA N 1 Ratahan.

The results of this study prove that students' hybridization experiment of local fruit flies makes it easier for them to learn and understand the concept of genetics. Through experimentation, students can concretize the concepts learned in textbooks to build their understanding. The more concrete students learn learning materials, the more learning experiences and students' understanding of the material being studied (Sanjaya, 2010; Wurarah et al., 2022). Fruit fly hybridization is the process of crossing male and female fruit flies to produce offspring. Because fruit flies complete a life cycle of approximately 14 days, students can observe and analyze the results of observations of the process of crossing and inheritance. Observations made by students every day train students' critical thinking and science process skills. In this study, students' scientific process skills were trained, namely observing, asking questions, reasoning skills, designing experiments and forming networks to work together. Thus, the fruit fly experiment learning process ef[35]tively improves student learning outcomes, scien[34] process skills, and problem-solving abilities. Science process skills, problem-solving and data interpretation analysis skills are life skills that are very much needed in the current era of the industrial revolution 4.0 (Catal and Tekinerdogan, 2019).

CONCLUSION

Biology learning with the hybridization experiment of local isolate fruit flies, in addition to improving high school students' learning outcomes on inheritance, can also improve students' scientific process skills. The hybridization experiment of local isolate fruit flies provides a meaningful learning experience for students, training the life skills needed in the current era of the industrial revolution 4.0.

[28]
CONFLICT OF INTEREST

The authors have no conflict of interest from the research, data analysis and preparation of this article.

REFERENCES

[1] Abdulkarim, A., Ratmaningsih, N., & Anggraini, D. N. (2018). Developing civicpedia as a civic education E-learning media to improve students' information literacy. *Journal of Social Studies Education Research*, *9*(3), 45-61.

[2] Akhund-Zade, J., Lall, S., Gajda, E., Yoon, D., Ayroles, J. F., & de Bivort, B. L. (2021). Genetic basis of offspring number–body weight tradeoff in Drosophila melanogaster. *G3*, *11*(7), jkab129.

[3] Amaliah, N., Indriwati, S. E., & Gofur, A. (2019). Penerapan Model Problem Solving dalam Penelitian Tindakan Kelas Berbasis Lesson Study untuk Meningkatkan Keterampilan Memecahkan Masalah Materi Sistem Ekskresi, Osmoregulasi dan Sirkulasi. *BIOMA: Jurnal Biologi dan Pembelajarannya*, *1*(1), 24-32.

[4] Arikunto, S. 2006. Prosedur Penelitian Suatu Pendekatan Praktik. Jakarta: PT Rineka Cipta.

[5] Baken, E. K., Adams, D. C., & Rentz, M. S. (2022). Jigsaw method improves learning and retention for observation-based undergraduate biology laboratory activities. *Journal of Biological Education*, *56*(3), 317-322.

[6] Bellen, H. J., Hubbard, E. J. A., Lehmann, R., Madhani, H. D., Solnica-Krezel, L., & Southard-Smith, E. M. (2021). Model organism databases are in jeopardy. *Development*, *148*(19), dev200193.

[7] Blumer, L. S., & Beck, C. W. (2019). Laboratory courses with guided-inquiry modules improve scientific reasoning and experimental design skills for the least-prepared undergraduate students. *CBE—Life Sciences Education*, *18*(1), ar2.

[8] Catal, C., & Tekinerdogan, B. (2019). Aligning education for the life sciences domain to support digitalization and industry 4.0. *Procedia computer science*, *158*, 99-106.

[9] Cheng, K. C., Burdine, R. D., Dickinson, M. E., Ekker, S. C., Lin, A. Y., Lloyd, K. K., & Bellen, H. J. (2022). Promoting validation and cross-phylogenetic integration in model organism research. *Disease models & mechanisms*, *15*(9), dmm049600.

[10] Flatt, T. (2020). Life-history evolution and the genetics of fitness components in Drosophila melanogaster. *Genetics*, *214*(1), 3-48.

[11] Handayani, E. U., Utami, R. L., & Tamsil, I. M. (2021). How to Create Effective and Efficient Naḥwu Media with Short Videos Based on the Cambridge Application?. *ALSUNIYAT: Jurnal Penelitian Bahasa, Sastra, dan Budaya Arab*, *4*(1), 15-28.

[12] Irion, U., & Nüsslein-Volhard, C. (2022). Developmental genetics with model organisms. *Proceedings of the National Academy of Sciences*, *119*(30), e2122148119.

[13] Kolesnyk, N., Simon, M., Marenkov, O., & Nesterenko, O. (2020). Cultivation of dipterous (Diptera Linnaeus, 1758) insects, such as fruit flies, synanthropic flies larvae and chironomids larvae for fish feeding. *Рибогосподарська наука України*, (4), 53-78.

[14] Koval, L., Zemskaya, N., Aliper, A., Zhavoronkov, A., & Moskalev, A. (2021). Evaluation of the geroprotective effects of withaferin A in Drosophila melanogaster. *Aging (Albany NY)*, *13*(2), 1817.

[15] Mokosuli Y.S., Kaunang, E. S. N., & Manopo, J. S. (2019). The bioactive contents and antioxidant activity of honey bee nest extract of Apis dorsata Binghami from the North Sulawesi. *Molekul*, *14*(2), 92-102.

[16] Orcos, L., & Magreñán, Á. A. (2018). The hologram as a teaching medium for the acquisition of STEM contents. *International Journal of Learning Technology*, *13*(2), 163-177.

[17] Permanasari, A., Rubini, B., & Nugroho, O. F. (2021). STEM Education in indonesia: science teachers' and students' perspectives. *Journal of Innovation in Educational and Cultural Research*, *2*(1), 7-16.

[18] Rolandi, C., Lighton, J. R., de la Vega, J., Schilman, P. E., & Mensch, J. (2018). Genetic variation for tolerance to high temperatures in a population of Drosophila

melanogaster. *Ecology and evolution*, *8*(21), 10374-10383.
[19] Savov, S. A., Antonova, R., & Spassov, K. (2019). Multimedia applications in education. In *Smart Technologies and Innovation for a Sustainable Future* (pp. 263-271). Springer, Cham.
[20] Semuel, M. Y., Wuarah, M., & Sumampouw, H. M. (2021).Pembelajaran Biologi Berbasis Eksperimen Menggunakan Lalat Buah Isolat Lokal: Bintang Pustaka. Bintang Pustaka Madani
[21] Sumampouw, H. M., Semuel, M. Y., Ch, D. N., Naharia, O., & Wurarah, M. (2021). Media Pembelajaran Konsep Genetika Menggunakan Drosophila melanogaster Isolat Lokal Dengan Aplikasi Whatsapp Berbasis Kearifan Lokal Budaya Mapalus. *Jurnal Pendidikan Biologi undiksha*, *8*(3), 145-160.
[22] Sugiyono. 2013. *Peneliian Kualitatif, Kuantitatif dan R&B*. Bandung
[23] Tumbel, F. M., Mokosuli, Y. S., & Paat, M. (2022). Application of Project Based Learning Insect Characteristics Around Lake Tondano in Entomology Course. *Jurnal Biologi Tropis*, *22*(1), 81-87.
[24] Wurarah, M., Yermia, M. S., & Sumampouw, H. M. (2022). Mangrove Biodiversity of Bunaken National Park in Project-Based Learning to Improve Students' Competitive Skills during the COVID-19 Pandemic. *Jurnal Pendidikan Progresif*, *12*(2), 647-659.
[25] Wurarah, M., & Semuel, M. Y. (2019). Development of Audio Visual Learning Media of Biology on the Concept of DNA, Based on the Results of Molecular Identification of Payangka Fish from Lake Tondano. *European Journal of Health and Biology Education*, *8*(1), 1-17.
[26] Williamson, B., & Piattoeva, N. (2019). Objectivity as standardization in data-scientific education policy, technology and governance. *Learning, Media and Technology*, *44*(1), 64-76.

Hybridization of Local fruit flies in experimental-based genetic learning

ORIGINALITY REPORT

17%	14%	10%	7%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journals.ums.ac.id Internet Source	1%
2	9lib.org Internet Source	1%
3	Submitted to University of Bristol Student Paper	1%
4	Submitted to University of Limerick Student Paper	1%
5	collaborate.princeton.edu Internet Source	1%
6	www.e-repository.unsyiah.ac.id Internet Source	1%
7	library.wi.mit.edu Internet Source	1%
8	Abdulrazak M. Aman, Norshuhada Shiratuddin. "Perceptions of female students toward hologram video conferencing	1%

	technology at AOU", International Journal of Engineering & Technology, 2020 Publication	
9	Kirsty M. Hooper, Julija Hmeljak. "Sharing resources to advance translational research", Disease Models & Mechanisms, 2022 Publication	1 %
10	proceedings.upi.edu Internet Source	1 %
11	j.mecs-press.net Internet Source	1 %
12	ojs.jmolekul.com Internet Source	1 %
13	repo.undiksha.ac.id Internet Source	1 %
14	research.wur.nl Internet Source	1 %
15	www.aging-us.com Internet Source	1 %
16	discovery.ucl.ac.uk Internet Source	1 %
17	journal.umg.ac.id Internet Source	1 %
18	Submitted to University of Queensland Student Paper	1 %

19	www.nrcresearchpress.com Internet Source	1 %
20	philsci-archive.pitt.edu Internet Source	1 %
21	A A Rahman. "Development Of Devices In Learning Based On Realistic Approaches To Improve Emotional Intelligence Of First Middle Students", Journal of Physics: Conference Series, 2019 Publication	<1 %
22	Zuliyanti Zuliyanti, Ilham Rizkianto. "Development of realistic mathematics education learning to enhance student's mathematical justification skill", AIP Publishing, 2022 Publication	<1 %
23	sipeg.unj.ac.id Internet Source	<1 %
24	Submitted to Sultan Agung Islamic University Student Paper	<1 %
25	Submitted to Universitas Sebelas Maret Student Paper	<1 %
26	thesis.binus.ac.id Internet Source	<1 %
27	Badarudin Badarudin. "THE EFFECTIVENESS OF STEM BASED LEARNING IN IMPROVING	<1 %

SCIENTIFIC THINKING ABOUT GRADE V OF ELEMENTARY SCHOOL", Dinamika Jurnal Ilmiah Pendidikan Dasar, 2021
Publication

28	research-management.mq.edu.au Internet Source	<1 %
29	scholar.google.com Internet Source	<1 %
30	Alexius Mege Revolson, Yermia Semuel Mokosuli, Jacqueline Jochebed Rayer Debby, Ellen Hetie Adil et al. "Philogenic Relationship of Wild Pigs and Local Pig from North Sulawesi Based on the Growth Hormone Gene (GH Gene)", Materials Science Forum, 2019 Publication	<1 %
31	biology.umm.ac.id Internet Source	<1 %
32	eprints.uny.ac.id Internet Source	<1 %
33	jsss.co.id Internet Source	<1 %
34	Erdal Tatar, Münir Oktay. "The effectiveness of problem-based learning on teaching the first law of thermodynamics", Research in Science & Technological Education, 2011 Publication	<1 %

35	Micheal Thair, David F. Treagust. "A review of teacher development reforms in Indonesian secondary science: The effectiveness of practical work in biology", Research in Science Education, 1997 Publication	<1 %

Exclude quotes	Off	Exclude matches	< 2 words
Exclude bibliography	Off		