

## The Development of Edu-Detective Thinking Learning Model for Biology Students

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### ABSTRACT

This study aims to produce: (1) an appropriate Edu-Detective Thinking learning model, (2) a practical Edu-Detective Thinking learning model, and (3) an effective Edu-Detective Thinking learning model to improve environmental character, science processes skill, and students' cognitive processing abilities. This Research & Development refers to the Borg & Gall's development model, which includes: (1) preliminary study and information gathering, (2) planning, (3) initial product development, (4) preliminary field testing, (5) product revision main field, (6) main field testing, (7) operational product, (8) operational field testing, (9) final product revision, (10) dissemination & implementation. Data on product validity and practicality were collected using questionnaires and observation sheets. Then, the data were analyzed descriptive quantitatively. Meanwhile, the effectiveness data was collected by test questions and analyzed using the MANOVA test. The results of the study are as follows: (1) the Edu-Detective Thinking learning model is feasible to improve the environmental character, science process skills, and students' cognitive processing abilities, (2) the practical Edu-Detective Thinking learning model to improve environmental character, science process skills, and students' cognitive processing abilities, and (3) the Edu-Detective Thinking learning model is effective for improving the environmental character, science process skills, and students' cognitive processing abilities. Thus, it can be concluded that the Edu-Detective Thinking model can be an alternative learning model to improve the quality of biology learning to be more challenging and fun for students.

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## 1. INTRODUCTION

The implementation of biology learning must meet the criteria as science learning in general. The science learning process should be oriented to the development of scientific attitudes, scientific process skills, and mastery of scientific products (Putra, Milama, & Saridewi, 2018; Alberida, et al., 2018) in order to build scientific knowledge and solve various scientific problems (Kustijono, Jatmiko, & Ibrahim, 2018). The nature of science, or what is seen as the dimension of science, includes four main elements, namely scientific attitudes, scientific processes, scientific products, and the application of scientific methods and knowledge in everyday life (Sulthon, 2016). The development of these four dimensions is expected to make biology learning more meaningful and in accordance with the competencies needed by students in the future.

The first dimension relates to scientific attitude. Suryawati & Osman (2018) states that scientific attitude is a tendency, adaptability, appreciation, and values put forward by scientists in carrying out their work. Dimensions of scientific attitude include curiosity, respect for evidence, willingness to change ideas, critical reflection (Zulirfan, et al., 2018), sensitivity in investigating the environment (Harlen, 2000), as well as diligence and environmental change sensitivity (Budiharti & Sane, 2018). One of the scientific attitude dimension characteristics that are important for students to have is the environmental character. The meanings of environmental character can refer to the opinion of Catford (1991) regarding the concept of Primary Environmental Care (PEC), namely the tendency of individuals, groups, and communities to develop and at the same time implement their capacity in managing the local environment accompanied by efforts to meet the needs of life including health. There is an assumption that changes in environmental behaviour at the individual level can encourage sustainable changes at the community level (Eilam & Trop, 2012). Environmental care is a driving factor for forming pro-environmental knowledge and behaviour underlies environmental conservation activities (Fu, et al., 2018). The character of caring for the environment is based on sensitivity to environmental conditions to encourage someone to do something good for the environment (Fua, et al., 2018). Environmental character indicators in this study are as follows, (1) Environmental knowledge and awareness: willingness to seek (collect) and analyze various information about environmental conditions, (2) Conservation behaviour: awareness to demonstrate effective, efficient, and responsible behaviour in utilizing environmental resources, (3) Environmental movement activism: awareness and at the same time readiness in planning and carrying out investigative activities in order to systematically address or resolve various environmental problems, (4) Attitude towards recycling: awareness and willingness to manage waste/waste correctly and responsibly, and (5) Environmental consciousness and behaviour issues: awareness to implement a healthy and clean lifestyle to strive for environmental preservation and personal and community health (Adapted from Milfont & Duckitt, 2010; Ugulu, Sahin, & Baslar, 2013; Artvinli & Demir, 2018). Thus, students with environmental characteristics are those who not only have awareness but also responsible attitudes and behaviours and love the environment.

The scientific process dimension refers to scientific process skills, namely a set of skills needed to apply scientific processes based on a scientific attitude. Science process skills are related to the ability of students to apply scientific methods, both in understanding, developing, or discovering knowledge (Priyanti & Baroroh, 2020). Rezba, et al. (1995) distinguishes science process skills into two categories: basic science process skills and integrated science process skill. Basic science process skills include observing, communicating, classifying, measuring metrically, inferring, and predicting. Integrated science process skills which include identifying variables, constructing a table of data, constructing a graph, describing relationships between variables, acquiring & processing data, analyzing investigations, constructing hypotheses, defining variables operationally, designing investigations, and experimenting. The aspects of science process skills developed in this study include identifying and defining variables, constructing hypotheses and analyzing investigation, experimenting, acquiring and processing data, and communicating the results of an investigation.

The scientific product dimension refers to the knowledge gained from studying science based on scientific processes and attitudes. The cognitive process is defined as the cognitive activity of learners in

finding and constructing the meaning of knowledge through constructive learning (Anderson-Krathwohl, et al., 2001). Cognitive processes are related to reasoning activities that involve four basic cognitive systems, namely attention, long-term memory, working memory, and metacognition, in producing an explanation (Horne, Muradoglu, & Cimpian, 2019). The cognitive processing abilities targeted in this study include the levels of C1 (remembering), C2 (understanding), C3 (applying), and C4 (analyzing), as referred to the Anderson-Krathwohl theory. The determination of this cognitive level has been adjusted to students' level of development and, at the same time, the level of depth and breadth of the material to be studied.'

Preliminary studies in this study include curriculum analysis, analysis of students' academic abilities (environmental characters, science process skills, and cognitive processing abilities), literature studies, classroom observations, and interviews with high school biology teachers. The preliminary study results show that the implementation of biology learning in high school is still experiencing some problems. These obstacles or problems include: (1) the biology learning process has not integrated the entertainment content proportionally in order to create a pleasant learning climate, (2) the biology learning process has not developed environmental characters, science process skills, and students' cognitive processing abilities optimally, and (3) the biology learning process has not cultivated a culture of outdoor learning activities (setting outdoor activities) which should be able to provide contextual experiences. The implementation of national education must prepare students to become citizens with Indonesian identity, namely citizens who can manage wealth on Indonesian soil, both natural, social, and cultural wealth (Slamet, 2014). Biology learning requires applying a human approach to shape the character and concern of students towards environmental conditions and the surrounding community.

The inquiry learning model has not been consistently applied to the biology learning process. As a result, the development of students' scientific inquiry skills is less than optimal. Observation results also show that the biology learning process still tends to be textual. The forms of learning activities that are commonly applied include lectures, memorizing concepts, discussions, assignments and homework, and presentations. Learning activities that are truly oriented towards new practices are realized through experimental activities in the laboratory. Monotonous learning in the classroom can cause boredom, pressure, or even excessive anxiety in students, which can hinder learning achievement. Several factors that can trigger learning saturation include learning methods that are not preferred, learning media that are less supportive, memorization activities and too many assignments (including homework), the pressure of subject matter, and monotonous learning activities (Damayanti, Suradika, & Asmas, 2020).

The literature study results show that there is no biology learning model that unites the elements of scientific inquiry or investigation with entertainment elements through characterization actions (role-playing) specially prepared for outdoor learning. Parikesit & Damiyanti (2019) have mapped the forms of approaches commonly used to reduce students' anxiety in science learning, such as thematic learning, school development for gifted children, psychotherapy approaches, spiritualism approaches, development of positive classroom conditions, application of problem-based learning, and information technology-assisted learning. Meanwhile, the pursuit of pleasure in learning through the joyful learning model is currently being carried out with interesting assignments (Permatasari, Mulyani, & Nurhayati, 2014), performance appreciation, games, moving places of study (such as in the canteen), learning in nature, learning in the community (such as market) (Sajjad & Djuhan, 2021), traditional games (Ilhami & Khaironi, 2018), guided discovery (Pramesthi, Catur, & Susanti, 2015), use of songs, dramas, demonstrations, film screenings, outdoor activities, discussions, and learning activities that relate subject matter to everyday life (Setyawati, 2020).

This fact encourages researchers to develop new learning model designs that combine elements of scientific inquiry with entertainment content proportionally to improve the character of the environment, science process skills, and students' cognitive processing abilities. The learning model developed is the Detective Thinking-based Edutainment learning model or the abbreviated Edu-Detective Thinking learning model. The Edu-Detective Thinking learning model is intended for outdoor learning, allowing students to be in direct contact with natural phenomena. The research objectives are:

(1) to produce an appropriate Edu-Detective Thinking learning model to improve environmental character, science process skills, and students' cognitive processing abilities, (2) to produce a practical Edu-Detective Thinking learning model to improve environmental character, science process skills, and cognitive process ability of students, and (3) produce an effective Edu-Detective Thinking learning model to improve the character of the environment, science process skills, and cognitive process abilities of students.

## 2. METHODS

The development procedure refers to the Borg & Gall (1983) model, which includes: (1) preliminary study and information gathering, (2) planning, (3) initial product development, (4) preliminary field testing, (5) main product revision, (6) main field testing, (7) operational product, (8) operational field testing, (9) final product revision, and (10) dissemination & implementation. The initial product draft was validated by two experts to test its feasibility according to the theoretical construct. Preliminary field testing aims to test the practicality of the Edu-Detective Thinking learning model in real situations. This stage is also supported by assessing the practicality of the learning model by biology teachers and high school students. While, the main field testing aims to test the effectiveness of the Edu-Detective Thinking learning model in improving the environmental character, science process skills, and students' cognitive processing abilities. In the main field testing, the quantitative data of the experimental group that carried out learning using the Edu-Detective Thinking learning model was compared with the data of the control group that carried out learning with the lecture-discussion learning model. The experimental scheme uses Quasi Experiment and Randomized Control-Group Pre-test & Post-Test Design methods. The subjects in the main field testing were high school students in Yogyakarta, where XA class was the experimental group and XB class was the control group.

Data collection techniques include (1) questionnaires for product validity assessment data by experts and product practicality data by biology teachers and students, (2) observations for collecting data of learning model practicality, student environmental character, and student science process skills, (3) a test for the data on the cognitive processing ability of students. The test is prepared to measure the level of cognitive processing abilities at the cognitive level C1 to C4 in the matter of ecosystems and environmental pollution. The data collection instruments include (1) product validation sheets for experts, (2) product practicality assessment sheets for biology teachers and students, (3) observation sheets for learning model practicality, (4) student environmental character observation sheets, (5) observation sheet of students' science process skills, and (6) questions of students' cognitive process ability tests. The analysis technique for product feasibility data from experts, the practicality of the learning model, the character of the students' environment, and the students' science process skills uses descriptive quantitative analysis regarding the established criteria guidelines. While the analysis technique for differences in environmental characters, science process skills, and cognitive processing abilities of students in the experimental and control groups was using the MANOVA test. The implementation of the MANOVA test refers to normal and homogeneous data.

## 3. FINDINGS AND DISCUSSION

Product feasibility data was obtained from two experts on ecosystem materials and environmental pollution and education experts. The validator assesses the feasibility of the draft Edu-Detective Thinking learning model using a product validation sheet. The validation sheet is arranged based on the learning model design grid. The comments and suggestions from the two experts were also used as a reference in making improvements. Based on Table 1 and Table 2 regarding the validation data of the learning model, it can be concluded that the Edu-Detective Thinking learning model is valid and feasible in terms of theory so that it can be tested in preliminary field testing.

**Table 1.** Data validation of the Edu-Detective Thinking learning model from experts on ecosystem materials and environmental pollution

No.	Indicators	Total Score
1.	The rationale and learning objectives	3,0
2.	Supporting theory	4,0
3.	Principles of reaction and social systems	4,0
4.	Learning syntax	4,0
5.	Direct impact and accompaniment	4,0
6.	Strengths and weaknesses of learning models and support systems	4,0
	Total score	23
	Average score	3,8
	Criteria	Very Good
	Predicate	A

**Table 2.** Data validation of the Edu-Detective Thinking learning model from education experts

No.	Indicators	Total Score
1.	The rationale and learning objectives	4,0
2.	Supporting theory	3,0
3.	Principles of reaction and social systems	4,0
4.	Learning syntax	3,0
5.	Direct impact and accompaniment	3,0
6.	Strengths and weaknesses of learning models and support systems	3,0
	Total score	20
	Average score	3,3
	Criteria	Very Good
	Predicate	A

Preliminary field testing is carried out by observing the level of implementation of the syntax of the Edu-Detective Thinking learning model. The product is said to be practical if every stage in the syntax of the Edu-Detective Thinking learning model can be carried out effectively and efficiently. The process of observing the implementation of learning is carried out by two observers. Based on Figure 1 and Table 3 regarding the practicality data of the learning model, it can be concluded that the Edu-Detective Thinking learning model has met the practical criteria so that it can be tested on the main field testing.

The results of expert validation and preliminary field testing stated that the Edu-Detective Thinking learning model was feasible in terms of theory and also practical in terms of implementation.

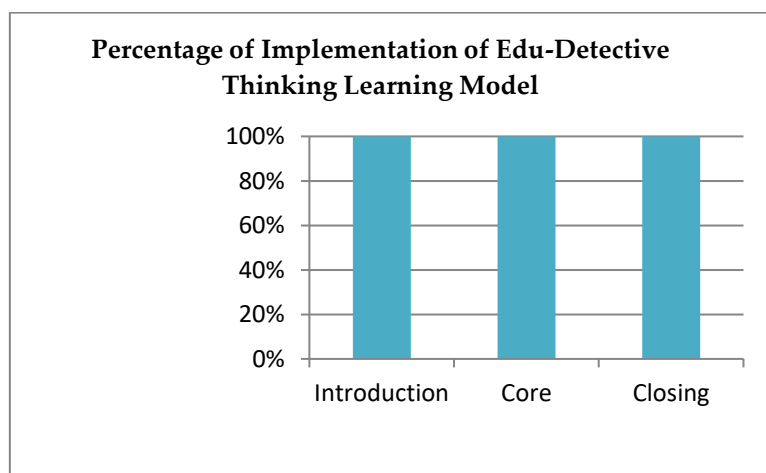
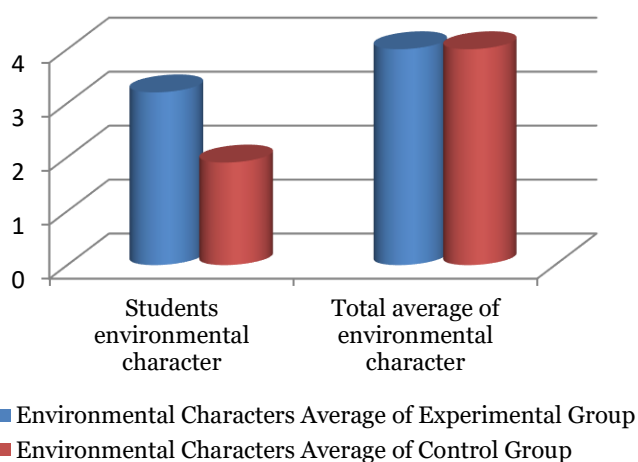


Figure 1. Data on the implementation of the Edu-Detective Thinking learning model in preliminary field testing

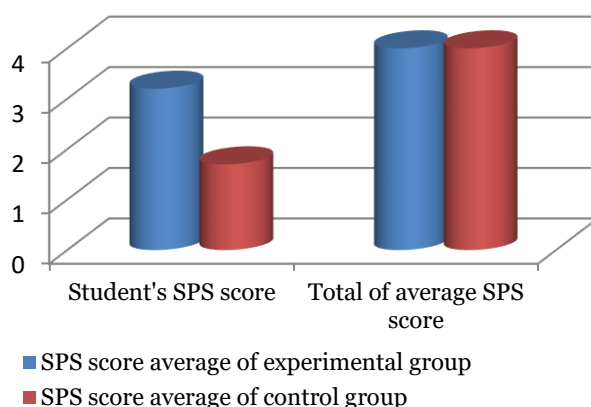
Table 3. Practical data of the Edu-Detective Thinking learning model based on the assessment of biology teachers

Teacher I	Teacher II	Teacher III	Teacher IV	Total Score	Average Score	Category
3,5	3,7	4,0	4,0	15,2	3,8	Very Good

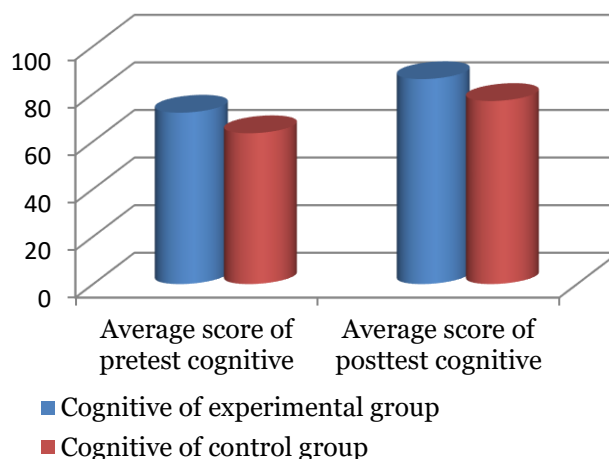
The experimental test results on the main field testing show that the Edu-Detective Thinking learning model is effective in improving the environmental character, science process skills, and students' cognitive processing abilities. The data in Figure 2, Figure 3, and Figure 4 show that there are differences in student learning outcomes between the experimental group and the control group. The MANOVA test also proves that the Edu-Detective Thinking learning model can significantly improve the environmental character, science process skills, and cognitive processing abilities of students (Table 4).



**Figure 2.** Differences in the achievement of the environmental character of the experimental and control group students after learning



**Figure 3.** Differences in the achievement of science process skills of students in the experimental and control groups after learning



**Figure 4.** Cognitive process ability of experimental and control group students

**Tabel 4.** The results of manova test

Multivariate Tests <sup>b</sup>			
	Effect	Value	Sig.
Model	Pillai's Trace	.767	.000
	Wilks' Lambda	.233	.000
	Hotelling's Trace	3.284	.000
	Roy's Largest Root	3.284	.000

The results of the manova test in Table 4. show that the value of the Pillai's Trace test is 0.767, the Wilks' Lambda test is 0.233, the Hotelling's Trace test is 3.284, and the Roy's Largest Root test is 3.284. The significance value of the four statistical tests is less than 0.05, so that H0 is rejected at the 5% significance level. Thus, it can be concluded that there are significant differences related to environmental characteristics, science process skills, and cognitive processing abilities between students in the experimental group who were treated with the Edu-Detective Thinking learning model and the

control group students who were treated with the conventional learning model (model learning lectures).

The design of the learning model adapts the components proposed by Joyce, Weil, & Calhoun (2015), which include supporting theories, syntax, social systems, reaction principles, support systems, and instructional and accompaniment impacts. The syntax of the Edu-Detective Thinking learning model includes (1) introduction: pre-lab activities, formulating important questions; (2) core: formulating hypotheses, analyzing experiments, investigating and inferring cases; and (3) closing: reflecting on process. The product in the form of the Edu-Detective Thinking learning model is also equipped with learning tools, including lesson plans, student worksheets, and assessment instruments (environmental character observation sheets, science process skills observation sheets, and cognitive process ability test questions).

Pre-lab activities are stages in identifying students' initial knowledge and at the same time ensuring their readiness to participate in the learning process. The teacher explains the topic of the study and an overview of the learning activities that will be carried out. Formulating important questions begins by giving guiding questions to students in order to foster curiosity so that they can formulate the various inquiry questions needed. The formulation of research questions is also supported by observations of the environmental conditions that are the target of the investigation. The formulation of research questions is then used as a reference in formulating hypotheses. In this stage, the teacher can assist in obtaining the appropriate and relevant hypothesis formulation. Analyzing experiments is a stage in designing investigation activities regarding the formulation of hypotheses. Investigation planning must be done as well as possible to ensure the smooth investigation process to be carried out. The investigating and inferring cases stage is marked by investigation activities that students start doing in groups. Students conduct investigations through characterization actions like scientists working in the field. Students are directed to work in collecting and reviewing various data and information supported by relevant literature studies. The results of the investigation are concluded and compiled in the form of a report. The reports that have been prepared by each group are then presented and discussed in the forum. The last stage, reflecting on process, is an activity to reflect on the entire learning process carried out. At this stage, the teacher can provide additional assignments as an enrichment option if needed.

The Edu-Detective Thinking learning model was developed by combining the principles of the edutainment model, role playing model, inquiry model, and socratic questioning method. The edutainment model aims to provide a pleasant learning climate and atmosphere to minimize the potential for boredom, stress, and learning anxiety for students. The cognitive development of high school students allows for abstract thinking that can trigger anxiety, especially for things that they have not been able to do (Faridah, et al., 2021). The operationalization of the entertainment element is by characterization action (role playing) as adopted from the principle of role playing model. In groups, students play the role of a group of scientists working in the field to study a case. Suchman's theory states that in the inquiry learning process, students should be invited to imagine or imagine as if they were in actual conditions (Trianto, 2009). The role playing method can bring out students' character through emotional involvement so that it can improve learning (Hernaningsih & Giyoto, 2020). The appreciation of certain characters or events can make it easier for students to identify themselves in the presented plays or games (Waluyo, 2001).

The concept of "detective thinking" represents the principles of the inquiry model and the socratic questioning method. The use of these principles aims to train students' cognitive processing abilities through scientific inquiry activities. Inquiry learning allows students to develop scientific inquiry and reasoning skills (Constantinou, Tsivitanidou, & Rybska, 2018), thinking skills (Minner in Moeed, 2013), and at the same time, the ability to ask various questions about natural phenomena (Crawford, 2007). Oliver (2008) states that inquiry learning can train thinking skills through information processing activities and exploring solutions.

The socratic questioning method and the inquiry model have similar principles. The socratic questioning method can train students' critical thinking skills, which are needed in the learning process



(Syaikhudin, 2016). The socratic questioning method can stimulate students' ability to clarify meaning; expose the assumptions of others or their assumptions; provide evidence, justification, reason or argumentation; identify the implications and consequences of a claim, belief, or action; explain their perspective or point of view; and ask critical questions (Yusoff & Seman, 2018). In essence, the socratic questioning method can train students to question various symptoms or phenomena studied critically, in detail, and in depth.

The teacher can start the investigation activity by giving some guiding questions (help questions) to stimulate students' curiosity regarding the topic of study. The curiosity that has been formed will encourage the emergence of new questions in the students themselves as a follow-up response to the stimulus given by the teacher. These various questions are used as the basis or reference in carrying out scientific investigations. During the investigation, students are directed to review the topic of the problem comprehensively with the support of various reference sources and relevant literature studies. This condition allows students to practice building their knowledge actively and constructively by not just passively relying on the teacher's role.

Learning activities are carried out outside the classroom by reviewing topics that have been determined by the teacher. Outdoor learning can provide opportunities for students to feel, observe, and at the same time examine directly various phenomena that occur in the environment. Contextual learning climate tends to be difficult to realize if learning is only done in the classroom by studying textbooks. The direct learning experience will foster interest, attention, concern, sensitivity, and deep understanding of students to various environmental problems to trigger the formation of environmental character. Contextual learning provides opportunities for students to seek, process, and discover various concrete learning experiences through trying, doing, and experiencing themselves (Ariani, Ristiati, & Setiawan, 2014).

#### 4. CONCLUSION

The Edu-Detective Thinking learning model has been declared valid and feasible in terms of theory based on expert judgment. The Edu-Detective Thinking learning model has met the practical criteria as the results of the preliminary field testing. The Edu-Detective Thinking learning model is proven to improve the environmental character, science process skills, and students' cognitive processing abilities based on experimental tests on main field testing. The limitation of this research is the product trial which is only carried out in two stages, namely preliminary field testing and main field testing. Testing the effectiveness of the learning model needs to be improved through operational field testing to support the wider dissemination and implementation process.

#### REFERENCES

- Alberida, H., et al. (2018). Problem solving model for science learning. *IOP Conf. Series: Materials Science and Engineering*, 335, 012084, 1-13. DOI: <https://doi.org/10.1088/1757-899X/335/1/012084>
- Anderson, L.W. & Krathwohl, D.R., et al. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's Taxonomy of educational objectives*. Abridged Edition, New York: Longman.
- Ariani, M. A. S., Ristiati, N. P., & Setiawan, I. G. A. N. (2014). Implementasi model pembelajaran kontekstual terhadap hasil belajar IPA dan ketrampilan berpikir kritis siswa SMP. *E-Journal Program Pascasarjana Universitas Pendidikan Ganesha Program Studi IPA*, 4. [https://ejournal-pasca.undiksha.ac.id/index.php/jurnal\\_ipa/article/download/1078/826](https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/download/1078/826)
- Artvinli, E. & Demir, Z.M. (2018). A study of developing an environmental attitude scale for primary school students. *Journal of Education in Science, Environment and Health (JESEH)*, 4(1), 32-45. DOI: <https://doi.org/10.21891/jeseh.387478>
- Budiharti, R. & Waras, N. S. (2018). Analysis of student's scientific attitude behaviour change effects blended learning supported by I-spring Suite 8 application. *Journal of Physics: Conf. Series*, 1022, 012024, 1-10. DOI: <https://doi.org/10.1088/1742-6596/1022/1/012024>

Catford, J.C. (1991). Primary environmental care: an ecological strategy for health. *Editorial Health Promotion International*, 6(4), 239-240.

Constantinou, C.P., Tsivitanidou, O.E., & Rybska E. (2018). *What is inquiry-based science teaching and learning?*. In: Tsivitanidou, O., Gray, P., Rybska, E., Louca, L., Constantinou, C. (eds) *professional development for inquiry-based science teaching and learning. Contributions from science education research*, 5. Springer, Cham. DOI: [https://doi.org/10.1007/978-3-319-91406-0\\_1](https://doi.org/10.1007/978-3-319-91406-0_1)

Crawford, B.A. (2007). Learning to teach science as inquiry in the rough and tumble of practice. *Journal of Research in Science Teaching*, 44(4), 613-642. DOI: <https://doi.org/10.1002/tea.20157>

Damayanti, A., Suradika, A., & Asmas, T.B. (2020). Strategi mengurangi kejenuhan anak dalam Pembelajaran Jarak Jauh (PJJ) melalui aplikasi ICANDO pada siswa kelas I SDN Pondok Pinang 08 Pagi. *Makalah disajikan dalam Seminar Nasional Penelitian LPPM Universitas Muhammadiyah Jakarta*, Jakarta. Diambil dari <https://jurnal.umj.ac.id/index.php/semnaslit/article/download/7861/4676>.

Eilam, E. & Trop, T. (2012). Environmental attitudes and environmental behavior-which is the horse and which is the cart? *Sustainability*, 4, 2210-2246. DOI: 10.3390/su4092210

Faridah, E., et al. (2021). Softball catching learning model development for high school students. *Al-Ishlah: Jurnal Pendidikan*, 13(3), 1593-1599. DOI: <https://doi.org/10.35445/alishlah.v13i3.808>

Fua, J.L, et al. (2018). Development of environmental care attitude of students through religion education approach in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 175, 012229, 1-7. DOI: <https://doi.org/10.1088/1755-1315/175/1/012229>

Fu, L., et al. (2018). Pro-environmental awareness and behaviors on campus: evidence from Tianjin, China. *EURASIA Journal of Mathematics, Science and Technology Education*, 14(1):427-445. DOI: <https://doi.org/10.12973/ejmste/77953>

Harlen, W. (2000). *Teaching, learning, and assessing science 5-12 (3<sup>rd</sup> eds)*. London: Paul Chapman Publishing Ltd.

Hernaningsih, T. & Giyoto. (2020). Pengaruh metode role playing untuk meningkatkan kecerdasan emosional siswa SMA Batik 1 Surakarta. *An-Nizom*, 5(3), 197-202. DOI: <http://dx.doi.org/10.29300/nz.v5i3.3810>

Ilhami, B.S. & Khaironi, M. (2018). Pelaksanaan joyful learning berbasis permainan tradisional sasak untuk meningkatkan motorik kasar anak usia 5-6 tahun. *Jurnal Golden Age Hamzanwadi University*, 2(2), 59-65. DOI: <https://doi.org/10.29408/goldenage.v2i02.1023>

Joyce, B., Weil, M., & Calhoun, E. (2015). *Models of teaching (9<sup>th</sup> ed)*. New Jersey: Pearson Education, Inc.

Kustijono, R., Jatmiko, B., & Ibrahim, M. (2018). The effect of scientific attitudes toward science process skills in basic physics practicum by using peer model. *International Journal of GEOMATE*, 15(50), 82-87. DOI: <https://doi.org/10.21660/2018.50>

Milfont, T.L. & Duckitt, J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. *Journal of Environmental Psychology*, 30(1), 80-94, DOI: <https://doi.org/10.1016/j.jenvp.2009.09.001>

Moeed, A. (2013). Science investigation that best supports student learning: Teachers' understanding of science investigation. *International Journal of Environmental & Science*, 8(4), 537-559. DOI: <https://doi.org/10.12973/ijese.2013.218a>

Oliver, R. (2008). Engaging first year students using a web-supported inquiry-based learning setting. *Higher Education*, 55, 285301. DOI: <https://doi.org/10.1007/s10734-007-9055-7>

Parikesit, A.A. & Damiyanti, M. (2019). Kecemasan terhadap mata ajar Ilmu Pengetahuan Alam (IPA) pada siswa sekolah dasar dan menengah. *Jurnal Manajemen Pendidikan*, 14(2), 82-90. DOI: <https://doi.org/10.23917/jmp.v14i2.4387>

Permatasari, A.I., Mulyani, B., & Nurhayati, N.D. (2014). Efektivitas penggunaan model pembelajaran joyful learning dengan metode pemberian tugas terhadap prestasi belajar siswa pada materi pokok koloid siswa kelas XI IPA SMA Negeri 1 Simo tahun pelajaran 2012/2013. *Jurnal Pendidikan Kimia (JPK)*, 3(1), 117-122.

Pramesthi, H.N., Catur S.A.N., & Susanti, V.H.E. (2015). Penerapan pendekatan joyful learning dengan metode guided discovery untuk meningkatkan rasa ingin tahu dan prestasi belajar pada materi hidrokarbon siswa kelas X SMA Negeri 1 Ngemplak Boyolali tahun ajaran 2013/2014. *Jurnal Pendidikan Kimia*, 4(1), 204-210.

Putra, G.D., Milama, B., & Saridewi, N. (2018). Scientific attitude profile of student through guided inquiry by experiment method. *Advances in Social Science, Education and Humanities Research*, 115, 191-195. DOI: <https://doi.org/10.2991/icems-17.2018.37>

Priyanti, B.A. & Baroroh, N. (2020, Juli 25). Kaitan model pembelajaran inkuiri dan keterampilan proses sains pada pembelajaran IPA di sekolah dasar. *Makalah disajikan pada Seminar Nasional Pendidikan Dasar Universitas Muhammadiyah Purworejo, Purworejo*. Diambil dari [http://eproceedings.umpwr.ac.id/index.php/semnaspgsd/article/view/1403/1220](http://eproceedings umpwr.ac.id/index.php/semnaspgsd/article/view/1403/1220)

Rezba, R.J., et al. (1995). *Learning and assessing science process skills (3rd ed)*. Des Moines: Kendall/Hunt. Publishing Company.

Sajjad, A.M. & Djuhan, M.W. (2021). Penerapan strategi joyful learning dalam penanaman sikap tanggung jawab siswa (studi kasus pembelajaran IPS di SMP Negeri 1 Mlarak). *JIPSI: Jurnal Ilmiah Ilmu Pengetahuan Sosial Indonesia*, 1(1), 106-116.

Setyawati, H. (2020). Penerapan joyful learning untuk meningkatkan hasil belajar mahasiswa matakuliah fisiologi tumbuhan. *Indonesian Journal of Mathematics and Natural Sciences Education*, 1(3), 158-164. DOI: <https://doi.org/10.35719/mass.v1i3.39>

Slamet, P.H. (2014). Politik pendidikan Indonesia dalam abad ke-21. *Cakrawala Pendidikan*, 33(3), 324-337. DOI: <https://doi.org/10.21831/cp.v3i3.2377>

Sulthon. (2016). Pembelajaran IPA yang efektif dan menyenangkan bagi siswa Madrasah Ibtidaiyah (MI). *ELEMENTARY*, 4(1), 38-54. DOI: <http://dx.doi.org/10.21043/elementary.v4i1.1969>

Suryawati, E., & Osman, K. (2018). Contextual learning: Innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 61-76. DOI: <https://doi.org/10.12973/ejmste/79329>

Syaikhudin, A. (2016, May 11-12). Fostering students' critical thinking skills in elementary social studies using Socrates Question Method (SQM). *Paper presented at The First International Conference on Child-Friendly Education (ICCE), Surakarta*. Retrieved from <https://publikasiilmiah.ums.ac.id/bitstream/handle/11617/7239/7%20-%20Ahmad%20Syai%20khudin.pdf?sequence=1&isAllowed=y>

Trianto. (2010). *Mendesain model pembelajaran inovatif-progresif*. Jakarta: Kencana Prenada Media Group.

Ugulu, I., Sahin, M., & Baslar, S. (2013). High school students' environmental attitude: scale development and validation. *International Journal of Educational Sciences*, 5(4), 415-424, DOI: <https://doi.org/10.1080/09751122.2013.11890103>

Waluyo, H.J. (2001). *Drama, teori dan pengajarannya*. Yogyakarta: Hanindita.

Yusoff, W.M.W. & Seman, S.C. (2018). Teachers' knowledge of higher order thinking and questioning skills: a case study at a primary school in Terengganu, Malaysia. *International Journal of Academic Research in Progressive Education and Development*, 7(2), 45-63. DOI: <https://doi.org/10.6007/IJARPED/v7-i2/4120>

Zulirfan, et al. (2018). Take-home-experiment: enhancing students' scientific attitude. *Journal of Baltic Science Education*, 17(5), 828-837. DOI: <https://doi.org/10.33225/jbse/18.17.828>