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Development of a science process skills-based interactive website 'bioenial' on environmental pollution material

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A R T I C L E I N F O	**A B S T R A C T**
	This study aims to develop an interactive website based on the science process skill 'Bioenial' on Environmental Pollution material for grade X SMA/MA and identify the achievement of science process skills in the use of the 'Bioenial' website. This study was designed based on the Research & Development design from the Thiagarajan 4D development model (Define, Design, Develop and Disseminate). The instruments used in this study were media and material expert validation sheets, student worksheets, and student and teacher response sheets. The analysis technique used the Rasch analysis. The results showed that (1) the Feasibility of the 'Bioenial' website, the average percentage score of validity obtained from the three media experts was 97,4% that within the "Very Eligible" category, and the percentage score from the material experts was 76.6% or within the "Eligible" category. The 'Bioenial' website was tested in a class of 32 students and on two biology teachers. The results of student responses according to the person measure obtained a mean of 85.5, meaning that the website is "Eligible" to use. The results of the teacher's response show that the Bioenial website is "Appropriate" for learning. (2) Science process skills can be developed on environmental pollution materials with the 'Bioenial' website observing, classifying, predicting, communicating, designing, and conducting experiments. Assessment of the skills of conducting experiments is unlikely during the distance learning period due to the difficulty to provide evaluations. Based on the study results, further research is needed to determine the effectiveness of the 'Bioenial' website in improving students' cognitive learning outcomes.

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INTRODUCTION

Science process skills (SPS) are skills to acquire, develop, and apply theories and concepts of natural sciences. Learning with science process skills allows teachers to get students to be active during the learning so they can find and develop a concept (Suryaningsih, 2017). The science process skills consist of two skills, namely, basic and integrated science process skills. The integrated science process skills are the combination of two or more basic science process skills (Nworgu & Otum, 2013). Model, method, and media used in the learning affect the development of students' science process skills. The reality, however, many teachers do not facilitate students to develop their science process skills.

The importance of SPS empowerment in the implementation of distance learning requires teachers to be more creative, innovative, and productive to create an interesting and fun classroom: one of them is by observing the surrounding environment (Nawawi, Handayani, & Sukardi, 2021). Science process skills are empowered through observation or simple experiments at home while in distance learning. It is necessary to apply SPS in information and communication technology-based media. Yusuf (2018) states that learning is easy to accept and increases motivation for further learning by applying information and communication technology. Additionally, science process skills can be developed interestingly (Yusuf & Widyaningsih, 2018). The use of information and communication technology-based teaching media increases science process skills achievement (Vebrianto & Osman, 2011); (Suyatna, Nugraha, & Rakhmawati, 2019).

ICT usage in education opens an opportunity to gain quality education and education administration. Appropriate use of ICT in learning can improve learning process effectiveness thus improving students' learning outcomes and quality (Chaidar, 2014). Distance learning (PJJ) is an example of ICT development in education. It is a teaching and learning activity that facilitates teachers and students in different locations to interact using media (Prawiyogi, Purwanugraha, Fakhry, & Firmansyah, 2020).

Biology is part of sciences or natural sciences that comprises four components based on its nature, namely, attitudes, processes, products, and technology (Carin & Sund, 1990). Teachers must pay attention to learning to suit its nature (attitudes, processes, products, and technology). Besides its focus on material, Biology learning also emphasizes process skills as one of the nature of the processes in sciences that is called science process skills.

On the other hand, learning activities during the pandemic are merely lectures and assignments; therefore, students sit, listen, and write during class without active participation. During the teaching and learning activity, students are unable to develop science process skills, such as observing, formulating problems, testing, and generalizing. The condition indicates that during distance learning, schools only act as an assignment collection point instead of a place to gain knowledge (Maesaroh, Anugrah, Elvianasti, & Irdalisa, 2021). Research by Zamista (2016), finds that teachers who apply a dominant conventional method of lectures lead to low students' cognitive results due to the lack of science process skills practice. Efforts to overcome the issue are by designing effective and interesting learning to enhance students' science process skills (Zamista, 2016).

Environmental pollution material is a material potential to develop science process skills. The material emphasizes high information processing and analytical skills among students (Azrai, Ernawati, & Sulistianingrum, 2017). It is an important material to study since it raises awareness of the environment among students. Moreover, it is essential to teach the material to the students so they could understand the concepts of environmental issues that will promote their environmental awareness attitudes.

A study by Parker (2018) finds that regarding the identity, behaviors, perceptions, and responsibilities of the Indonesian young generation towards the environment, 90% of the students state that they care about the environment but less action towards it. Students lack the capability to identify and solve environmental problems in their surroundings. Awareness to manage waste such as recycling bank is low, which is 41.7% (Parker, Prabawa-Sear, & Kustiningsih, 2018).

Issues of environmental awareness are common in Indonesian schools. An observation in a study by Safitri (2019) shows that, in terms of student ethics towards the environment, 34% of the students are unkind to the environment. A similar result indicates by Sinmarmata (2018) that students' awareness about the environment is low. An observation by Simarmata, Daulae, and Raihana shows that many students scribble on tables and chairs, throw trash in the desk drawer, and use the bathroom as a garbage dump (Simarmata, Daulae, & Raihana, 2018). A study by Simarmata (2018) also suggests that

an increase in student knowledge of the environment has a weak effect on the improvement of environmental awareness attitudes; hence, real learning is necessary to improve the attitude. The current study requires students to have meaningful experiences so they can find ideas to solve environmental problems that occur in their surroundings.

Irianto (2017) opines that the low attitudes of caring for the environment of the students are due to teachers who have not implemented appropriate learning approaches and methods. Inappropriate learning is meaningless since it becomes irrelevant in solving daily environmental problems. Teachers lack in encouraging students to foster their attitude of caring for the environment through real actions (Nisa, Nadiroh, & Siswono, 2018). Therefore, developing students' process skills require interactive and constructive learning that gives opportunities for students to explore the to-be-studied objects (Irianto, Nadiroh, & Nuryadin, 2017).

Numerous researchers have conducted a study on website development on environmental pollution material. A study by Fitriani (2018) concludes that the use of learning media become interactive, more interesting, and less monotonous and enhances students' learning interest. Another research summarizes that ICT-based learning media, such as the use of electronic teaching materials, can train science process skills. Suryaningsih (2017), science process skills contribute to improving students' cognitive results. The research highlights meaningful experiences in the form of student activities to acquire knowledge.

The aforementioned suggests efforts in creating online and fun learning media to help students to develop science process skills. Innovation can be the combination of ICT and learning media in the form of the Development of Science Process Skills-based Interactive Website Media of Bioenial on Environmental Pollution Material. Bioenial is a 4.0-based website that facilitates students to have learning experiences in the form of meaningful activities so they can find their knowledge. The learning experience feature is one of the pillars of the Bioenial website in empowering science process skills. The feature demands students to upload concrete evidence of their independent activities related to their learning experience and it becomes a requirement for students to gain material prepared by the teachers. The interactive website is a solution to develop students' science process skills while in distance learning via the internet. The current study aims to identify the eligibility of the 'Bioenial' website in improving students' science process skills.

METHODS
Research Design

The research was a research and development with the Thiagarajan 4D (Define, Design, Develop, and Disseminate) development model. Each stage in the research had been conducted according to the current arrangement. The define stage included activities of analyzing curriculum, student and teacher needs, and material and formulating learning objectives. The second stage, which is design, was started by compiling materials, selecting media, and choosing the initial product's form and design. The third stage, which is develop, consisted of media evaluation, media revision, product trial, product revision, product evaluation, and product improvement. The last stage, which is disseminate, was informing and applying the Bioenial website (https://bioenial.com/) in several schools in Surakarta City.

Population and Samples

The research subject for initial data was selected using a purposive random sampling technique, which was Grade XI which was in distance learning. The research subject for the data of limited scale media testing was Class X of MIPA 6 SMAN 4 Surakarta, Indonesia which consisted of 32 students. The limited trial aimed to identify the eligibility response of the 'Bioenial' website with real user targets, which were students and teachers. The analysis used in the limited trial was the Rasch model analysis. Three media experts and one material expert tested the eligibility of the 'Bioenial' website on the Environmental Pollution material. The 32 students of Class X MIPA 6 and 2 biology teachers in SMAN 4 Surakarta, Indonesia assessed the usage response.

Instrument

The research instruments consisted of a questionnaire on need analysis, validation sheets, student activities questions, and a questionnaire on the media usage response. The validation sheets evaluated the eligibility of the developed product. The essay test questions would indicate the SPS achievement.

The assessment aspects included usability, functionality, and visual communication. The usability aspect employed indicators of menu presentation understanding and access to the website address. The functionality aspect disclosed the functionality of the website menus. The visual communication aspect comprised the website display, language use, and the suitability of language with student development.

Procedure
Define Stage
The define stage included activities of analyzing curriculum, student and teacher needs, and material and formulating learning objectives. The curriculum analysis aimed at identifying the needs of students' learning sources according to the 2013 curriculum. The need analysis of students and teachers employed a questionnaire on SPS empowerment during distance learning. The formulation of the learning objective helped in identifying goals to be achieved by the students.

Design Stage
The second stage was the design stage which started with preparing materials, selecting media, and choosing the form to design the initial product. Preparing materials aimed at adjusting the materials to the 2013 curriculum and students' needs. Media selection determined learning media that were suitable to the materials and students' characteristics. The media chosen was effective, efficient, and usable for a long time. The selection of form was directed to obtain the optimal form of the media presentation in the use of the media. The form of the developed website in the research was dynamic and interactive. Initial product design adjustment intended to combine media, materials, and the form of presentation into an initial product adjusted to the 21st-century learning characteristics.

Develop Stage
The third stage was the develop stage, which was developing Bioenial website media with an address https://bioenial.com/ and followed by the stages of media validation, media revision, product trial, product revision, product evaluation, and product improvement. The media validation was a formative assessment stage conducted by the media and material experts. The design validation assessed the eligibility and usability as improvement suggestions for the developed product before the field trial.

Disseminate Stage
This stage was the dissemination stage of the media so teachers could use it as a mode of online biology learning. Teachers who have an interest and awareness in implementing meaningful learning in online biology learning during the pandemic can use the website that was specifically designed to facilitate SPS empowerment. They will receive an account that includes a username and password to open and manage classrooms.

Data Analysis Techniques
The analyzed data consisted of data from the validation results of the media and material experts, the response of students and teachers, and the results of the questions. The data analysis techniques were quantitative and qualitative. The qualitative descriptive analysis technique was obtained from suggestions and input from the experts, students, and teachers. The quantitative descriptive analysis technique was for the results of the expert assessment in a percentage, whereas the student and teacher responses and SPS achievement were analyzed using the Rasch model analysis.

1. **Eligibility Analysis of Bioenial Website Media**
   Data collected from the media and material experts were processed using a quantitative analysis technique with the following formula:

$$P = \frac{\sum xi}{\sum x} \text{ x } 100\%$$

<div align="right">(Tegeh & Pudjawan, 2014)</div>

Where:
P   = Percentage of assessment
∑xi   = Total score from the validator

∑x   = Total maximum score

The media eligibility categories are presented in Table 1.

Table 1.
Media Eligibility Scale

Percentage	Qualification	Description
90% - 100%	Very Eligible	No revision
75 – 89%	Eligible	Necessary Revision
65 – 74%	Fairly Eligible	Much Revision
55 – 64%	Less Eligible	Substantial Revision
0 – 54%	Not Eligible	Total Revision

(Tegeh & Pudjawan, 2014)

2. **Response to website usage**
The data of teachers' and students' responses towards the use of interactive website media were generated using a response questionnaire. The data were processed using the Rasch model analysis. George Rasch developed the Rasch model analysis in the 1960s. The analysis is one of the models of the Item Response Theory (IRT) popularized by Ben Wright (Linacre, 2011). The analysis employed Winsteps software version 4.3.2.

Item measure aimed to find out the quality of each tested item. The higher the logit score of the item measure the more difficult it is for the item or assessment aspect to receive a positive score.

3. **SPS Achievement**
The data from the observation results on the use of an interactive website using a checklist (√) on an observation sheet were analyzed using a quantitative descriptive analysis with a percentage. The collected data were processed using the Rasch model analysis. Students who have the high ability should be able to answer the questions correctly (Sumintono & Widhiarso, 2015).

RESULTS AND DISCUSSION
a) Image of Bioenial Product
Main Display of Website Bioenial homepage
The main display includes a homepage (*beranda*), about us (*tentang*), and contact (*kontak*). The homepage contains the front page of the website and explains the website.
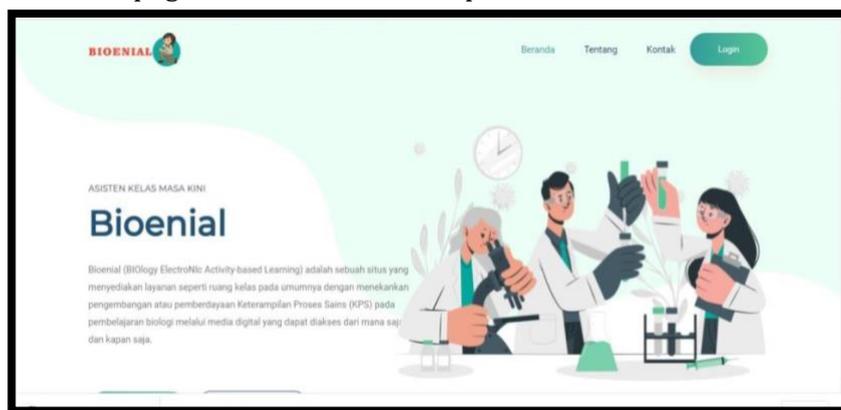

Figure 1. Main Display of the Website

About Us (*Tentang*) Menu
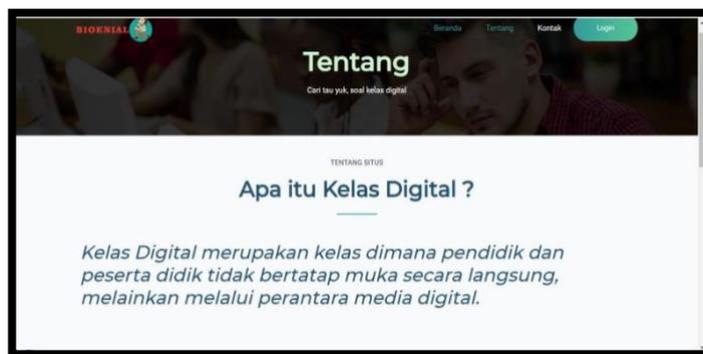The menu contains definitions and the purposes of the bioenial website.

Figure 2. Display of "About Us (*Tentang*)"

Main Menu of Class Page (*Halaman Kelas*)

The menu contains sub-menus that comprise Learning Objectives, Glossary, and References
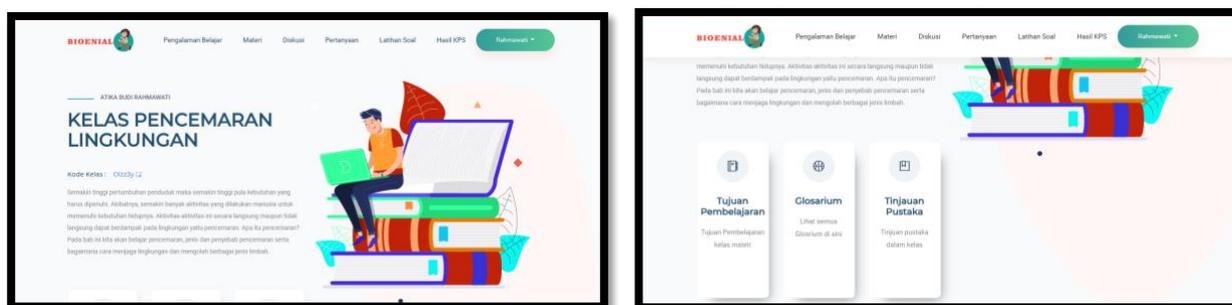

Figure 3. Main Class (*Kelas Utama*) Menu

Learning Experience (*Pengalaman* Belajar) Menu

In the Learning Experience Menu, teachers facilitate input on activity instructions for students according to the material studied. Students can answer the instructions by uploading files or inputting answers in the form of text in the given column. Teachers can set the deadline for the answer submission and submission after the deadline is rejected. Learning is meaningful if it presents real objects in the classroom and structured assignments outside the classroom (Uno & Koni, 2012). The Learning Experience Menu presents authentic evidence of the structured assignment work.
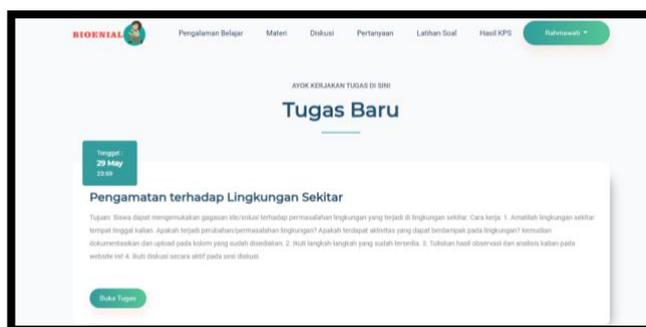

Figure 4. Display of Learning Experience (*Pengalaman Belajar*)

Material (*Materi*) Menu

Students can download the materials provided by the teachers after they complete their meaningful experience assignments contained in the learning experience menu.
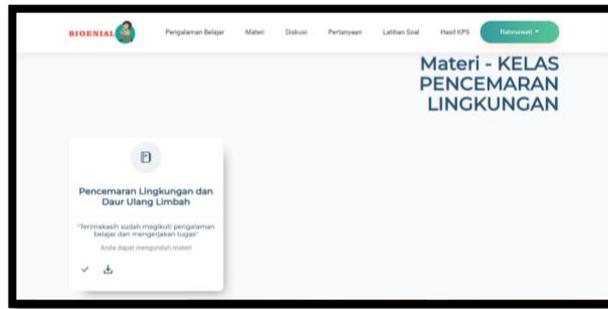
Figure 5. Display of Material (*Materi*)

Discussion (*Diskusi*) Menu

The purpose of the menu is for two-way synchronous communication. The menu contains a live chat feature that facilitates the two-way communication when students are online at the same time.
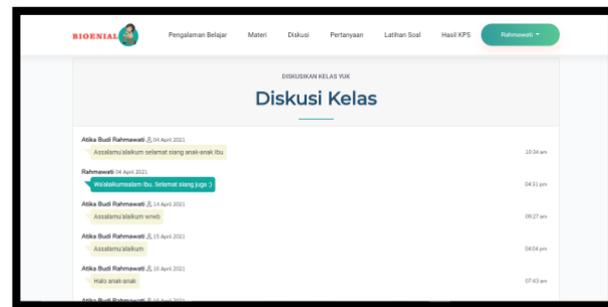
Figure 6. Display of Discussion (*Diskusi*)

Question (*Pertanyaan*) Menu

The menu is for asynchronous learning that helps students to understand the materials and ask questions outside the learning hours. Asynchronous means that students and teachers are not in the real-time virtual room (Muhammad Hanif Fahmi, 2020).

Figure 7. Display of Question (*Pertanyaan*)

Exercise (*Latihan Soal*) Menu

The menu covers exercises of multiple-choice questions on the studied materials. If students have completed the questions, they receive the score and the question discussion. The exercises can indicate the students' cognitive level.

Figure 8. Display of Exercise (*Latihan Soal*)

SPS (KPS) Score Menu

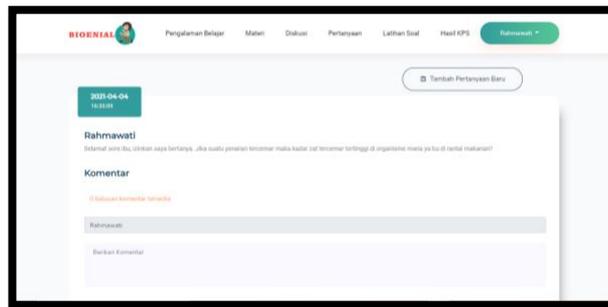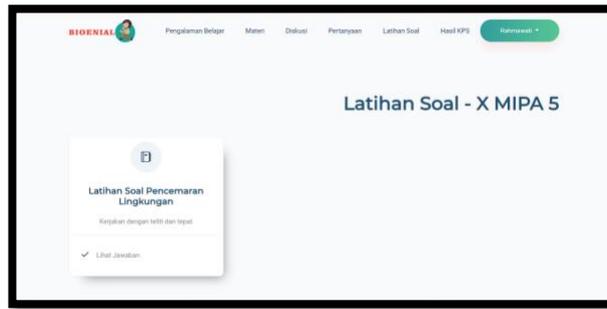The menu comprises students' SPS scores after the SPS learning activities according to the given materials. It also contains an assessment rubric that allows students to find out their scores according to the rubric.
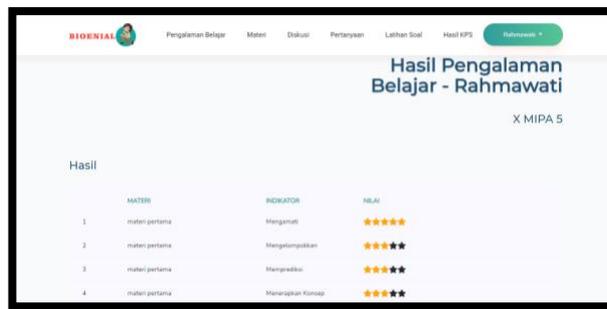

Figure 9. Display of SPS Score

b) Media Eligibility
Media Experts

The assessment of Bioenial Website media eligibility used indicators of *usability* (understanding of menu presentation, access of website address, actuality of website content), functionality (functionality of website menus), and visual communication (display of the website, the use of language, and language according to the student development). Table 2 presents the recapitulation results of the validation from the three media experts.

Table 2.
Media Expert Assessment

No	Assessment Aspect	Indicator	Expert			Percentage	Category
			1	**2**	**3**		
1.	Usability	Understanding of menu presentation	5	4	5	93.3%	Very Eligible
		Access to the website address	5	5	5	100%	Very Eligible
2.	Functionality	The functionality of the website menu	5	5	5	100%	Very Eligible
3.	Visual Communication	Display of the website	5	5	5	100%	Very Eligible
		The use of language	5	4	5	93.3%	Very Eligible
		Language according to the student development	5	4	5	93.3%	Very Eligible
	Average					**97.4%**	**Very Eligible**

Table 2 shows the quality of the developed Bioenial website media on the environmental pollution material. The table indicates that the average percentage of the assessment aspects of (1) usability was 88.9%, (2) functionality was 100%, and (3) visual communication was 95.5%; the three aspects were within the "very eligible" category. All in all, the assessment aspects of the developed SPS-based interactive website media 'Bioenial' on the environmental pollution material meet the very eligible category; however, it needs revision according to the suggestions and input from the three media experts.

The media experts gave a good evaluation of the Bioenial website with input for further development. The input includes: 1) emphasize the color of the website display to make it more attractive, 2) the "Exercise (*Latihan Soal*) Menu" on the website should add essay questions besides the multiple-choice questions, and 3) the expectation is to develop the website further. An attractive display of the learning media will bring enthusiasm among students to learn (Mulyani, 2019). The essay questions will train students' analysis and critical thinking skills (Yustyan, Widodo, & Pantiwati, 2015). Interactive multimedia will make students easy to grasp and remember a lesson due to the visualization of the lesson in the form of text, audio images, video, and animation (Sadikin, Johari, & Suryani, 2020).

Material Expert

The indicators to measure the eligibility of the 'Bioenial' website media on the environmental pollution material by the material expert consisted of content eligibility (the material completeness and depth, material accuracy and truth, and learning support materials) and presentation eligibility (presentation technique and material display). Table 3 shows the recapitulation results of the validation by the three media experts.

Table 3.
Assessment of Material Experts

No	Assessment aspect	Indicator	Material Expert	Percentage	Category
1.	Material Eligibility	Material completeness and depth	4	80%	Very Eligible
		Material accuracy and truth	3	60%	Eligible
		Learning support materials	4	80%	Very Eligible
2.	Presentation Eligibility	Presentation Technique	4	80%	Very Eligible
		Material display	4	80%	Very Eligible
	Average			**76.65%**	**Eligible**

The quality of the environmental pollution material of the developed Bioenial website indicates that the average percentage of the assessment aspects of (1) the content eligibility was 73.3% and (2) the presentation eligibility was 80%; both aspects were in the eligible category. Overall, the material assessment aspects in the developed SPS-based interactive website 'Bioenial' on the environmental pollution materials obtained an average percentage of 76.65% or in the "eligible" category for use with revisions. The revisions refer to the material experts' suggestions.

The input from the material experts focuses on the addition of important materials related to environmental pollution. The materials include parameters of air pollution according to Environmental Law No. 41/1999 and waste issues as the focus of the soil pollution subject. The environmental pollution material is closes to students thus it has the potential to provide meaningful learning that trains students' analysis and thinking skills to solve problems (Aninda, Permanasari, & Ardianto, 2019).

c) Students and Teachers' Responses in the use of 'Bioenial' Website Students Responses

The results of the Rasch Analysis on the students' response suggest that the majority of the students agreed on the utilization of the 'Bioenial' website as a learning medium and it could help them to understand the materials. Moreover, they also agreed in the media display, the media's ease of use, and the language presentation and it can be used as an independent learning medium. About 17 students

were on the logit scale of 4.47-1.79 and expressed their agreement on all assessment aspects with different logit scales suggesting that the positive rating rate of each individual is different depending on the logit scale produced. The Person-map item of students' responses is illustrated in Figure 10.
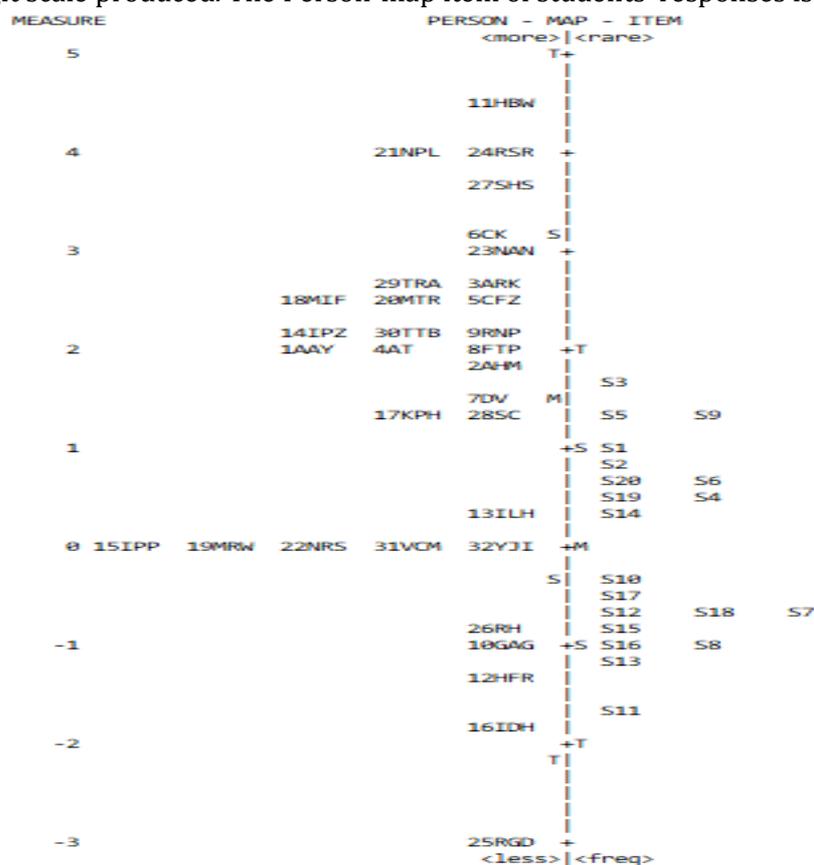
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MEASURE                          PERSON - MAP - ITEM
                                   <more>|<rare>
    5                                   T+
                                        |
                              11HBW     |
                                        |
    4                21NPL   24RSR      +
                             27SHS      |
                                        |
                              6CK     S|
    3                        23NAN      +
                    29TRA   3ARK        |
            18MIF   20MTR   5CFZ        |
            14IPZ   30TTB   9RNP        |
    2       1AAY    4AT     8FTP      +T
                           2AHM        |
                                       |     S3
                    7DV     M|          S5          S9
            17KPH   28SC      |         S5          S9
    1                       +S S1
                               |        S2
                               |        S20         S6
                               |        S19         S4
                    13ILH      |        S14
    0  15IPP  19MRW  22NRS  31VCM  32YJI +M
                              S|        S10
                               |        S17
                               |        S12         S18    S7
                    26RH       |        S15
   -1               10GAG    +S S16         S8
                               |        S13
                    12HFR      |
                               |        S11
                    16IDH      |
   -2                        +T
                             T|
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   -3               25RGD     +
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Figure 10. Person-map-Item of students' response to the Bioenial website

The lowest logit score in the item measure was in the assessment item number 11 (the material is well downloaded) and number 13 (the material on the website is following the taught materials). The item measure with the highest logit scale found in the assessment items number 3, 5, 9, and 1. The higher the logit score of the item measure the more difficult the assessment items are to gain a positive score. Based on the student's comments in the questionnaire, students struggled in submitting the assignments since they must submit the answer one by one, which is ineffective. Moreover, they commented that they must refresh the Discussion menu page. Therefore, assessment items number 3, 5, 9, and 1 received a high logit score in the item measure. Assessment item number 2 received the lowest logit scale, which was -1.59, indicating that many students gave a positive response on the aspect.

Teachers' response
Both teachers gave a positive impression of the use of the 'Bioenial' website. The result suggests that the positive assessment level of a teacher with code 2YEM on the 'Bioenial' website was below those of a teacher with code 1TS. The teacher with code 1TS gave a very positive assessment on assessment aspects number 4, 5, 6, 7, 8, 10, and 15, yet was doubtful with assessment aspect number 12. The teacher with code 2YEM provided a very positive score on aspects number 6, 8, 10, and 13, but was doubtful with assessment aspect number 12. Item number 12 discloses the aspect of curiosity of the teachers on whether they are familiar with the use of the 'Bioenial' website in learning. Both teachers gave a dubious assessment since they rarely use the 'Bioenial' website. The results of the teachers' responses can be seen in Figure 11.
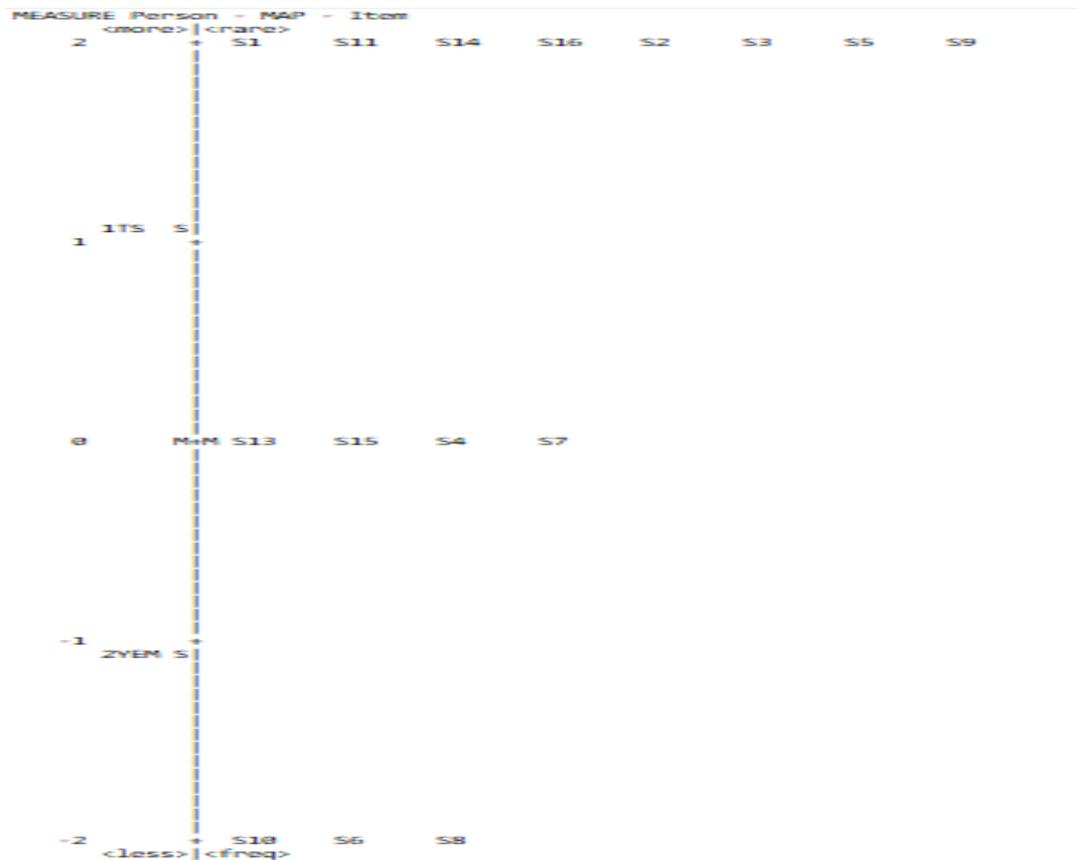
Figure 11. Person-map-item of teachers' response

The teachers, in general, appraise that the 'Bioenial' website on the environmental pollution material is eligible to develop ICT-integrated SPS. Input from the biology teachers includes 1) The website needs further development for broader use by including subjects other than Biology; 2) The website is adequate to forge students' SPS, especially in distance learning; however, it needs to develop the features.

d) SPS Achievement

The analysis of students' science process skills was conducted on the results of students' learning experience activities on the 'Learning Experience (*Pengalaman Belajar*)' Menu. Based on the logit score in the person measure, the students' SPS level was in the range of -4.28 logit to 2.78 logit. The highest ability was found in a student with code 151IPP (measure = +2.78) and the lowest was in a student code 27SHS (measure = -4.28). Other students who received the lowest logit were students with codes 4AT, 6CK, 14IPZ, 19MRW, 2RM, and 27SHS. The person-map-item of the students' SPS achievement is illustrated in Figure 12.

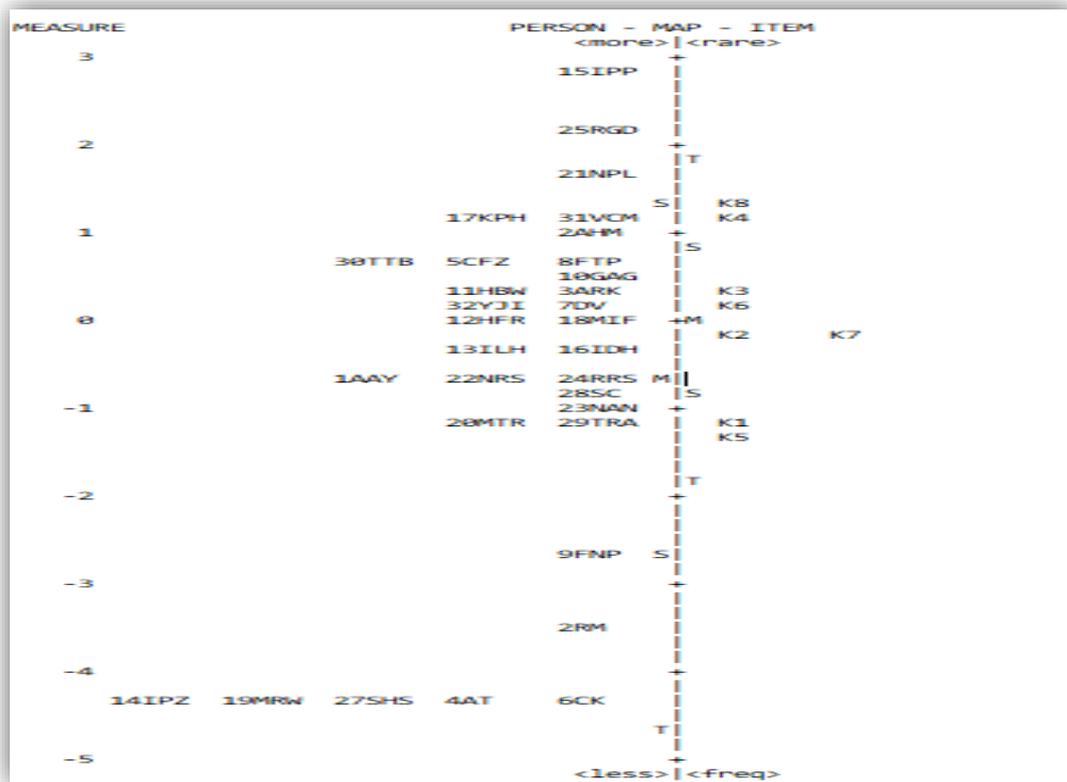**Figure 12.** *Person-map-Item* of Students' SPS Achievement

The item measure indicates that the instrument of skills to experiment (measure=+1.26) had the highest difficulty level or the hardest to achieve by the students, whereas the skills of applying the concepts (measure = -1.29) had the lowest difficulty or the easiest to achieve by the students. The item measure of each SPS item to be developed can be seen in Figure 13.

ITEM STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	PTMEASUR-AL EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	ITEM
8	35	32	1.26	.25	.69	-1.24	.73	-.41	.75	.70	50.0	55.9	K8
4	37	32	1.13	.25	.59	-1.79	.49	-1.14	.80	.71	68.8	54.7	K4
3	50	32	.36	.24	.88	-.39	.76	-.58	.82	.78	53.1	55.2	K3
6	54	32	.12	.24	.85	-.52	.79	-.54	.81	.80	59.4	55.5	K6
2	58	32	-.11	.24	.76	-.92	.67	-1.05	.86	.81	71.9	55.3	K2
7	60	32	-.23	.25	2.29	3.69	1.99	2.55	.73	.82	40.6	55.3	K7
1	76	32	-1.23	.25	1.45	1.62	1.37	1.32	.78	.84	25.0	53.7	K1
5	77	32	-1.29	.25	.60	-1.72	.61	-1.61	.88	.84	62.5	53.3	K5
MEAN	55.9	32.0	.00	.25	1.01	-.2	.93	-.2			53.9	54.9	
P.SD	14.6	.0	.88	.00	.55	1.8	.47	1.3			14.5	.9	

Figure 13. Item measure KPS students

The analysis results suggest that the hardest SPSs to achieve by the students were those with codes K8, K4, and K3. Code K3 is for skills to experiment, code K4 is for interpreting data, and code K3 is for predicting. The skills to experiment/project received the lowest percentage since the assessment performed was incomplete, particularly in the use of tools and materials. Students received even points in the assessment of the skills since they merely submitted the results of their experiment or project activities (Apsari & Budiyanto, 2021). Several indicator items were unassessed due to the distance

learning situation, namely observing the utility and level of accuracy of tools used and whether the implementation of research procedures followed the plan.

Dimyati (2009), expresses that predicting means stating the possibilities of what will happen in the future based on patterns or tendencies between principles, facts, and concepts in science. Students have predicting skills if they use patterns of observation results to state a prediction. The low percentage of achievement in the predicting skills was due to the students, in answering the questions, stating predicted events without connecting them to facts, finding, and patterns of the performed observation results. Examples of answers from one of the students are seen in Table 4.

Table 4.
Analysis of Student Answers

| Question	Skills tested	Student Answer	Analysis
If the condition remains unchanged (environmental issues in the surrounding environment of the students), what negative impacts of the environmental pollution occurred?	Predicting	Dead Fish	Students did not link to the findings and patterns of their previous observations in predicting; thus, the prediction was inadequate.
		Climate change is unpredictable, air condition is deteriorating, and global warming.	Students' answers are unrelated to the finding facts obtained from the previous observation activities. Therefore, the answers do not refer to the observed phenomenon.
		Accumulation of garbage in the gutter will block water flow and if not cleaned will cause flooding. Moreover, garbage accumulation is stink.	Students can use patterns of the observation results to state the prediction. The prediction is in accordance with the finding facts.
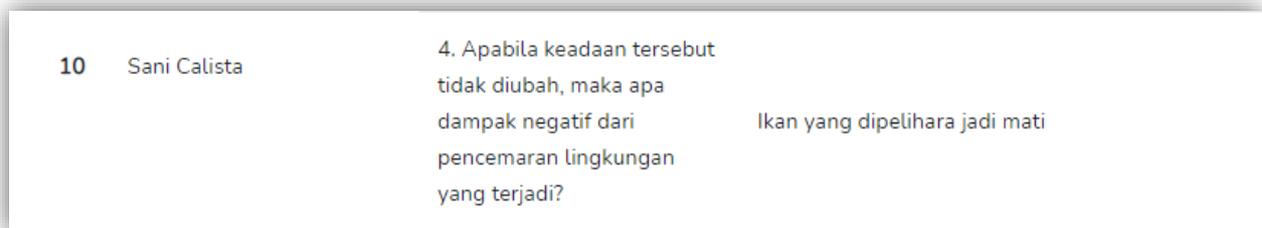
Figure 5. Answer from one of the students

Interpreting skills received the lowest percentage since students only concluded without referring to the findings of the observation results when answering the questions. This is consistent with Dimyati (2009) that interpreting is drawing a tentative conclusion based on observation result data. The science process skills implemented in distance learning are novel things; hence, the effect of the learning objective achievement is minimum (Syazali, Rahmatih, & Nursaptini, 2021). The analysis results reflect that teachers facilitate students in developing SPS; therefore, students get used to it in learning. The increase in SPS will be in line with the increase in students' cognitive results (Suryaningsih, 2017).

The analysis of SPS achievement level on students in Class X MIPA 6 in SMA N 4 Surakarta employed student average in answering the test instrument items provided on the "Learning Experience (*Pengalaman Belajar*)' Menu. Based on the person separation score, the H value = [(4x2.86)+1]/3 = 4.1 ≈ 4. The results indicate the existence of student groups with high, medium, less, and poor SPS. The importance of SPS empowerment demands teachers to be more creative and innovative to facilitate students in the development of SPS during distance learning. The science process skills implemented in distance learning are novel things; hence, the effect of the learning objective achievement is minimum (Syazali, Rahmatih, & Nursaptini, 2021). Efforts to improve SPS in distance learning are by modifying

observation and practicum activities so students can perform the activities at home. These activities include observation, description, and classification of learning objects found around the students and submitting reports of activities (experiments) to improve practicum activities (Maesaroh et al., 2021). The SPS-based learning approach must continue to be developed although in a distance learning situation by utilizing tools and materials available in the surrounding environment of the students. Suryaningsih (2017), activities contribute significantly to enhancing students' SPS.

e) SPS that can be developed in the environmental pollution materials during distance learning (PJJ)

Basic SPS developed in the research consisted of observing, classifying, interpreting, predicting, applying the concept, and communicating. Observing skills refer to observation activities on changes or issues that occurred in the student living environment; therefore, students can perform the activities independently at home. Agustina, dkk (2016), state that students must possess observing skills, which is a basic skill. Rustaman (2005), activities in observing skills include the use of the senses of sight, smell, hearing, touch, and taste to observe an object and the use of relevant facts. Distance learning causes the sense of sight to become the primary sense in observing skills.

Classifying skills include activities of classifying waste found in the observation activities into groups of domestic, industrial, agricultural, or mining waste. Rustaman (2005), the classifying process involves activities of searching for similarities and differences, contrasting characteristics, comparing, and looking for the basis of a classification.

Interpreting skills are developed by students interpreting the causes of a change or an environmental issue that occurred referring to the findings from observation activities. Interpreting is an activity to draw a tentative conclusion based on the observation result data (Dimyati & Mudjiono, 2009). Predicting skills are fostered through students expressing their prediction if changes or environmental issues occurred are not immediately addressed. Dimyati (2009) states that predicting means stating the possibilities of what will happen in the future based on patterns or tendencies between principles, facts, and concepts in science. Students have predicting skills if they use patterns of observation results to state a prediction (Khairunnisa, Ita, & Istiqamah, 2019).

Students have concept application skills if they can use the studied concepts in a new situation or explain what is going on (Rustaman, 2005). Reports can train communication skills, particularly those in observation activities and a project on household waste utilization communicated orally through a presentation or writing in a live chat discussion (Nawawi et al., 2021). According to Rustaman (2005), communication skills are skills to read diagrams, tables, or charts from experiments and draw data in a diagram, table, or chart. The skills also include student skills in expressing their ideas or findings. SPS in communication is a basic SPS that is related to social skills. It is necessary to equip students with communication skills so they can interact well in the community (Agustina & Saputra, 2016).

The integrated SPS developed in the research is planning and performing an experiment. Planning an experiment can be developed through student skills in designing a project from the tools and materials to the steps in utilizing household waste as an effort in household waste management. The skills of experimenting are developed through the implementation of designs previously built by the students in utilizing household waste. Reports on the activity of experimenting could include evidence of pictures and videos of the activity that show the emerging SPS (Nawawi et al., 2021).

The design of the SPS on the environmental pollution materials emphasizes students' interaction with their environment so they can generate answers to problems acquired. Piaget states that students' cognitive development mostly depends on how actively students interact with their environment. Basic SPS includes observing, classifying, interpreting, predicting, applying the concept, and communicating, whereas integrated SPS consists of designing and performing an experiment. These SPS can be applied in the environmental pollution material despite the distance learning (PJJ) situation.

CONCLUSION

The eligibility of the 'Bioenial' website based on the average percentage of validity from the three media experts was 97.4% or in the "Very Eligible" category and from the material expert was 76.6% or in the "Eligible" category. The 'Bioenial' website was tested in the classroom with 32 students and 2 biology teachers. The results of the student responses indicated in the person measure showed a mean of 85.5 suggesting that the website is "Eligible" for use. The teacher responses suggest that the Bioenial

website is "Eligible" for use in learning. SPS that can be developed on the environmental pollution material in the website consists of observing, classifying, interpreting, predicting, communicating, designing an experiment, and performing an experiment. The assessment of skills in experimenting is challenging during distance learning due to difficulties to give a rating. The research results indicate the need for further research to find out the effectiveness of the 'Bioenial' website in improving students' cognitive learning.

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REFERENCES

Agustina, P., & Saputra, A. (2016). Analisis Keterampilan Proses Sains (Kps) Dasar Mahasiswa Calon Guru Biologi Pada Matakuliah Anatomi Tumbuhan (Studi Kasus Mahasiswa Prodi P . Biologi Fkip Ums Tahun. *Seminar Nasional Pendidikn Sains*, 71–78. https://jurnal.fkip.uns.ac.id/index.php/snps/article/view/9816

Aninda, A., Permanasari, A., & Ardianto, Di. (2019). Implementasi Pembelajaran Berbasis Proyek pada Materi Pencemaran Lingkungan untuk Meningkatkan Literasi STEM Siswa SMA. *Journal of Science Eduacation and Practice*, *3*(2), 1–16. https://doi.org/10.33751/jsep.v3i2.1719

Apsari, M. R., & Budiyanto, M. (2021). Peningkatan Hasil Belajar Sekalama Masa Pandemi dengan Menggunakan Lembar Kerja Peserta Didik Berorientasi Keterampilan Proses Sains. Pensa E-Jurnal: Pendidikan Sains, 9(2), 171–175. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa/article/view/37698

Azrai, E. P., Ernawati, E., & Sulistianingrum, G. (2017). Pengaruh Gaya Belajar David Kolb (Diverger, Assimilator, Converger, Accommodator) Terhadap Hasil Belajar Siswa Pada Materi Pencemaran Lingkungan. *Biosfer: Jurnal Pendidikan Biologi*, *10*(1), 9–16. https://doi.org/10.21009/biosferjpb.10-1.2

Carin, A. ., & Sund, R. . (1990). *Teaching Science Through Discovery*. New York: Merrill Publishing Company.

Chaidar, H. (2014). Pemanfaatan Teknologi Informasi dan Komunikasi dalam Pembelajaran di SMA Muhammadiyah Tarakan. *Jurnal Kebijakan Dan Pengembangan Pendidikan*, *2*(2), 184–192. https://ejournal.umm.ac.id/index.php/jkpp/article/view/1917

Dimyati, & Mudjiono. (2009). *Belajar dan pembelajaran*. Jakarta: Rineka Cipta.

Fitriani, U., Adisyahputra, A., & Komala, R. (2018). Eco-friendly website development in biology learning based on project activities on environmental pollution. *Biosfer: Jurnal Pendidikan Biologi, 11*(1), 33–47. https://doi.org/10.21009/biosferjpb.11-1.4

Irianto, D. M., Nadiroh, & Nuryadin, S. (2017). Pengaruh Model Pembelajaran Dan Hasil Belajar Ipa Terhadap Kemampuan Memecahkan Masalah Lingkungan Hidup. *Jurnal Ilmiah Pendidikan Lingkungan Dan Pembangunan*, *16*(2), 122–142. https://doi.org/10.21009/plpb.162.05

Khairunnisa, K., Ita, I., & Istiqamah, I. (2019). Keterampilan Proses Sains (KPS) Mahasiswa Tadris Biologi pada Mata Kuliah Biologi Umum. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *1*(2), 58–65. https://doi.org/10.20527/binov.v1i2.7858

Linacre, J. (2011). *A User's guide to WINSTEPS Ministeps; Rasch-model Computer Program. Program Manual 3.73*.

Maesaroh, Anugrah, D., Elvianasti, M., & Irdalisa. (2021). Analysis of Online Learning Impact of the

Covid-19 Pandemic from the Perfective of Biology Educators. *Jurnal Pendidikan Biologi*, *10*(1), 24–31. Retrieved from http://jurnal.unimed.ac.id/2012/index.php/JPB

Muhammad Hanif Fahmi. (2020). Komunikasi Synchronous dan Asynchronous dalam E-Learning pada Masa Pandemic Covid-19. *Jurnal Nomosleca*, *6*(April), 68–76. https://doi.org/https://doi.org/10.26905/nomosleca.v6i2.4947

Mulyani, S. W. W. (2019). Peningkatan Hasil Belajar Siswa Materi Limbah Lunak Melalui Media Pembelajaran Carta. *Edubiotik : Jurnal Pendidikan, Biologi Dan Terapan*, *4*(1), 45–52. https://doi.org/10.33503/ebio.v4i01.440

Nawawi, N., Handayani, I. 'Indar, & Sukardi, S. (2021). Pickles: Independent Biology Practicum Diffusion and Material Osmosis On the Concept of Substance Transport during the Pandemic Period. *Jurnal Pendidikan Sains (Jps)*, *9*(1), 61. https://doi.org/10.26714/jps.9.1.2021.61-68

Nisa, N. C., Nadiroh, N., & Siswono, E. (2018). Kemampuan Berpikir Tingkat Tinggi (Hots) Tentang Lingkungan Berdasarkan Latar Belakang Akademik Siswa. *Jurnal Ilmiah Pendidikan Lingkungan Dan Pembangunan*, *19*(2), 1–14. https://doi.org/10.21009/plpb.192.01

Nworgu, L. N., & Otum, V. V. (2013). Effect of Guided Inquiry with Analogy Instructional Strategy on Students Acquisition of Science Process Skills . *Journal of Education and Practice* , *4*(27), 35–40. Retrieved from https://www.iiste.org/Journals/index.php/JEP/article/view/9880

Parker, L., Prabawa-Sear, K., & Kustiningsih, W. (2018). How young people in Indonesia see themselves as environmentalists: Identity, behaviour, perceptions and responsibility. *Indonesia and the Malay World*, *46*(136), 263–282. https://doi.org/10.1080/13639811.2018.1496630

Prawiyogi, A. G., Purwanugraha, A., Fakhry, G., & Firmansyah, M. (2020). Efektifitas pembelajaran jarak jauh terhadap pembelajaran siswa di sdit cendekia purwakarta. *JPD: Jurnal Pendidikan Dasar*, *11*(1), 94–101. Retrieved from https://doi.org/10.21009/10.21009/JPD.081

Rustaman, N. (2005). *Strategi Belajar Mengajar Biologi*. Malang: UM Press.

Sadikin, A., Johari, A., & Suryani, L. (2020). Pengembangan multimedia interaktif biologi berbasis website dalam menghadapi. *Edubiotik: Jurnal Pendidikan, Biologi Dan Terapan*, *5*(1), 18–28. https://doi.org/https://doi.org/10.33503/ebio.v5i01.644

Safitri, A., Surbakti, A., Lengkana, D., Biologi, P., Universitas, F., & Prof, J. (2019). Hubungan Antara Penguasaan Pengetahuan Lingkungan Hidup Terhadap Etika Lingkungan Siswa SMA. Jurnal Bioterdidik, 7(5), 11–19. Retrieved from http://jurnal.fkip.unila.ac.id/index.php/JBT/article/view/17848

Simarmata, B., Daulae, A. H., & Raihana, R. (2018). Hubungan Tingkat Pengetahuan Lingkungan Hidup dengan Sikap Peduli Lingkungan Siswa. *Jurnal Pelita Pendidikan*, *6*(4), 204–210. https://doi.org/10.24114/jpp.v6i4.10584

Sumintono, B., & Widhiarso, W. (2015). *Aplikasi Permodelan Rasch pada Assesment Pendidikan*. Bandung: Trim Komunikata.

Suryaningsih, Y. (2017). Pembelajaran Berbasis Praktikum Sebagai Sarana Siswa untuk Berlatih Menerapkan Keterampilan Proses Sains dalam Materi Biologi. *Bio Educatio*, *2*(2), 49–57. https://jurnal.unma.ac.id/index.php/BE/article/view/759

Suyatna, A., Nugraha, M. G., & Rakhmawati, I. (2019). ICT media utilization model to increase science process skills on natural science lessons in junior high school. *Journal of Physics: Conference Series*, *1280*(5). https://doi.org/10.1088/1742-6596/1280/5/052004

Syazali, M., Rahmatih, A. N., & Nursaptini, N. (2021). Profil Keterampilan Proses Sains Mahasiswa Melalui Implementasi SPADA Unram. *Jurnal Pijar Mipa*, *16*(1), 103. https://doi.org/10.29303/jpm.v16i1.2290

Tegeh, I. ., & Pudjawan, K. (2014). *Model Penelitian Pengembangan*. Yogjakarta: Graha Ilmu.

Uno, H. B., & Koni, S. (2012). *Assessment Pembelajaran*. Jakarta: Bumi Aksara.

Vebrianto, R., & Osman, K. (2011). The effect of multiple media instruction in improving students' science process skill and achievement. *Procedia - Social and Behavioral Sciences*, *15*, 346–350. https://doi.org/10.1016/j.sbspro.2011.03.099

Yustyan, S., Widodo, N., & Pantiwati, Y. (2015). Peningkatan Kemampuan Berpikir Kritis dengan Pembelajaran Berbasis Scientific Approach Siswa Kelas X SMA Panjura Malang. *Jurnal Pendidikan Biologi Indonesia*, *1*(2), 240–254. Retrieved from http://ejournal.umm.ac.id/index.php/jpbi/article/view/3335

Yusuf, I., & Widyaningsih, S. W. (2018). Implementasi Pembelajaran Fisika Berbasis Laboratorium Virtual terhadap Keterampilan Proses Sains dan Persepsi Mahasiswa. *Berkala Ilmiah Pendidikan Fisika*, *6*(1), 18. https://doi.org/10.20527/bipf.v6i1.4378

Zamista, A. A. (2016). Pengaruh Model Pembelajaran Process Oriented Guided Inquiry Learning Terhadap Keterampilan Proses Sains Dan Kemampuan Kognitif Siswa Pada Mata Pelajaran Fisika. *Edusains*, *7*(2), 191–201. https://doi.org/10.15408/es.v7i2.1815