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Development of Problem Based Eco-website Media on the Topics of Ecosystem to Improve Critical Thinking and Problem Solving Skills

Ieva Farisna*, Hanum Isfaeni, & Diana Vivanti Sigit

Masters' Program in Biology Education, State University of Jakarta, Indonesia

Abstract: Learning activities that can be applied to students are by providing innovative learning media so that students are encouraged to hone critical thinking skills and problem solving skills. The purpose of this research is to develop PBL based eco-website media on ecosystem material and analyze the improvement of critical thinking and problem solving skills of class X students of SMAN 1 Waringinkurung Serang district. The research method used is educational design research (EDR) using the Hannafin and Peck model which includes three stages. The need assessment stage shows that students need interesting media equipped with the presentation of images, videos, games, there are cases and media can be used anytime and anywhere without burdening smartphone memory. The design stage is carried out product design to produce eco-website media by providing learning material features in the form of images, text, and videos. Cases are available and equipped with activities with the PBL approach, and interesting games are available. The development and implement stage produces PBL based eco-website media that is feasible to use, this is indicated by the acquisition of values given by media and material experts of 88.33% and 89.17%. The results of the small group readability test to students and educators obtained results of 91,80% and 95.83%, so the media is feasible to use in learning biology ecosystem material. The results of the implementation of learning using PBL based eco-website media in the experimental class were analyzed by MANOVA test which proved that PBL based eco-website media used in biology learning can improve students' critical thinking and problem solving skills on ecosystem material. Thus, the media developed, namely PBL based eco-website, is feasible to use and can improve students' critical thinking and problem solving skills on ecosystem material.

Keywords: critical thinking, eco-website, ecosystem, hannafin and peck, manova, problem solving.

▪ INTRODUCTION

Learning is a teaching and learning process designed by educators to provide experiences for students in order to change behavior and improve their ability to think (Wagner, 2017). The success of the learning process can be influenced by many factors such as the physical condition of the school, classroom equipment, lesson plans, and especially learning media (Ozcan, 2021). The use of learning media in the teaching and learning process is an effort to increase the effectiveness of the learning process so that it can improve student learning outcomes (Sihombing et al., 2023; Winda & Dafit, 2021). Educators have limitations in making learning media due to lack of knowledge about IT-based media (information technology) (Sihombing et al., 2023). Educators make simple media that contains a lot of text in slides, making it less attractive to students so that it inhibits students in integrating information and less attractive to student learning interests (Herting et al., 2019), Khaerunnisa et al., 2018, Roberts, 2017).

The use of media in learning can have implications for higher-order thinking skills, such as students' ability to think critically and solve problems. Critical thinking and problem solving skills are considered as necessary abilities in life in the 21st century

Ieva Farisna
*Email: evafarisna24@gmail.com

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(Ling et al., 2024). Curiosity and questioning are signs for students who think critically because students always try to find answers to the questions asked (Erdogan, 2019; Saleh, 2019). The ability of students to find solutions so that problems can be solved as quickly and effectively as possible through the process of understanding and organizing information is called problem solving (Ling et al., 2024; Veríssimo et al., 2024).

Improving students' critical thinking and problem solving skills is expected in biology subjects, one of the biological materials studied is ecosystem material. Ecosystems are closely related to the interaction between living things and the surrounding environment. Students are trained by developing their thinking in understanding the concept of ecosystems to explore critical thinking and problem solving skills that occur in the environment (Rahma & Windyariani, 2020; Shaw et al., 2019). Learning activities that can be applied to students are by providing innovative learning media so that students are encouraged to hone their critical thinking and problem solving skills, especially in ecosystem material.

Based on the results of observations made at SMAN 1 Waringinkurung Serang Regency, it is known that students find it difficult in ecosystem material because the subject is too complex and many terms in the ecosystem are still not understood by students. As many as 40% of 40 students stated that they felt difficulties in learning ecosystem material, because the learning process was less interactive and less use of learning media. The difficulties felt by students have an impact on understanding a material so that it inhibits the critical thinking process and solving ability in solving a problem. Then learning tends to be teacher-centered so that students are less trained to ask and answer questions. Thus it is necessary to design learning tools that can support students' needs in learning. One way is to develop learning media that considers the context, characteristics and needs of students so that the success of the learning process can be achieved, especially in improving students' critical thinking and problem solving skills. Alternative media developed to be used in the learning process is website media.

Website media has very good attractiveness (Sadikin et al., 2020). One of the facilities that can be used in creating a website is google sites. The selection of google sites web media is based on free creation, the availability of various features that can be used, and can be accessed easily by students via laptops and cellphones. Google sites can be utilized by educators as learning media in the form of websites to provide interesting learning for students. The media is named eco-website media based on problem-based learning. The name eco-website is a website that contains ecosystem content that will be presented by combining images, writings, videos, sounds and so on. The development of this learning media uses a problem-based learning (PBL) approach, which is a learning model that involves problems in everyday life so that students learn to think, so that it can improve critical thinking and problem solving skills (Mertasari & Ganing, 2021; (Mondal, 2020; Pebriyani, 2020). Thus, this research focuses on developing problem-based learning-based eco-website media on ecosystem material to improve students' critical thinking and problem solving skills.

▪ METHOD

Participants

The subject for the needs analysis of this research is class XI of SMAN 1 Waringinkurung Serang Regency as many as 40 students. The subject of the product

readability test was conducted on a small group of 36 students in class X of 2023/2024 and 2 educators by applying simple random sampling technique. The subject of the product effectiveness test was carried out on 2 experimental groups and 2 control groups by applying simple random sampling techniques, then 66 out of 80 students were selected. The number of samples was determined based on calculations using the Slovin formula.

Research Design and Procedures

This research uses the educational design research (EDR) or Research and Development (R&D) method by developing problem based eco-webaite media on the topic of ecosystems. This research uses the Hannafin and Peck development model which consists of three phases, including the Need Assessment phase which aims to determine the needs and problems of students and educators in carrying out the biology learning process at school. The design phase aims to create a learning media design based on the results of the needs analysis. The development and implementation phase aims to develop products that can be implemented, in this phase the media that has been completed is assessed by media and material expert validation tests and continued with a readability test to educators and students as media users. all phases involve an evaluation and revision process. After that, the media is implemented to test the effectiveness of the media with a nonequivalent control groups design pretest-postest.

Research Instruments

The research instruments used to collect research data consisted of, (a) the feasibility of problem-based eco-website media on the topic of ecosystems was assessed using instruments in the form of 1) media expert feasibility sheet consisting of 5 indicators with a total of 26 items regarding the feasibility of learning media, 2) material expert feasibility sheet consisting of 3 indicators with a total of 15 items regarding the feasibility of material on the media, 3) educator readability test sheet totaling 15 items regarding the feedback response of biology educators to the media, 4) student small group readability test sheet totaling 14 items regarding the feedback response of students' views on the media. (b) the effectiveness of problem-based eco-website media on the topic of ecosystems was assessed using a test instrument consisting of 1) critical thinking assessment instrument consisting of 6 indicators adapted from Facione, (2015) namely indicators a) regarding interpretation, b) analysis, c) evaluation, d) inference, e) explanation, f) self-regulation. Each critical thinking indicator is represented by 1 item each. 2) the problem solving assessment instrument consists of 4 indicators adapted from Polya, (2004), namely indicators a) regarding understanding the problem, b) devising a plan, c) carrying out the plan, d) looking back. Each problem solving indicator is represented by 1 item each.

The items used have been tested for validity and reliability using SPSS software version 25. Test the validity of critical thinking and problem solving instruments using Pearson product moment correlation. The validity test aims to determine the valid value or not of the question items determined from a significance value of 0.05. This test will obtain r count from the pearson correlation table, then the results of r count will be compared with r table. The validity criteria if r count> r table then the item is declared valid while if r count < r table then the item is declared invalid. Then the reliability test aims to measure the level of consistency or not of the items to determine the results of data in the form of real or fact. if it is said to be reabel has a value of more than 0.60.

Reliability is reviewed from the calculation of the Reliability Statistics results, namely the Cronbach Alpha value. Based on the results of the reliability test on the question of critical thinking ability obtained a Cronbach Alpha value of 0.668 on the question of problem solving ability obtained a Cronbach Alpha value of 0.611, so the question is declared reliable.

Data Analysis Technique

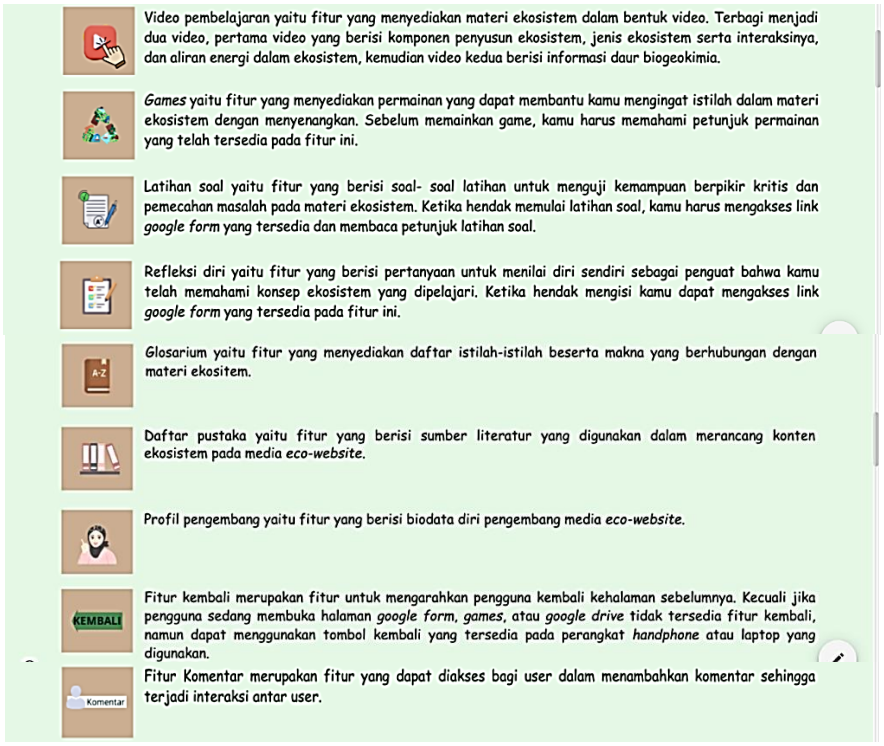
Data analysis techniques are carried out in various stages, the first stage is the feasibility test instrument for media experts and material experts, as well as readability tests on small groups of students and educators using a modified likert scale from Riduwan, (2008) including (1) very bad, (2) not good, (3) good, (4) very good. The results of the calculation of the feasibility of problem-based eco-website products are interpreted based on the product feasibility test interval score as follows: (1) score 81% - 100% (very feasible), (2) score 61% - 80% (feasible), (3) score 41% - 60% (fair), (4) score 21% - 40% (less feasible), (5) score 0% - 20% (very less feasible).

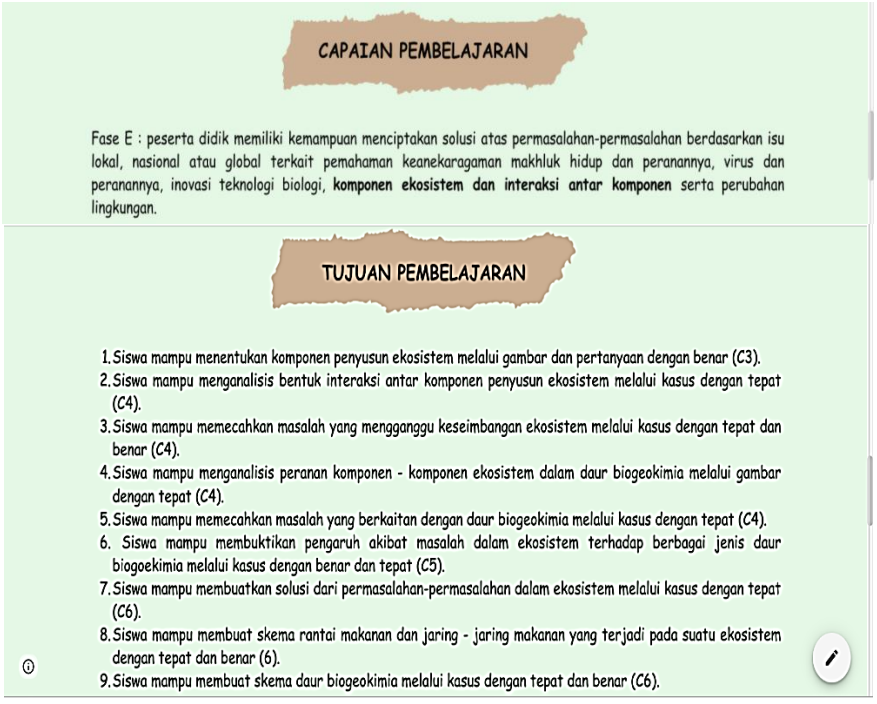
The second stage of the pretest-posttest data was analyzed using the N-Gain test to see the difference and increase in each indicator of critical thinking and problem solving of the experimental and control groups. Then the prerequisite tests were carried out, among others: multivariate normality test, linearity test, multicollinearity test, variance homogeneity test, covariance matrix homogeneity test. Furthermore, hypothesis testing was carried out using MANOVA statistical analysis to measure the effect of independent variables on a number of dependent variables simultaneously. The MANOVA test used is a univariate test to review whether there are differences or not in the variables used. After that, a multivariate test was conducted to see the increase in the dependent variable.

▪ RESULT AND DISSCUSSION

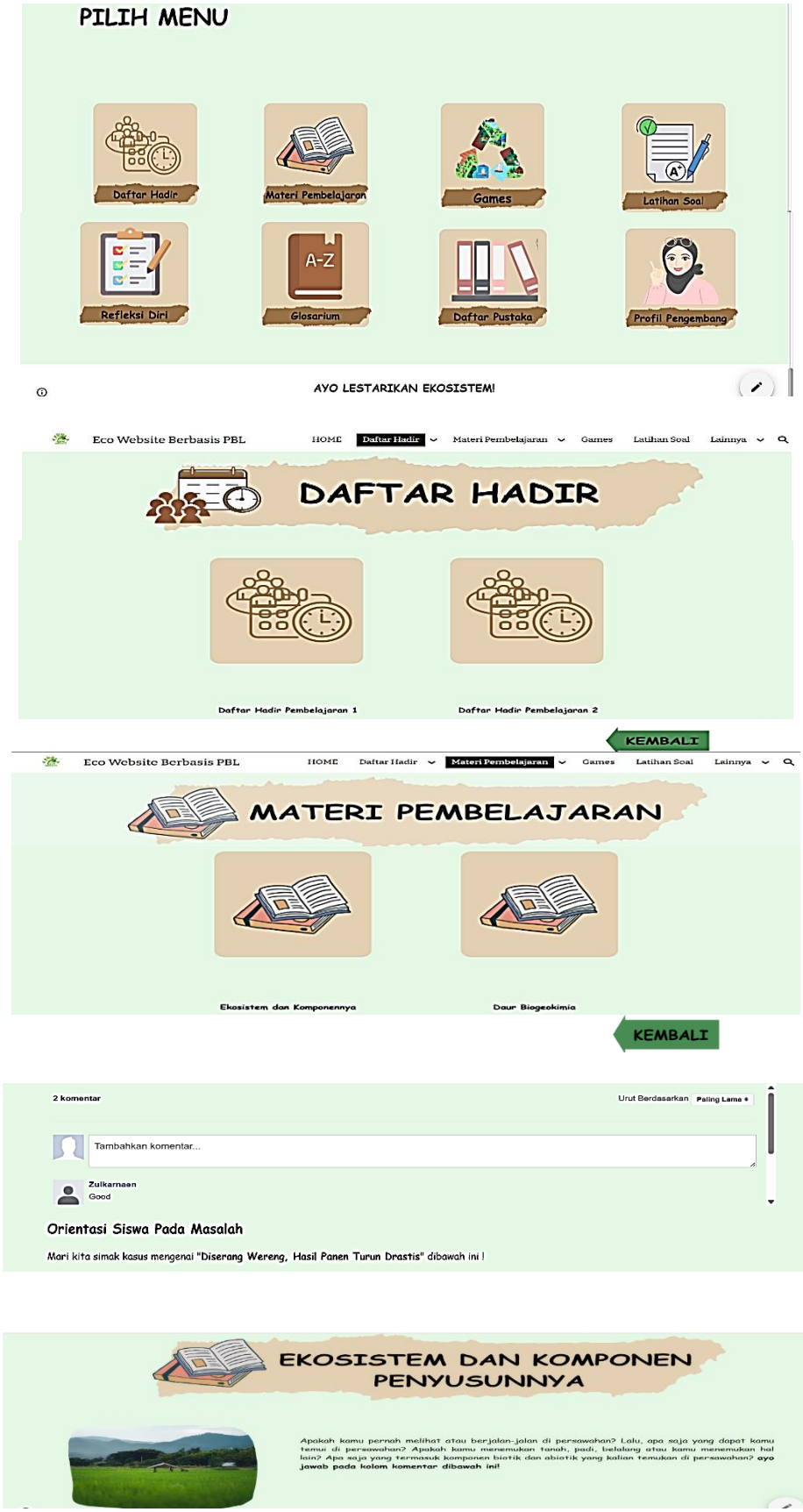
Description Of Eco-Website Media Characteristics

The product developed in this study is a PBL based eco-website learning media on ecosystem material for class X SMA. The preparation of eco-website media starts from making templates on the header of the eco-website using google sites while the illustrations used adopt from the canva application.


Video pembelajaran yaitu fitur yang menyediakan materi ekosistem dalam bentuk video. Terbagi menjadi dua video, pertama video yang berisi komponen penyusun ekosistem, jenis ekosistem serta interaksinya, dan aliran energi dalam ekosistem, kemudian video kedua berisi informasi daur biogeokimia.
Games yaitu fitur yang menyediakan permainan yang dapat membantu kamu mengingat istilah dalam materi ekosistem dengan menyenangkan. Sebelum memainkan game, kamu harus memahami petunjuk permainan yang telah tersedia pada fitur ini.
Latihan soal yaitu fitur yang berisi soal- soal latihan untuk menguji kemampuan berpikir kritis dan pemecahan masalah pada materi ekosistem. Ketika hendak memulai latihan soal, kamu harus mengakses link *google form* yang tersedia dan membaca petunjuk latihan soal.
Refleksi diri yaitu fitur yang berisi pertanyaan untuk menilai diri sendiri sebagai penguat bahwa kamu telah memahami konsep ekosistem yang dipelajari. Ketika hendak mengisi kamu dapat mengakses link *google form* yang tersedia pada fitur ini.
Glosarium yaitu fitur yang menyediakan daftar istilah-istilah beserta makna yang berhubungan dengan materi ekositem.
Daftar pustaka yaitu fitur yang berisi sumber literatur yang digunakan dalam merancang konten ekosistem pada media *eco-website*.
Profil pengembang yaitu fitur yang berisi biodata diri pengembang media *eco-website*.
KEMBALI
Fitur kembali merupakan fitur untuk mengarahkan pengguna kembali kehalaman sebelumnya. Kecuali jika pengguna sedang membuka halaman *google form*, *games*, atau *google drive* tidak tersedia fitur kembali, namun dapat menggunakan tombol kembali yang tersedia pada perangkat *handphone* atau laptop yang digunakan.
Komentar
Fitur Komentar merupakan fitur yang dapat diakses bagi user dalam menambahkan komentar sehingga terjadi interaksi antar user.


CAPAIAN PEMBELAJARAN
Fase E : peserta didik memiliki kemampuan menciptakan solusi atas permasalahan-permasalahan berdasarkan isu lokal, nasional atau global terkait pemahaman keanekaragaman makhluk hidup dan peranannya, virus dan peranannya, inovasi teknologi biologi, **komponen ekosistem dan interaksi antar komponen** serta perubahan lingkungan.
TUJUAN PEMBELAJARAN
1. Siswa mampu menentukan komponen penyusun ekosistem melalui gambar dan pertanyaan dengan benar (C3).
2. Siswa mampu menganalisis bentuk interaksi antar komponen penyusun ekosistem melalui kasus dengan tepat (C4).
3. Siswa mampu memecahkan masalah yang mengganggu keseimbangan ekosistem melalui kasus dengan tepat dan benar (C4).
4. Siswa mampu menganalisis peranan komponen - komponen ekosistem dalam daur biogeokimia melalui gambar dengan tepat (C4).
5. Siswa mampu memecahkan masalah yang berkaitan dengan daur biogeokimia melalui kasus dengan tepat (C4).
6. Siswa mampu membuktikan pengaruh akibat masalah dalam ekosistem terhadap berbagai jenis daur biogoekimia melalui kasus dengan benar dan tepat (C5).
7. Siswa mampu membuatkan solusi dari permasalahan-permasalahan dalam ekosistem melalui kasus dengan tepat (C6).
8. Siswa mampu membuat skema rantai makanan dan jaring - jaring makanan yang terjadi pada suatu ekosistem dengan tepat dan benar (6).
9. Siswa mampu membuat skema daur biogeokimia melalui kasus dengan tepat dan benar (C6).


AYO BELAJAR BERSAMA


PILIH MENU
Daftar Hadir
Materi Pembelajaran
Games
Latihan Soal
Refleksi Diri
Glosarium
Daftar Pustaka
Profil Pengembang
AYO LESTARIKAN EKOSISTEM!
Eco Website Berbasis PBL
HOME
Daftar Hadir
Materi Pembelajaran
Games
Latihan Soal
Lainnya
DAFTAR HADIR
Daftar Hadir Pembelajaran 1
Daftar Hadir Pembelajaran 2
KEMBALI
Eco Website Berbasis PBL
HOME
Daftar Hadir
Materi Pembelajaran
Games
Latihan Soal
Lainnya
MATERI PEMBELAJARAN
Ekosistem dan Komponennya
Daur Biogeokimia
KEMBALI
2 komentar
Urut Berdasarkan
Paling Lama
Tambahkan komentar...
Zulkarnaen
Good
Orientasi Siswa Pada Masalah
Mari kita simak kasus mengenai "Diserang Wereng, Hasil Panen Turun Drastis" dibawah ini !
EKOSISTEM DAN KOMPONEN PENYUSUNNYA
Apakah kamu pernah melihat atau berjalan-jalan di persawahan? Lalu, apa saja yang dapat kamu temui di persawahan? Apakah kamu menemukan tanah, padi, belalang atau kamu menemukan hal lain? Apa saja yang termasuk komponen biotik dan abiotik yang kalian temukan di persawahan? ayo jawab pada kolom komentar dibawah ini!

DISERANG WERENG, HASIL PANEN TURUN DRASTIS

SUKOHARJO, KRJOGJA.com - Tanaman padi petani disejumlah wilayah di Sukoharjo diserang hama wereng dan tikus. Akibatnya petani mengalami kerugian setelah hasil panen menurun drastis. Petani asal Kecamatan Baki Sutrisno, Minggu (9/7) mengatakan, hama tikus menyerang sejak satu bulan lalu sampai sekarang. Akibatnya tanaman menjadi rusak dan meresahkan para petani di wilayah Baki. Serangan hama tikus juga membuat petani harus bekerja keras melakukan pemberantasan. "Hampir setiap hari petani melakukan gropyokan untuk mengurangi populasi. Serangan hama tikus semakin ganas sekarang. Petani sudah sering melakukan gropyokan, "ujarnnya.

Sutrisno mengatakan, akibat serangan hama tikus diperkirakan berpengaruh pada hasil panen nanti. Sebab banyak tanamannya yang mengalami kerusakan. "Kemungkinan hasil panen berkurang karena serangan hama tikus. Mungkin hanya bisa dipanen 70 persen saja," lanjutnya. Selain tikus, kata Sutrisno hama wereng menyerang tanaman padi petani di wilayah Kecamatan Sukoharjo. Akibatnya tanaman menjadi rusak dan mengurangi produktivitas panen padi.

"Disini tanaman padi diserang hama tikus dan wereng dan merusak tanaman. Kemungkinan hasil panen turun drastis," ujar petani asal Kelurahan Sonorejo, Kecamatan Sukoharjo Kota Riyanto. Kepala Desa Tiyaran, Kecamatan Bulu Sutarno mengatakan, diwilayahnya juga terjadi serangan hama wereng dan tikus. Banyak petani melapor dan mengeluhkan serangan hama wereng dan tikus tersebut. Sebab serangan menyebabkan tanaman rusak dan menurunkan hasil panen.

Sumber:https://www.krjogja.com/klaten/1242613045/diserang-wereng-hasil-panen-turun-drastis

Mengorganisasi Siswa Untuk Belajar

Setelah membaca kasus di atas, diskusikanlah dengan anggota kelompok mengenai permasalahan dalam kasus di atas.

Membimbing Penyelidikan

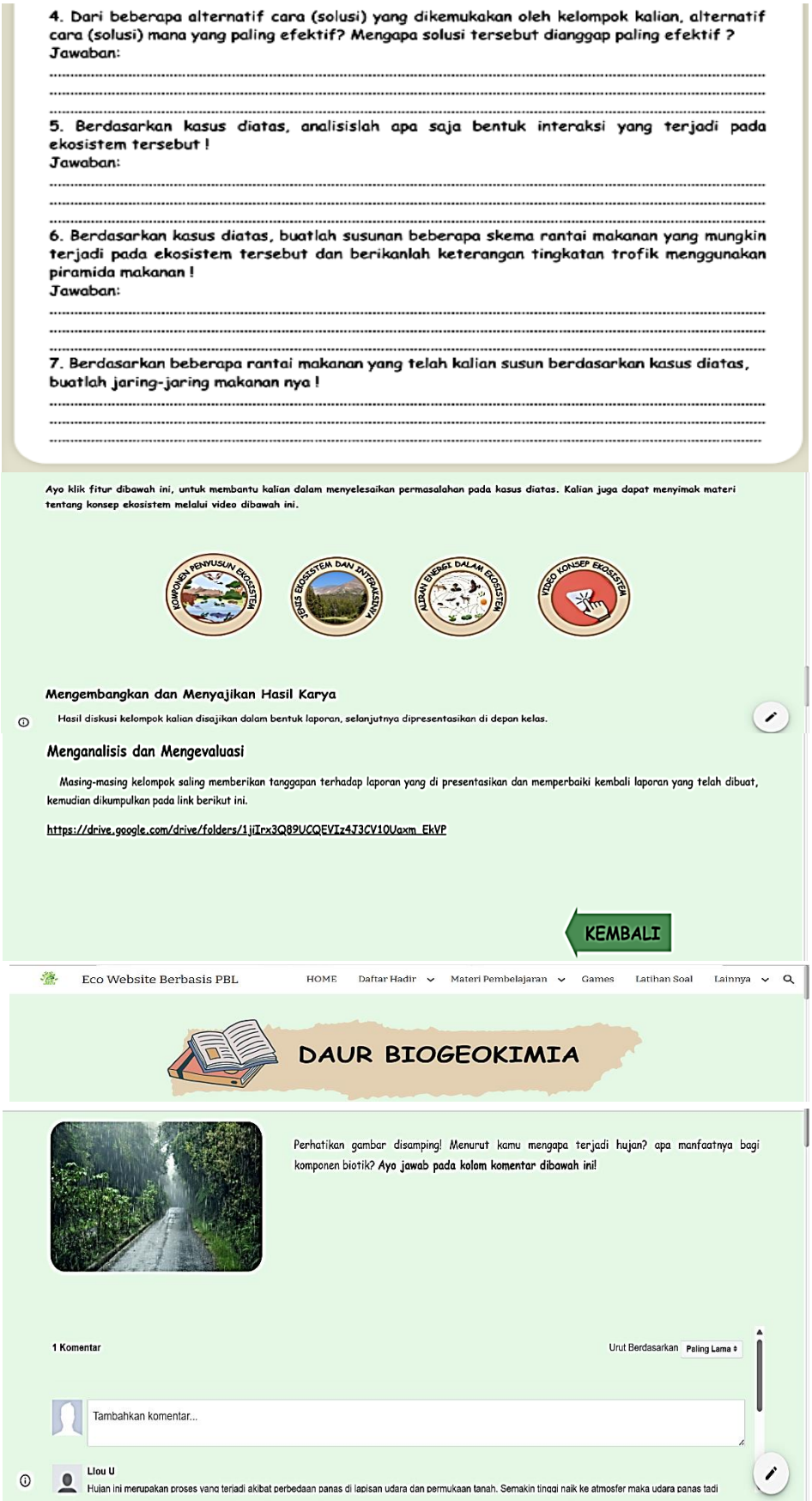
Masing-masing kelompok melakukan penyelidikan mengenai kasus diatas untuk menjawab pertanyaan-pertanyaan dibawah ini.

Penyelidikan Kelompok

1.Berdasarkan kasus di atas, identifikasi permasalahan-permasalahan yang dapat mengganggu keseimbangan ekosistem !
Jawaban:
.....
.....
.....

2. Setelah kelompok kalian mengidentifikasi permasalahan yang dapat mengganggu keseimbangan ekosistem dalam kasus tersebut, tentukan satu permasalahan yang menurut kelompok kalian perlu untuk dipecahkan dan buatlah rumusan masalahnya !
Jawaban:
.....
.....
.....

3. Berikan beberapa alternatif cara (solusi) yang dapat diambil untuk mengatasi permasalahan dari rumusan masalah yang telah dibuat oleh kelompok kalian !
Jawaban:
.....
.....


4. Dari beberapa alternatif cara (solusi) yang dikemukakan oleh kelompok kalian, alternatif cara (solusi) mana yang paling efektif? Mengapa solusi tersebut dianggap paling efektif ?
Jawaban:
5. Berdasarkan kasus diatas, analisislah apa saja bentuk interaksi yang terjadi pada ekosistem tersebut !
Jawaban:
6. Berdasarkan kasus diatas, buatlah susunan beberapa skema rantai makanan yang mungkin terjadi pada ekosistem tersebut dan berikanlah keterangan tingkatan trofik menggunakan piramida makanan !
Jawaban:
7. Berdasarkan beberapa rantai makanan yang telah kalian susun berdasarkan kasus diatas, buatlah jaring-jaring makanan nya !
Ayo klik fitur dibawah ini, untuk membantu kalian dalam menyelesaikan permasalahan pada kasus diatas. Kalian juga dapat menyimak materi tentang konsep ekosistem melalui video dibawah ini.
KOMPONEN PENYUSUN EKOSISTEM
JENIS EKOSISTEM DAN INTERAKSINYA
ALIRAN ENERGI DALAM EKOSISTEM
VIDEO KONSEP EKOSISTEM
Mengembangkan dan Menyajikan Hasil Karya
Hasil diskusi kelompok kalian disajikan dalam bentuk laporan, selanjutnya dipresentasikan di depan kelas.
Menganalisis dan Mengevaluasi
Masing-masing kelompok saling memberikan tanggapan terhadap laporan yang di presentasikan dan memperbaiki kembali laporan yang telah dibuat, kemudian dikumpulkan pada link berikut ini.
https://drive.google.com/drive/folders/1jiIrx3Q89UCQEVIz4J3CV10Uaxm_EkVP
KEMBALI
Eco Website Berbasis PBL
HOME
Daftar Hadir
Materi Pembelajaran
Games
Latihan Soal
Lainnya
DAUR BIOGEOKIMIA
Perhatikan gambar disamping! Menurut kamu mengapa terjadi hujan? apa manfaatnya bagi komponen biotik? Ayo jawab pada kolom komentar dibawah ini!
1 Komentar
Urut Berdasarkan
Paling Lama
Tambahkan komentar...
Llou U
Hujan ini merupakan proses yang terjadi akibat perbedaan panas di lapisan udara dan permukaan tanah. Semakin tinggi naik ke atmosfer maka udara panas tadi

DAUR BIOGEOKIMIA

Daur biogeokimia merupakan pemanfaatan dan pelepasan unsur-unsur kimia penting melalui peristiwa biologis yang melibatkan komponen biotik maupun abiotik pada lingkungan. Proses ini terjadi berulang kali dan tanpa batas waktu. Fungsi daur biogeokimia sebagai daur materi yang mencakup seluruh unsur kimia yang digunakan oleh segala sesuatu yang ada di bumi, baik komponen biotik maupun abiotik, untuk menjaga kelangsungan kehidupan di bumi.

Daur biogeokimia dapat dikelompokkan menjadi tiga jenis antara lain daur cair, daur padat/sedimen, dan daur gas. Daur cair meliputi daur air, daur padat meliputi fosfor dan belerang, sedangkan daur gas meliputi daur karbon dan daur nitrogen. Dengan demikian hujan salah satu contoh peristiwa dari jenis daur biogeokimia yakni daur hidrologi, agar kamu lebih memahami mengenai daur biogekimia ikutilah langkah pembelajaran diberikut ini.

Orientasi Siswa Pada Masalah

Mari kita baca kasus mengenai "**Akibat penebangan hutan secara liar**" dibawah ini !

AKIBAT PENEBANGAN HUTAN SECARA LIAR

KOMPAS.com - Hutan merupakan salah satu sumber oksigen bagi makhluk hidup. Hutan juga menjadi kawasan tempat tinggal untuk satwa. Dalam kehidupan manusia, hutan telah membawa banyak manfaat. Contohnya mencegah banjir, tanah longsor, menjadi sumber oksigen dan lain sebagainya. Namun, sayangnya kini banyak manusia yang melakukan penebangan liar atau illegal logging. Penebangan hutan secara liar bisa diartikan sebagai aktivitas penebangan hutan secara ilegal atau tanpa izin. Mengutip dari Proses Pembelajaran (Learning Lessons) Promosi Sertifikasi Hutan dan Pengendalian Penebangan Liar di Indonesia (2004) karua Luca Tacconi dan kawan-kawan, penebangan hutan secara liar telah membawa dampak negatif bagi lingkungan.

Contoh nyatanya ialah banjir dan tanah longsor akibat penebangan hutan secara liar. Selain membawa dampak negatif untuk lingkungan, penebangan liar juga menghilangkan produk hutan, misalnya hasil getah atau buah pohon, dan lain sebagainya, yang merugikan ekonomi warga di sekitar hutan tersebut. Secara lebih spesifik, mari kita lihat akibat jika menebang hutan sembarangan, yang dilansir dari situs Kementerian Kesehatan:

- Kesuburan tanah dapat menurun atau menghilang

Tingkat kesuburan tanah dapat menurun atau menghilang karena tanah menyerap langsung sinar matahari. Berbeda jika ada pohon atau hutan yang melindungi tanah, karena sinar matahari akan diserap terlebih dahulu oleh pohon. Jika kesuburan tanah sudah menurun, nutrisi yang ada pun perlahan terkikis, menguap dan akhirnya menghilang. Upaya reboisasi akan sulit dilakukan di kawasan tersebut, karena kandungan nutrisi tanah sudah hilang.

- Sumber daya air akan menurun

Tidak hanya nutrisi yang akan menghilang, sumber daya air juga bisa menurun jika hutan ditebang secara liar. Karena pohon sangat berperan penting untuk menjaga siklus air dengan akar yang dimilikinya. Pohon akan menyerap air tanah, kemudian dialirkan ke daun dan akhirnya air itu akan menguap dan dilepaskan ke atmosfer. Jika hutan ditebang secara liar, maka daerah itu seketika berubah menjadi gersang.

- Keanekaragaman hayati dapat punah

Hutan menjadi tempat tinggal bagi sejumlah makhluk hidup, seperti flora dan fauna. Jika hutan ditebang secara liar, akibatnya hewan akan kehilangan tempat tinggalnya. Apabila hal ini terus berlangsung, dikhawatirkan keanekaragaman hayati di hutan tersebut akan punah.

Sumber:https://www.kompas.com/skola/read/2021/06/07/100000569/akibat-penebangan-hutan-secara-liar

Mengorganisasi Siswa Untuk Belajar

Setelah membaca kasus di atas, diskusikanlah dengan anggota kelompok mengenai permasalahan dalam kasus di atas.

Membimbing Penyelidikan

Masing-masing kelompok melakukan penyelidikan mengenai kasus diatas untuk menjawab pertanyaan-pertanyaan dibawah ini.

Penyelidikan Kelompok

1.Berdasarkan kasus di atas, identifikasi permasalahan-permasalahan yang dapat mengganggu daur biogeokimia !
Jawaban:
.....
.....
.....

2. Setelah kelompok kalian mengidentifikasi permasalahan yang dapat mengganggu daur biogeokimia dalam kasus tersebut, tentukan satu permasalahan yang menurut kelompok kalian perlu untuk dipecahkan dan buatlah rumusan masalahnya !
Jawaban:
.....

3. Berikan beberapa alternatif cara (solusi) yang dapat diambil untuk mengatasi permasalahan dari rumusan masalah yang telah dibuat oleh kelompok kalian !
Jawaban:

4. Dari beberapa alternatif cara (solusi) yang dikemukakan oleh kelompok kalian, alternatif cara (solusi) mana yang paling efektif? Mengapa solusi tersebut dianggap paling efektif ?
Jawaban:

5. Bagaimana pengaruh akibat penebangan hutan secara liar terhadap berbagai jenis daur biogeokimia ?
Jawaban:

6. Buatlah masing - masing kelompok skema tentang jenis daur biogeokimia yang berhubungan dengan kasus diatas ! (minimal dua jenis daur).
Jawaban:

Penyelidikan Kelompok

1.Berdasarkan kasus di atas, identifikasi permasalahan-permasalahan yang dapat mengganggu daur biogeokimia !
Jawaban:

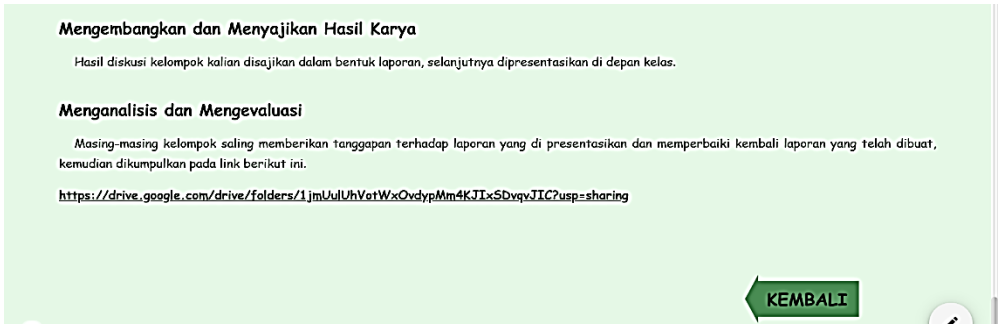
2. Setelah kelompok kalian mengidentifikasi permasalahan yang dapat mengganggu daur biogeokimia dalam kasus tersebut, tentukan satu permasalahan yang menurut kelompok kalian perlu untuk dipecahkan dan buatlah rumusan masalahnya !
Jawaban:

3. Berikan beberapa alternatif cara (solusi) yang dapat diambil untuk mengatasi permasalahan dari rumusan masalah yang telah dibuat oleh kelompok kalian !
Jawaban:

4. Dari beberapa alternatif cara (solusi) yang dikemukakan oleh kelompok kalian, alternatif cara (solusi) mana yang paling efektif? Mengapa solusi tersebut dianggap paling efektif ?
Jawaban:

5. Bagaimana pengaruh akibat penebangan hutan secara liar terhadap berbagai jenis daur biogeokimia ?
Jawaban:

6. Buatlah masing - masing kelompok skema tentang jenis daur biogeokimia yang berhubungan dengan kasus diatas ! (minimal dua jenis daur).
Jawaban:



Mengembangkan dan Menyajikan Hasil Karya

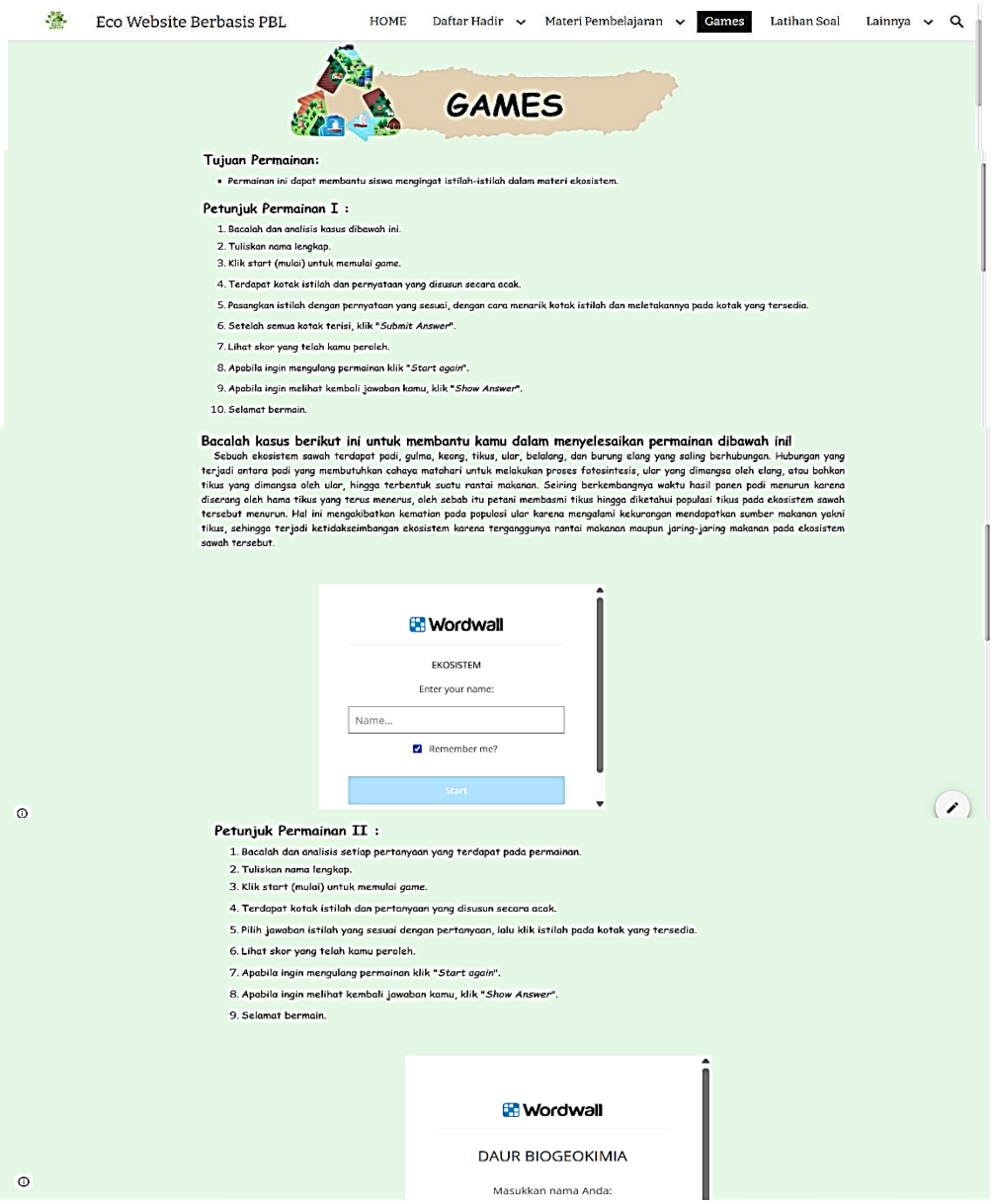
Hasil diskusi kelompok kalian disajikan dalam bentuk laporan, selanjutnya dipresentasikan di depan kelas.

Menganalisis dan Mengevaluasi

Masing-masing kelompok saling memberikan tanggapan terhadap laporan yang di presentasikan dan memperbaiki kembali laporan yang telah dibuat, kemudian dikumpulkan pada link berikut ini.

https://drive.google.com/drive/folders/1jmUulUhVotWxOvdypMm4KJIxSDvqvJIC?usp=sharing

KEMBALI



Eco Website Berbasis PBL HOME Daftar Hadir Materi Pembelajaran Games Latihan Soal Lainnya

GAMES

Tujuan Permainan:

- Permainan ini dapat membantu siswa mengingat istilah-istilah dalam materi ekosistem.

Petunjuk Permainan I :

1. Bacalah dan analisis kasus dibawah ini.
2. Tuliskan nama lengkap.
3. Klik start (mulai) untuk memulai *game*.
4. Terdapat kotak istilah dan pernyataan yang disusun secara acak.
5. Pasangkan istilah dengan pernyataan yang sesuai, dengan cara menarik kotak istilah dan meletakannya pada kotak yang tersedia.
6. Setelah semua kotak terisi, klik "*Submit Answer*".
7. Lihat skor yang telah kamu peroleh.
8. Apabila ingin mengulang permainan klik "*Start again*".
9. Apabila ingin melihat kembali jawaban kamu, klik "*Show Answer*".
10. Selamat bermain.

Bacalah kasus berikut ini untuk membantu kamu dalam menyelesaikan permainan dibawah ini!

Sebuah ekosistem sawah terdapat padi, gulma, keong, tikus, ular, belalang, dan burung elang yang saling berhubungan. Hubungan yang terjadi antara padi yang membutuhkan cahaya matahari untuk melakukan proses fotosintesis, ular yang dimangsa oleh elang, atau bahkan tikus yang dimangsa oleh ular, hingga terbentuk suatu rantai makanan. Seiring berkembangnya waktu hasil panen padi menurun karena diserang oleh hama tikus yang terus menerus, oleh sebab itu petani membasmi tikus hingga diketahui populasi tikus pada ekosistem sawah tersebut menurun. Hal ini mengakibatkan kematian pada populasi ular karena mengalami kekurangan mendapatkan sumber makanan yakni tikus, sehingga terjadi ketidakseimbangan ekosistem karena terganggunya rantai makanan maupun jaring-jaring makanan pada ekosistem sawah tersebut.

Wordwall

EKOSISTEM

Enter your name:

Name...

Remember me?

Start

Petunjuk Permainan II :

1. Bacalah dan analisis setiap pertanyaan yang terdapat pada permainan.
2. Tuliskan nama lengkap.
3. Klik start (mulai) untuk memulai *game*.
4. Terdapat kotak istilah dan pertanyaan yang disusun secara acak.
5. Pilih jawaban istilah yang sesuai dengan pertanyaan, lalu klik istilah pada kotak yang tersedia.
6. Lihat skor yang telah kamu peroleh.
7. Apabila ingin mengulang permainan klik "*Start again*".
8. Apabila ingin melihat kembali jawaban kamu, klik "*Show Answer*".
9. Selamat bermain.

Wordwall

DAUR BIOGEOKIMIA

Masukkan nama Anda:

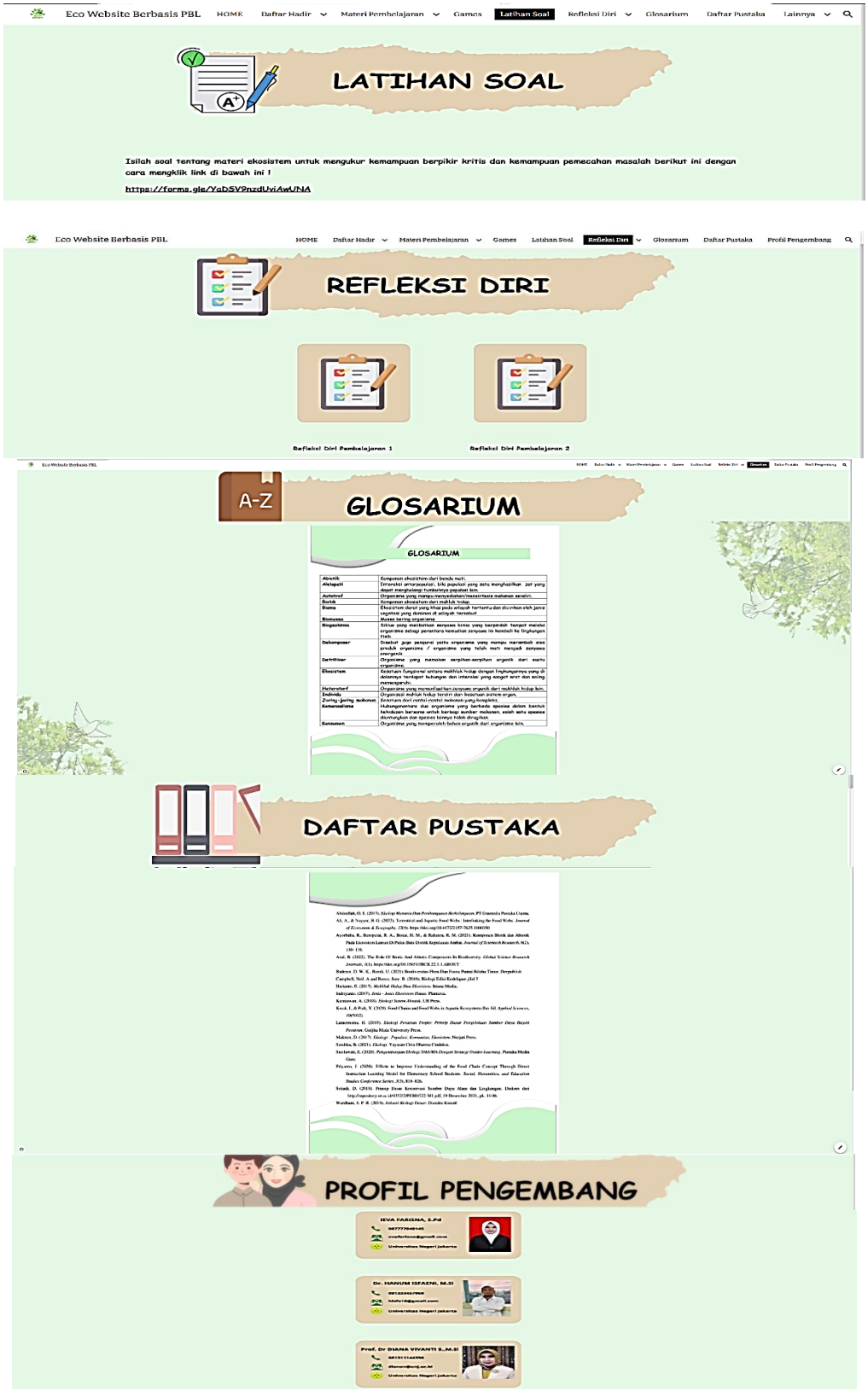


Figure 1. Display of PBL based eco-website media

The PBL based eco-website media design developed provides a variety of features. These features are made to make it easier for users to access the next page. Surachman, (2013) concluded that features or icons make it easy for users to open the desired page without having to search one by one. The student attendance feature is made through google form then the link is inserted on the eco-website as a presence tool for students.

The arrangement of topics is presented in the form of text and images that contain explanations of ecosystem topics and there are videos connected to YouTube through the links that have been inserted. Ecosystem topics are presented in the topic features 1) ecosystem features and its components, 2) biogeochemical cycle features. Each feature is available problems in the form of cases related to the topic of ecosystems.

The case must be discussed by each group of students by following the PBL learning procedures that have been available on the eco-website media including problem orientation, organizing students to learn, guiding investigations, developing and presenting work, analyzing and evaluating. The procedure of learning activities makes students interactive. This is characterized by the active contribution of students through discussions in providing responses, solutions related to problems in cases presented on eco-website media. In addition, ecosystem topic is available on the eco-website media presented in the form of images, writings, and videos that can be accessed easily to help solve cases about ecosystems. This can provide encouragement for students to read more and find out about the material being studied so that they can easily understand the ecosystem topic.

The arrangement of the material is presented in the form of text and images that contain explanations of ecosystem topic and there are videos connected to YouTube through the links that have been inserted. Mayer, (2017) stated that using a combination of text, images, and videos in learning media can improve student understanding. There are more positive results observed in students when using learning media that combines images and words than students who only use media in the form of words. (Abdulrahaman et al., 2020; Chen & Liu, 2008).

The learning material feature also provides a comment column as a facility for interaction between users via online, but PBL based eco-website media is applied directly in the classroom so that more direct interaction occurs. Then there is also a games feature that is directly connected to the wordwall which makes learning more fun, games are made by including cases about ecosystems that must be resolved by students, this encourages students' thinking activities to be more critical. It is also supported by the availability of a problem practice feature containing questions with critical thinking and problem solving aspects, in addition to the self-reflection feature that provides questions about student understanding in learning ecosystem material. Then there is a glossary feature containing terms contained in ecosystem material to help students' memories in interpreting terms related to ecosystems so that they can increase student understanding. The bibliography feature contains various sources used in compiling ecosystem material. The profile feature contains the contact name of the PBL based eco-website media compiler that can be contacted. The PBL based eco-website media that has been tidied up is then set to create a website link so that it can be accessed by users.

Product Feasibility

The eco-website media that has been developed is assessed by media experts and material experts, to provide criticism and suggestions on the feasibility and suitability of the media needed by students. The media that has been revised in accordance with the suggestions of the experts was then assessed by media experts and material experts. The media feasibility test assessment from both experts based on five aspects of assessment obtained an average value of 88.33% with a very feasible category. Therefore, it is known that the media developed, namely PBL based eco-website, is very feasible to use. The criticisms and suggestions given by learning media experts are "the title of the media should include PBL based. Then on each feature page there is no back icon, the icon should be given to make it easier for users to return to the previous page. In the material features section in the form of text, one page should be inserted with video features to make it easier for users to access the desired type of material. Presentation of problem cases regarding ecosystems should be presented directly on the eco-website so that users can still access the media on that page without having to move to the google drive section. The games section is arranged by inserting cases that can be analyzed by the user in order to increase the user's understanding of the ecosystem. After revision, the eco-website media is suitable for use in schools for biology learning with revisions according to the input that has been given".

Next is the material assessment on PBL based eco-website media. The results of the material assessment from the material expert found that the ecosystem material as a learning resource contained in the PBL based eco-website media is very feasible to use. This is indicated from the assessment of three aspects obtained an average value of 89.17%. Criticisms and suggestions given by material experts include "an explanation of PBL-based eco-website media should be given by explaining the benefits of the various features provided. Linking previously learned topics with ecosystem topics. Include examples of the types of interactions in the ecosystem and include the source of the images used on the topic. The material expert stated that the ecosystem material in this media is suitable for implementation in schools with revisions according to the suggestions that have been given".

The next stage is a readability test to determine the response of educators and small groups of students after using PBL-based eco-website media. The readability test (small group trial) was conducted on 40 class X students of class 2023/2024 and 2 educators who taught biology class X of the Merdeka curriculum. Based on the assessment given by educators from three indicators, the average score was 95.83% with a very feasible category. Educators respond by providing suggestions so that the images on the media feature buttons can be more creative to attract learners' interest in accessing each feature available on the media, but the material presented is interesting and structured and neat. This is in line with the principle of coherence, which is the principle that presents learning material in an organized and cohesive manner so that it is more easily understood by learners (Mayer, 2017).

The readability test was also conducted on students, the assessment given from three indicators obtained an average value of 91.80% with a very feasible category. Students responded that the PBL based eco-website media on the topic of ecosystems is good, interesting to use, there are games that are easily accessible, can be used anytime and anywhere, the ecosystem material presented is easy to understand, and helps in the

process of independent and group learning. The use of web-based learning can make the teaching and learning process more effective and interesting (Yulianeta et al., 2022).

The Media Effectiveness On Students' Critical Thinking And Problem Solving Skills

PBL based eco-website media that has been conducted small group trials and has been revised according to responses from educators and students so as to produce learning media that is ready to be implemented in the experimental class. This implementation is done to determine whether or not there is an increase in students critical thinking and problem solving skills after using PBL based eco-website media in the experimental group, as a comparison is the control group using a website from gramedia.com. The experimental and control groups conducted pretest and postest to determine the differences in the results of critical thinking and problem solving skills of students. The following are the results of the analysis of critical thinking indicators on the use of PBL based eco-website media in the experimental group which includes indicators of interpretation, analysis, evaluation, inference, explanation, self-regulation.

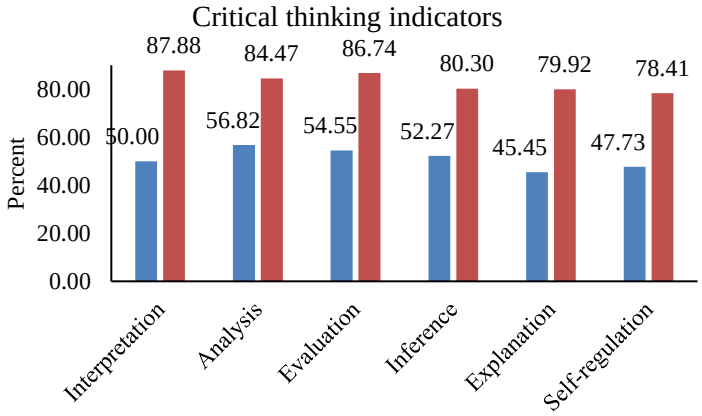


Figure 2. Experimental group critical thinking indicator results

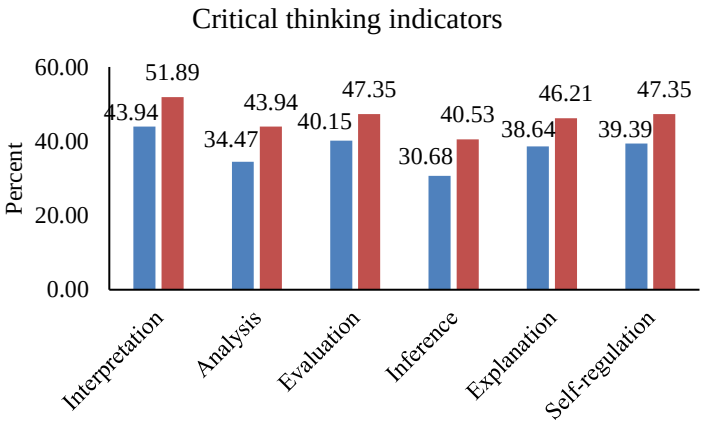


Figure 3. control group critical thinking indicator results

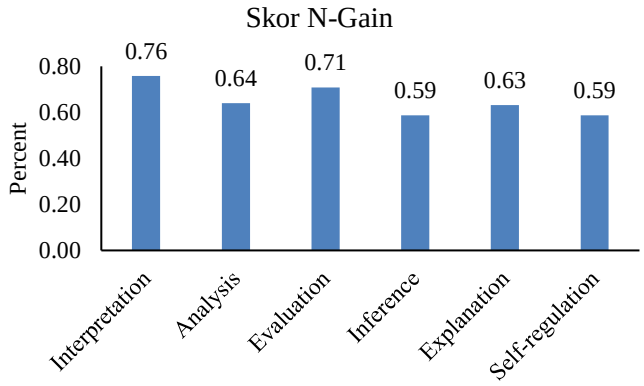


Figure 4. Experimental group critical thinking indicator N-Gain score

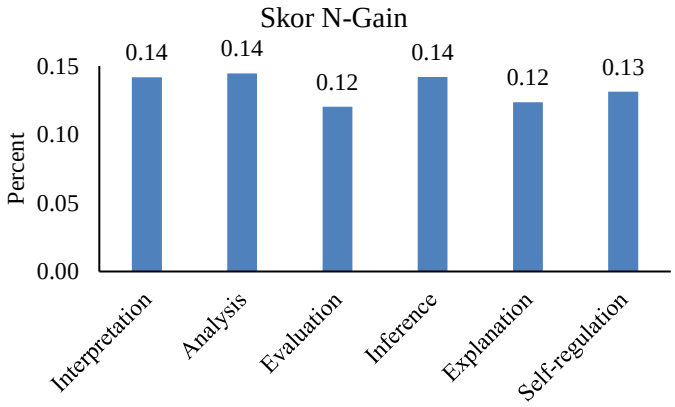


Figure 5. Control group critical thinking indicator N-Gain score

The increase in N-Gain of critical thinking indicators can be seen in the following figure. Based on the test results, it shows that the highest achievement indicator on critical thinking skills is the interpretation indicator from 50.00% to 87.88% with an increase in the N-gain score of 0.76 high criteria, the second highest indicator is evaluation from 54.55% to 86.74% with an N-gain increase score of 0.71 high criteria, and the last indicator is self-regulation from 47.73% to 78.41% with an N-gain increase score of 0.59 medium criteria. In contrast, the results obtained by the control group on each critical thinking indicator were low. This is influenced by the utilization of PBL-based eco-website media that can provide a stimulus to students in thinking because it is designed by presenting a case about the ecosystem and interactive PBL learning activities. The utilization of interactive learning media can generate direct interaction between students and motivate students to learn (Zulhelmi et al., 2017). In the learning process, students are directed to describe an event about the ecosystem, express perceptions or opinions, and evaluate the results of decisions that have been made on a case. This can encourage critical thinking activities in students (Facione, 2020).

Critical thinking skills are needed to solve problems, and problem solving can help develop critical thinking. The following are the results of the analysis of problem solving indicators on the use of PBL based eco-website media in the experimental group which

includes indicators of understanding problems, devising a plan, carrying out the plan, looking back.

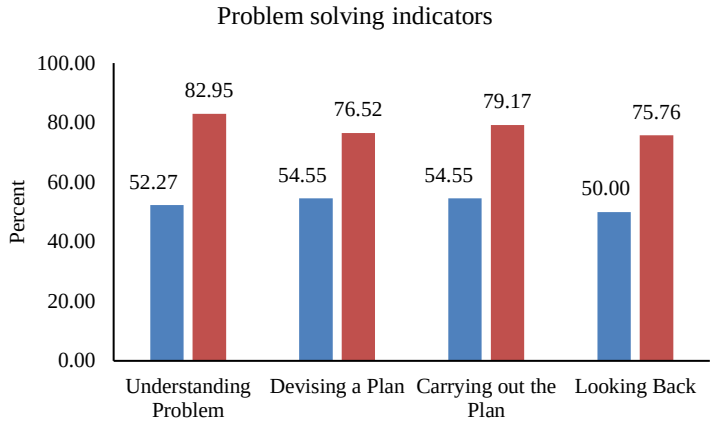


Figure 6. Experimental group problem solving indicator results

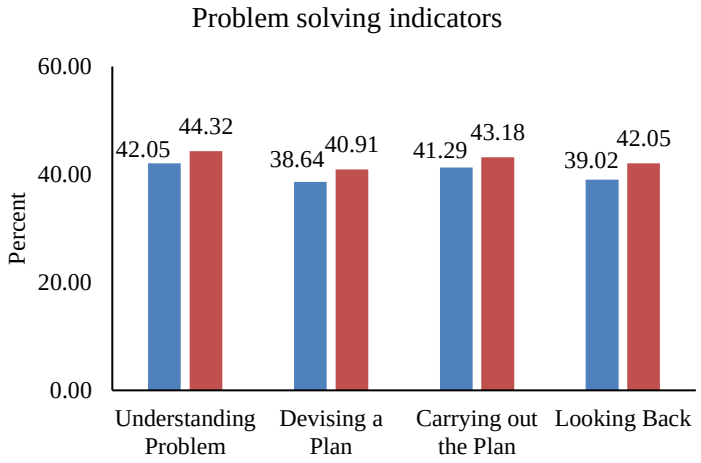


Figure 7. Control group problem solving indicator results

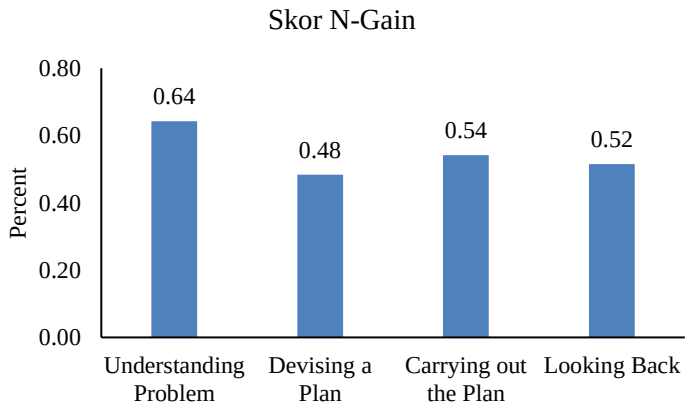


Figure 8. Experimental group problem solving indicator N-Gain score

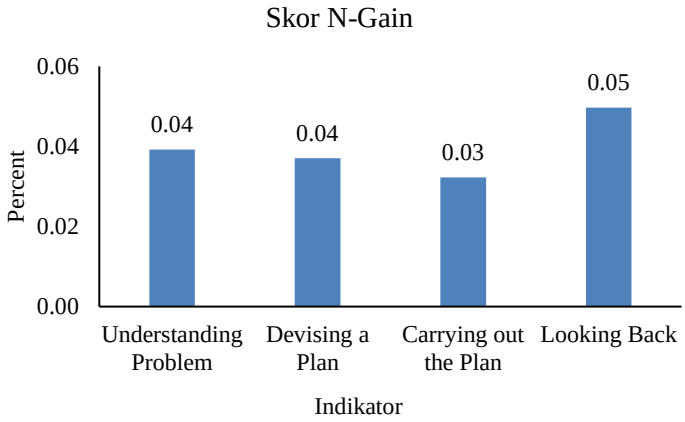


Figure 9. Control group problem solving indicator N-Gain score

Critical thinking skills are needed to solve problems, and problem solving can help develop critical thinking. The following are the results of the analysis of problem solving indicators on the use of PBL-based eco-website media in the experimental group which includes indicators of understanding problems, devising a plan, carrying out the plan, looking back.

Based on the test results, it shows that the highest achievement indicator in problem solving ability is the understanding problem indicator from 52.27% to 82.95% with an increase in the N-gain score of 0.64 medium criteria, and the second highest indicator is carrying out the plan from 54.55% to 79.17% with an N-gain increase score of 0.54 medium criteria. In contrast, the results obtained by the control group on each indicator of problem solving were low. This is because the eco-website media is integrated with problem-based learning steps that can direct students to carry out the learning process systematically and independently. The PBL approach can help and develop students' problem solving skills (Yew & Goh, 2016). The material feature on PBL based eco-website media contains a description of the ecosystem topic provided in the form of text, images, and videos to form knowledge and can make it easier for students to understand the material in the learning process that involves various senses (Mayer, 2014). Students are also introduced to cases so that students clearly understand the problem being studied. The case presented is of course related to real problems and ecosystem material to be studied. The reaction given by the students was very enthusiastic to read and analyze involving vision and understanding the written case. The presentation of problems that can be seen or even felt can arouse interest and motivate students' curiosity (Arends, 2012). Thus there is an increase in critical thinking and problem solving skills after using PBL based eco-website media.

Next, the prerequisite test is carried out which consists of multivariate normality test, linearity test, multicollinearity test, variance homogeneity test, covariance matrix homogeneity test. Multivariate normality test using the Mahalanobis test. The following is a scatterplots image of the results of the multivariate normality test of the pretest data of the experimental group and control group can be seen below.

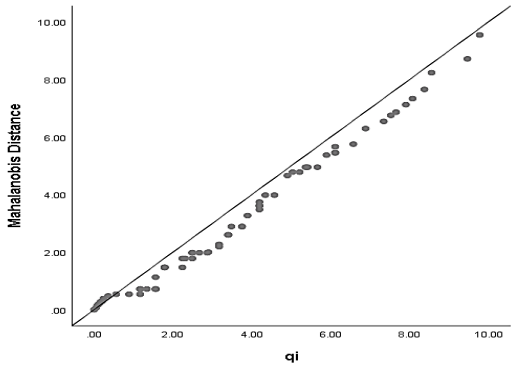


Figure 10. Scatterplot of experimental class posttest

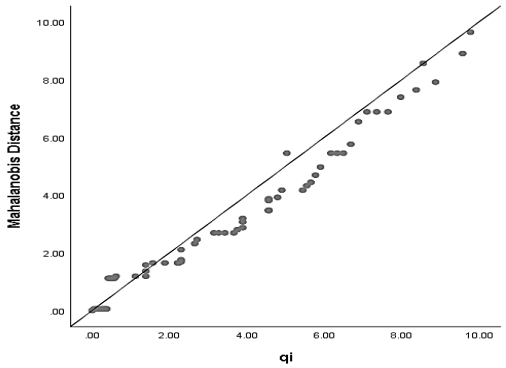


Figure 11. scatterplot of control class posttest

Based on Figure 2 and Figure 3, it shows that the Mahalanobis scatterplot tends to form a straight line from the bottom left to the top right, so the data is declared normally distributed. Furthermore, a linearity test was conducted to determine the linearity of the two dependent variables, namely critical thinking and problem solving in the experimental and control classes. The following scaterplott of linearity test results can be seen in Figure 4.

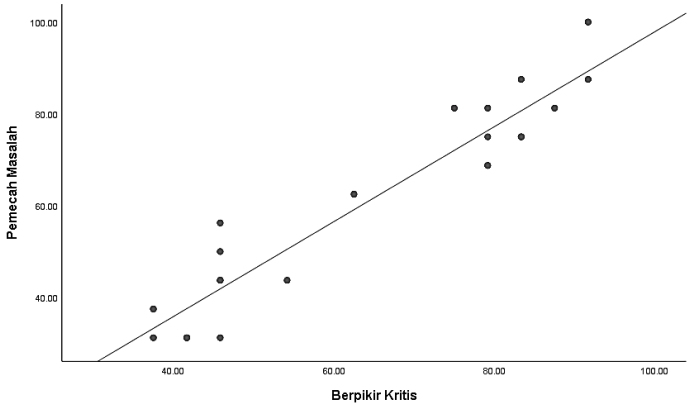


Figure 13. Scaterplott of linearity test results

Scatterplott was generated to analyze the linearity of the relationship between critical thinking and problem solving in the experimental and control classes. The scatterplot results show that critical thinking and problem solving show a linear relationship in the experimental and control classes. Furthermore, the multicollinearity test results from the critical thinking and problem solving variables obtained a Tolerance result of 1.00 and a VIF value of 1.00. Based on the multicollinearity test decision making by looking at the Tolerance value which obtained a result of 1.00 greater than> 0.10 then looking at the results of the VIF value, namely 1.00 smaller than < 10.00, it is stated that there is no multicollinearity. Furthermore, the results of the critical thinking variance homogeneity test obtained a result of 0.64 while problem solving obtained a result of 0.07, this shows that the significance value of critical thinking and problem solving skills is homogeneous or has the same variance because it is greater than 0.05. Then the results

of the homogeneity of the covariance matrix obtained a significance value of 0.13 > 0.05, this indicates that the covariance matrix of the dependent variable is classified as homogeneous or has the same variance. Thus the next stage can be done hypothesis testing using the MANOVA test.

The MANOVA test applied is a univariate test and a multivariate test. Based on the results of the univariate test, it is known that there are differences in the results of critical thinking and problem solving whose learning uses PBL-based eco-website media rather than using the gramedia.com website. This can be seen from the acquisition of a significance value of 0.00 < 0.05. Multivariate test results seen based on the value of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root obtained a significance value of 0.00 < 0.05. This proves that there is an increase in critical thinking skills and problem solving skills of students in the use of PBL-based eco-website media in SMA Negeri 1 Waringinkurung Serang District.

The learning process using PBL based eco-website media is efficient because it attracts students' attention so that students are actively involved in the learning process. PBL-based eco-website media designed using google sites is practical and easy to use because it provides various features needed for learning, so it attracts students' interest in learning to build knowledge and can improve student learning outcomes (Maharani et al., 2024; Orooji & Taghiyareh, 2015; Ramadannisaa & Hartina, 2021).

PBL based eco-website media is designed using google sites to improve critical thinking and problem solving skills by presenting interesting ecosystem content and paying attention to students cognitive load. The material feature contains descriptions of ecosystem material provided in the form of text, images, and videos to form knowledge and can facilitate understanding in the learning process that involves various senses (Mayer, 2014). The eco-website media also contains stimulus in the form of apperceptions and cases about ecosystems to stimulate students' critical thinking activities and problem solving. This is shown in the PBL stages section contained in the eco-website media. Students are encouraged to identify problems, analyze, express opinions, and evaluate things that have been found and discussed with their groups (Nurtanto & Sofyan, 2015).

The initial part of the learning material features an apperception that assists educators in stimulating students' prior knowledge of the material to be learned. Apperception is one of the processes aimed at building thinking and efforts to deepen understanding and focus students' attention as the first step in learning. (Florio, 2012; Octaviani et al., 2020). Jean Piaget stated that students can adjust themselves by assimilation, which occurs when individuals combine new information into existing knowledge, then accommodation, which occurs when individuals adjust to new information (Panggabean et al., 2021). Apperception is directly communicated in class by involving PBL-based eco-website media. This makes it easier for students' working memory to process information that has been previously known and stored, even if it is no longer intact in long-term memory, the process of absorbing new information becomes easier so that students more quickly understand the material being studied (Sweller, 2011). In addition, the learning materials feature provides learning activities with an approach of problem based learning.

The problem-based learning approach is packaged through eco-website media in which there are cases about problems raised from real life and related to ecosystem

material to train students in thinking critically and being able to solve a problem. The problem in the case becomes the starting point of the learning process, presenting a factual problem situation for investigation.(Graaff & Kolmos, 2003). Students conduct investigations to find solutions by discussing the problems of the case, so as to encourage students to analyze and identify problems, collect information, make conclusions, and draw conclusions (Arends, 2012). Problem-based learning activities help students develop and improve their critical thinking and problem-solving skills (Arends, 2012; Camp et al., 2014; Graaff & Kolmos, 2003; Lubis & Rahayu, 2023). PBL based eco-website media is also equipped with game features used to build interest and encourage students to learn, so that students are not easily bored or saturated during the learning process. (Panggabean et al., 2021).

PBL based eco-website media also provides a practice question feature that contains description questions because students need integrative abilities in forming answers. This feature is equipped with a "back" button to make it easier for users to access the destination page. This practice question is done by students to find out the extent to which students understand ecosystem material and can hone students' critical thinking and problem solving skills on ecosystem material. The exercise questions made refer to the indicators of critical thinking and problem solving. After working on this exercise, students may be able to fulfill their intellectual needs and develop their potential by applying the knowledge they already have (Pohan, 2020).

Critical thinking and problem solving skills of students can be formed with the support of PBL-based eco-website media. Based on learning activities using PBL-based eco-website media, it turns out to provide results that can improve students' critical thinking and problem solving skills. This is evidenced by an increase in student learning outcomes through practice questions conducted after learning activities take place and supported by the results of filling out a self-reflection questionnaire which states that students have understood various ecosystem concepts. The use of PBL-based eco-website as learning media is well implemented. The problem-based learning (PBL) approach contained in the eco-website media makes students directly involved in solving real-world problems, encouraging the development of key critical thinking and problem solving skills (Arends, 2012; Camp et al., 2014; Graaff & Kolmos, 2003; Nurtanto et al., 2019). Learning activities using PBL-based eco-website media allow students to learn ecosystem material repeatedly both visually and audio-visually. Robert M Gagne stated that repetitive learning occurs information storage, which is stored in the short term and then processed in the long term, through repetition of information in short-term memory can be transferred to long-term memory and can recall or recall information in memory. (Panggabean et al., 2021).

PBL based eco-website media is able to maximize learning activities because it has directed learning steps and makes the learning atmosphere more active. Visualization of material in PBL-based eco-website media makes it easier for students to understand and remember the description of the ecosystem concept. This can encourage students to explore the concept of ecosystems that can be utilized for active learning by accessing various features available in the eco-website media. PBL-based eco-website stimulates critical thinking and problem solving in problem-oriented situations and can facilitate students in investigation, discussion, and finding the information needed (Arends, 2012 ; Nurtanto & Sofyan, 2015).

The advantages of PBL-based eco-website media products include, (1) the developed media is interesting because it is equipped with learning flow, pictures, videos, and games. (2) the media is equipped with critical thinking and problem solving exercises so that it can support to empower students' critical thinking and problem solving skills. (3). Easily accessible using a laptop or cellphone and does not take up memory storage space on a laptop or cellphone. (4) Help students learn independently by accessing PBL-based eco-website anytime and anywhere. PBL based eco-website media is inseparable from the shortcomings that are owned, among others, (1) the user / user must know the media link to be able to access. (2) the media needs to be connected to the internet to be accessed. (3) the display is less organized if accessed using a cellphone.

▪ CONCLUSION

Based on the research results of PBL based eco-website media developed using the Hannafin and Peck model, it can be concluded that it is very feasible to be used as a biology learning media. The assessment of media and material expert validators obtained very feasible results to be applied at school, the application of PBL based eco-website media showed significant results in improving students' critical thinking and problem solving skills on the concept of ecosystems.

Suggestions for further research can develop website media with other biology materials or different subjects. Further website media development can integrate with other learning models such as discovery learning, project-based learning (PJBL), Inquiry Based Learning and so on. In addition, other variations are needed to develop media that can improve students' abilities from various domains in the 21st century.

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