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Biology learning innovation: KIT "EGCA" based on sustainable development goals by problem-based learning model in global warming sub-matter

Jonathan Wahyu Triswidiyanto, Marisa Christina Tapilouw *, Sucahyo

Study Program of Biology Education, Faculty of Biology, Universitas Kristen Satya Wacana, Salatiga, Central Java, Indonesia

** Corresponding Author Email: marisa.tapilouw@uksw.edu*

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Abstract

Learning innovation is a form of learning development, such as teaching media development. One of the Sustainable Development Goals (SDGs), namely climate action, is introduced through the ecosystem and environmental change sub-material of global warming in grade 10. At SMA Kristen 1 Salatiga, learning global warming material has not used KIT (Integrated Instrument Components) learning media and problem-based learning models. This research aims to develop KIT "EGCA" media and test its effectiveness. This is an R&D (Research and Development) study with the 4D model (Define, Design, Development, Disseminate). Data analysis used media validity analysis and N-Gain Score to determine the improvement of learning outcomes (Pre-Post test). Based on the results of the study, most students are not familiar with SDGs, PBL, and KIT. The results of the validation test of KIT "EGCA" and learning modules obtained a very valid category, while the KIT "EGCA" instructions and student worksheets were valid. The results of the N-Gain calculation obtained a moderate category, which means that the developed product is effective. These results indicate that the "EGCA" KIT developed is valid and effective for use in learning. The implementation of KIT "EGCA" still needs to be optimized so that students are more familiar with SGDs, PBL, and KIT itself.

Abstrak. *Inovasi pembelajaran merupakan bentuk pengembangan pembelajaran, seperti pengembangan media pembelajaran. Salah satu tujuan Sustainable Development Goals (SDGs), yaitu climate action yang diperkenalkan melalui materi ekosistem dan perubahan lingkungan sub materi pemanasan global kelas 10. Pada SMA Kristen 1 Salatiga proses kegiatan pembelajaran materi pemanasan global belum menggunakan media pembelajaran KIT (Komponen Instrumen Terpadu) dan model pembelajaran berbasis masalah (Problem based learning). Tujuan penelitian ini yaitu mengembangkan media KIT "EGCA" dan menguji keefektifan media. Penelitian ini merupakan penelitian R&D (Research and development) dengan model 4D (Define, Design, Development, Disseminate. Analisis data yang digunakan analisis kevalidan media dan N-Gain Score untuk mengetahui peningkatan hasil belajar (Pre-Post test). Berdasarkan hasil penelitian, Sebagian besar peserta didik tidak familiar dengan SDGs, PBL, dan KIT. Hasil uji validasi KIT "EGCA" dan modul pembelajaran memperoleh kategori sangat valid, sedangkan instruksi KIT "EGCA" dan lembar kerja peserta didik valid. Hasil perhitungan N-Gain diperoleh kategori sedang, yang berarti produk yang dikembangkan efektif. Hasil ini menunjukkan KIT "EGCA" yang dikembangkan valid dan efektif digunakan dalam pembelajaran. Implementasi KIT "EGCA" masih perlu dioptimalkan agar peserta didik lebih familiar dengan SGDs, PBL, dan KIT itu sendiri.*

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A. Introduction

Education is a conscious and planned endeavour to realise the process and atmosphere of education so that students can actively develop potential, personality and skills (Mukti & Nurcahyo, 2017). Education aims to produce people who are qualified to deal with problems so that they can improve a person's standard of life, knowledge, and behaviour. Teachers can innovate by increasing student knowledge through the use of media and learning models. According to Syarifah (2019), it is essential in the learning process that students are active in developing their knowledge and skills; learning processes will run optimally when the learning process is centred on the student (student-centred instruction). Global warming is one of the lessons in class 10 on ecosystem matter and environmental change.

For decades, the world's problem has been global warming due to the accumulation of greenhouse gases (Carbon Dioxide, Chloro Fluoro Carbon, and Methane) (Sofianto, 2019). Global warming has environmental impacts, such as floods and droughts, and impacts on climate change, such as uneven rainfall, uncertain climate and the emergence of various diseases and economic problems. (Ainurrohmah & Sudarti, 2022). Then came the concept of reducing and solving such issues known as SDGs (Sustainable Development Goals). According to Safitri et al. (2022), the SDGs are an effort to reduce the impact of environmental problems caused by global warming, with one of the goals of the SDGs being Climate action or real action to mitigate the effects of global warming.

According to Segara (2015), Education for Sustainable Development (ESD) is the key to achieving the SDGs through the provision of broad and futuristic insights into the global environment, as well as the formation of understanding, attitudes, and values relevant to social, economic, and environmental life. In realising ESD, it is necessary to learn Biology, which makes it easier for students to understand and apply the goals of SDGs in everyday life. It is in line with the goal of biology teaching that students can understand, discover and explain concepts, principles and problems in biology to shape their knowledge, attitudes and character (Safitri et al., 2022). The role of teachers is vital in teaching about ESD rather than the objectives of climate action so that it can shape students' attitudes and knowledge about the impact, causes and solutions of global warming.

According to a study by Supiandi & Julung (2017), students have difficulty understanding the learning material, which is challenging to visualise. Global warming material is one of the hard-to-observe sub-material students associated with heat waves and gas particles. So, we need a student model to help students conduct research and observations related to a problem. One of the learning models that can be used is Problem-Based Learning (PBL). PBL requires students to solve the issues presented by digging into as much information as possible and then analysing and seeking solutions to the existing issues. Students are expected to be broad-minded individuals who can see the relationship of learning with the environment (Asyhari, 2018).

In this case, it is necessary to innovate learning to deliver the learning material well. According to Astatin & Nurcahyo (2016), learning innovation is one of the efforts made by teachers to help students shape the concept of understanding. Teachers can innovate through teaching media, learning models and learning-related components. Learning media is essential in delivering learning material, especially in biology learning. The function of the learning media is as the teacher's medium in teaching a learning material (Wulandari et al., 2023). Based on the problems found, an innovation is needed as a learning medium that is integrated with the goals of the SDGs and can help students understand the material, use contextual problems, and learners can observe issues found in the sub-material of global warming Class 10. KIT (Integrated Instrument Component) is one of the learning media that teachers can use to convey global warming material. According to Indriani et al. (2017), KIT media serves as a message delivery to the student so that the student can understand the concept of the experience he does. In other words, students learn to use simulations in the original form or form of the material taught through KITs designed to approach actual circumstances.

Development research was conducted in the learning media KIT by Seniwati (2014) as KIT enzyme media and Juwita (2015) as the KIT Electrochemistry. From both of these studies, it is known that KIT media can help improve students' understanding of what is being taught. In the study, media development was carried out with the aim of this research, namely, to develop the KIT media “EGCA” (1) and to test the effectiveness of the media “EGCA” KIT (2).

B. Material and method

Research and Development (R&D) was used in this research. According to Sugiyono (2016), R&D is a research method to produce a product and then test for its effectiveness. This study developed a biology learning medium in the form of KIT using a 4-D design, namely Define, Design, Development and Disseminate (Figure 1).

The research was conducted at SMA Kristen 1 Salatiga in the second semester of the 2022/2023 academic year with the subject of research students of the 10th grade in 2 classes (56 students) for the disseminate class and 10 students for the KIT test. Research was carried out in as many as 3 meetings

(8JP) on global warming sub-material in the Environmental Change material. The research instrument used is a sheet of interviews consisting of 10 questions with indicators (Learning Media, KIT, Learning Model, Global Warming and SDGs), the leaflet of student needs comprised of four indicators, student and teacher response leaflets, media expert validation sheets and material experts.

In the 4D research design (Figure 1), several instruments are used, such as the interview sheet at the Define stage and lifting the student's needs. A material expert and media expert evaluation sheet is required at the Development stage, and a test class response leaf is needed for the Development stage.

Data analysis is carried out qualitatively and quantitatively, with analysis techniques in validity categories and N-Gain scores. At the definition stage, the needs of learners are elevated and analysed using the Guttman scale (Table 1). As for the elevation of the student's needs, analysis and evaluation of media validation using the Likert scale, with criteria like in Table 2. The obtained data was analysed using Formula 1 by Yulvinamaesari & Tenriawaru (2017). In the development phase, there are evaluation sheets of media experts and material experts to test the validity of KIT media; the calculations for the selection of experts are categorised according to the level of validity, with the criteria in Table 3.

In the Disseminate phase, the product was distributed and pre and post-tested to the students of the disseminate class; the results of the pre and post-tests were then analysed N-Gain scores. N-Gain score calculated using Formula 2. This N-Gain test was performed to see how big the difference between the results of the pretest and posttest students in the control and expressive classes and the influence of the implementation of the learning process (Isdayanti et al., 2022). Based on Table 4, there are three categories of N-Gain. To determine the effectiveness of the media, the N-Gain Score is interpreted in the efficacy category, as shown in Table 5.

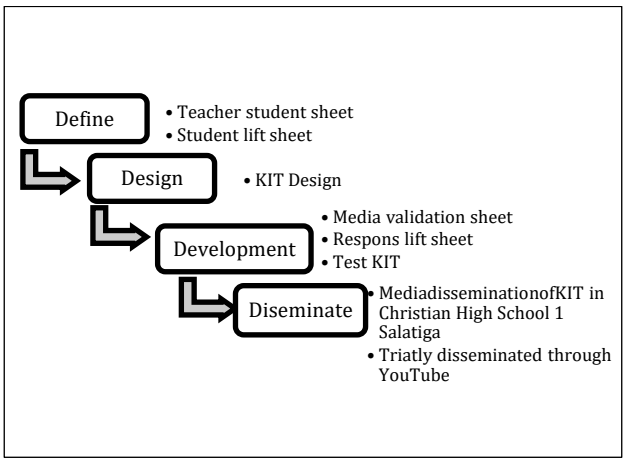

Figure 1 4D chart

Table 1 Guttman scale

Criteria	Score
Yes	1
No	0

(Source: Safitri et al., 2022)

Table 2 Likert scale

Score	Category
1	Very bad
2	Bad
3	Good enough
4	Good
5	Very good

(Source: Sembung et al., 2022)

$$P = \frac{F}{N} \times 100\% \text{.....Formula 1}$$

Description:
P = Percentage
F = Frequency of scores
N = Maximum score

Table 3 Media validity test

Percentage	Validity
81% - 100%	Very valid
61% - 80%	Valid
41% - 60%	Valid enough
21% - 40%	Not valid
≤ 20%	Very not valid

(Source: Vela, 2021)

$$N - Gain = \frac{\text{postteest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \text{.....Formula 2}$$

Table 4 N-Gain test category

Range	Category
g ≤ 0,3	Low
0,3 < g ≤ 0,7	Medium
0,7 < g ≤ 1,00	High

(Source: Isdayanti et al., 2022)

Table 5 Interpretation of effectiveness

Score value	Category
76-100	Highly effective
51-75	Effective
26-50	Less effective
0-25	Not effective

(Source: Riduwan & Sunarto, 2013)

C. Results and discussion

The results and discussion of the development of the biology learning media KIT "EGCA" along with learning devices on the ecosystem and the change of the environment sub-material of global warming. The development process of KIT has several stages, namely, Define, Design, Development, and Disseminate.

Define

School observations, interviews, and student elevations are conducted at the defined stage. The information and data obtained are then analysed. The Sustainable Development Goals (SDGs), learning media, and learning models are indicators for implementing the observations.

Based on interviews with Biology teachers, it is known that the delivery of material is always focused on the problems in the textbook, not on the contextual issues that are occurring in the surrounding environment. In addition, there are no SDGs in global warming material. The problem-based learning model has not been used in learning activities on global-warming sub-matter, whereas global-heating material is closely linked to a problem and event. This is supported by the results of the observations carried out on the pupils, which can be seen in Figure 2.

Based on Figure 2, 85.1% of students are unaware of the SDGs, 66.9% of students are not familiar with KIT as a learning media that helps obtain learning information, and 80.9% have never experienced problem-based learning on global warming material. According to research conducted by Krisna et al. (2021), many students have not appreciated the concept of a global warmer. From the results of interviews with teachers and student needs, the problem is that there is no learning media with the KIT on the sub-material of global heating, no learning model has been done on the global warning material with contextual problems, and SDGs have not been achieved in learning. Based on research conducted by Usmeldi & Amini (2021), the advantages of using KIT are that it is easy to carry, allows for mobile experiments, and facilitates equipment, storage, and administrative management. However, based on the results of the preliminary observations, it is known that in one of the high schools in Salatiga, there is no learning media KIT about global warming and the greenhouse effect, so in the learning process, biology teachers only use textbooks in teaching.

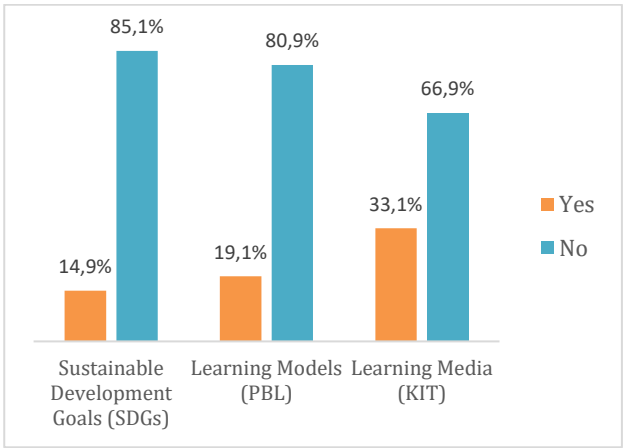

Figure 2 Need analysis results

In some studies, KIT can help teachers improve learning outcomes as one factor influencing learning activities and facilitating teachers in teaching materials (Sari, 2020). In research conducted by Rima et al. (2020), KIT media on global warming materials can help students gain learning experience in observing phenomena associated with the greenhouse effect. So that students can actively gain information about global heating through the observation process. Learning biology using KIT is one of the efforts to teach students to realise one of the SDGs goals (Tapilouw, 2023), which is climate action.

Design

Based on the findings at the Define stage, learning media in the form of "EGCA" KIT, EGCA (Greenhouse Gas Effect) was developed. The design of the learning media KIT is expected to help students understand global warming material. In addition, students can learn about the causes and effects of global warming caused by the impact of greenhouse gases.

This KIT plays a role in helping students investigate the impact of greenhouse effect gases, which is by the syntax in PBL, namely investigating problems. The EGCA (Greenhouse Gas Effect) KIT was designed in the first stage. The "EGCA" KIT consists of a glass box with sizes (20cm x 15cm x 10cm), a thermometer, charcoal, and plants (Figure 3). Furthermore, it is designed in the form of KIT instructions, which help students use KIT in the learning process. The KIT instructions describe the completeness of the tools used and instructions for using and organising the KIT (Figure 4).

Furthermore, the student's worksheet was designed to help students find problems in the global warming sub-material caused by the greenhouse gas effect (Figure 5). By working on worksheet, students were able to discover the causes of global warming caused by the greenhouse gas effect. In addition, students were able to learn about the impact of global warming so that they could provide solutions to reduce the impact of global warming as a goal of the SDGs. The designed student's worksheet corresponds to the initial syntax of PBL, namely problem orientation, organising students in investigations, and presenting work (Sugiyanto, 2010).

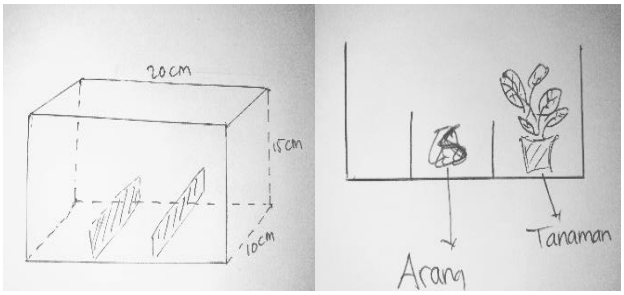

Figure 3 Initial KIT design (in Indonesian)

Teaching modules are helpful in helping teachers carry out learning activities using the PBL model. Therefore, teaching modules are needed to be able to plan the learning process; teaching modules are composed of CP (Learning Outcomes), ATP (Flow of Learning Objectives) and the core of learning activities (Yuliani et al., 2023). According to Tapilouw et al. (2017), environmental problems can have the potential for learning implementation with the PBL (Problem-based learning) model. Ecological problems are contextual things that teachers can use as questions in learning activities with problem-based models.

Panduan Penggunaan KIT Pemanasan Global

1. Persiapkan alat dan bahan
   a. Alat : Media KIT, termometer, korek, pasir
   b. Bahan : Es, tanaman, kapas,
2. Untuk percobaan pertama dimasukan pasir kedalam media KIT pada ruang bagian tengah KIT
3. Dimasukkan es batu pada ruang KIT bagian kiri
4. Dimasukkan tanamana pada ruang KIT bagian kanan lalu ditutup dengan penutup KIT
5. Kemudaian dicatat suhu dengan termometer dan kondisi es pada periode waktu 0 menit, 8 menit dan 15 menit
6. Kemudain dibersihkan KIT dari es, pasir dan tanaman
7. Untuk percobaan kedua dimasukan pasir kedalam media KIT pada ruang bagian tengah KIT
8. Dimasukkan es batu pada ruang KIT bagian kiri
9. Kemudian letakkan kapas diatas pasir lalu dibakar lalu ditutup dengan penutup KIT
10. Kemudaian dicatat suhu dengan termometer dan kondisi es pada periode waktu 0 menit, 8 menit dan 15 menit
11. Kemudiaan dibersihkan KIT dari es, pasir dan kapas yang dibakar
12. Lalu analisa hasil yang didapat dari percobaan tersebut.

Figure 4 Initial design of kit instructions (in Indonesian)

LKPD

Pemanasan Global

Tujuan	:	Diakhir pembelajaran ini peserta didik mampu mengidentifkasi fakta-fakta perubahan lingkungan sebagai dampak pemanasan global, menganalisis perubahan lingkungan sebagai dampak pemanasan global, mengidentifkasi aktivitas manusia yang menyebabkan perubahan lingkungan sebagai dampak pemanasan global, dan menciptakan solusi untuk mengatasi perubahan lingkungan sebagai dampak pemanasan global
Kelas	:	X/ Fase E
Materi	:	Pemanasan Global

Nama Anggota Kelompok :	

Petunjuka Penggunaan LKPD

1. Bacalah dengan baik dan pahamilah dengan benar tujuan yang akan dicapai setelah mempelajari LKPD ini.
2. Bertanyalah pada guru untuk memperjelas perintah yang tertera pada LKPD ini jikadiperlukan.
3. Bacalah panduan penggunaan KIT Pemanasan Global
4. Sediakanlah alat dan bahan sebelum mengerjakan tugas maupun percobaan dalam LKPD ini
5. Lakukan kegiatan sesuai dengan panduan penggunaan KIT Pemanasan Global.
6. Catat hasil yang didapat dari penggunaan KIT Pemanasan Global
7. kemudian mintalah untuk dievaluasi LKPD yang telah dikerjakan.

Figure 5 Students worksheet (in Indonesian)

Development

After designing the "EGCA" KIT product (Figure 6), an assessment was carried out with material experts and media experts consisting of 1 lecturer and 2 practitioners. In this KIT media validation, actions were taken to measure the durability and accuracy of the media. The validation results are shown in Table 6. The validation results obtained an average of 88.8% for KIT (Table 6), included in the very valid category. There were several suggestions for KIT instruction. Based on the validator's suggestions, improvements were made by redesigning using Canva and correcting some sentences (Figure 7). Based on the validation results (Table 7), the KIT instruction and student's worksheet average validation value was 78.8%, categorised as Valid. According to Vela (2021), the value of 78.8% is classified as valid. In the student's worksheet, there are two primary questions, namely, the impact of global warming and the causes of global warming. The improvement results can be seen in Figure 8. Based on research conducted by Riani et al. (2017), questions about the impacts and causes of global warming are closely related to the syntax of PBL, namely organising students in problems.

Table 6 Validation of KIT

Indicator of KIT	Validator			Average
	1	2	3	
Durability	100%	100%	80%	93.3%
Accuracy	80%	80%	100%	86.6%
Component protection	80%	100%	80%	86.6%
Average				**88.8%**
Category				**Very valid**

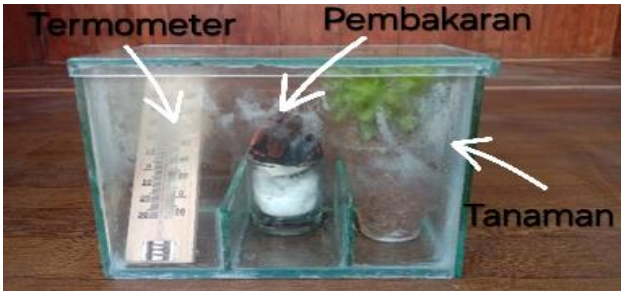

Figure 6 KIT design (in Indonesian)

Table 7 Validation of KIT instructions and student's worksheet

Indicator	Score			Average
	1	2	3	
Readability	100%	100%	60%	76,3%
Guide support to use KIT	80%	100%	60%	80%
Spelling correctness	100%	80%	60%	80%
Average				**78,8%**
Category				**Valid**

Figure 7 KIT instructions after improvement (in Indonesian)

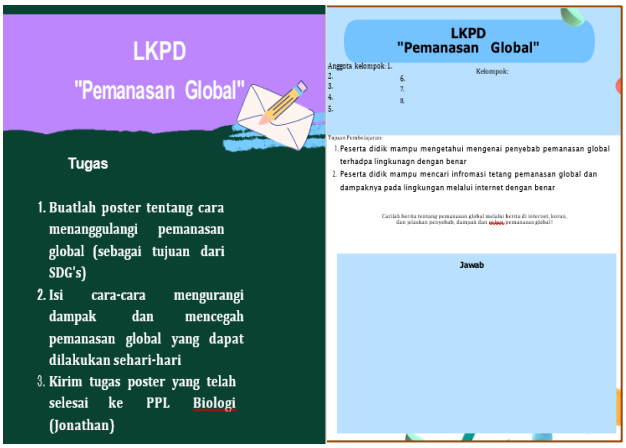

Figure 8 Student's worksheet after improvement (in Indonesian)

Improvements made to the student's worksheet are related to suggestions from experts. For this reason, a Canva redesign was carried out, and improvements were made to correct spelling and words. Based on the media expert assessment (Table 8), an average assessment of 86.7% was obtained and included in the "very valid" category. According to Vela (2021), the validity value of 86.7% is classified as media that can be categorised as very valid. Revisions to the teaching module include improvements to sentences and errors in spelling (Figure 9).

In the teaching module, improvements were made to the use of wrong words. In addition, adjustments were made to the CP (Learning Outcomes) and ATP (Flow of Learning Objectives). The limited trial was conducted on grade 10 students. In the limited trial, pre-test and post-test, 10 multiple choice questions were used with indicators: 1) causes of global warming, 2) impacts of global warming, and 3) prevention of global warming. As well as giving a response questionnaire. The trial results are presented in Table 9.

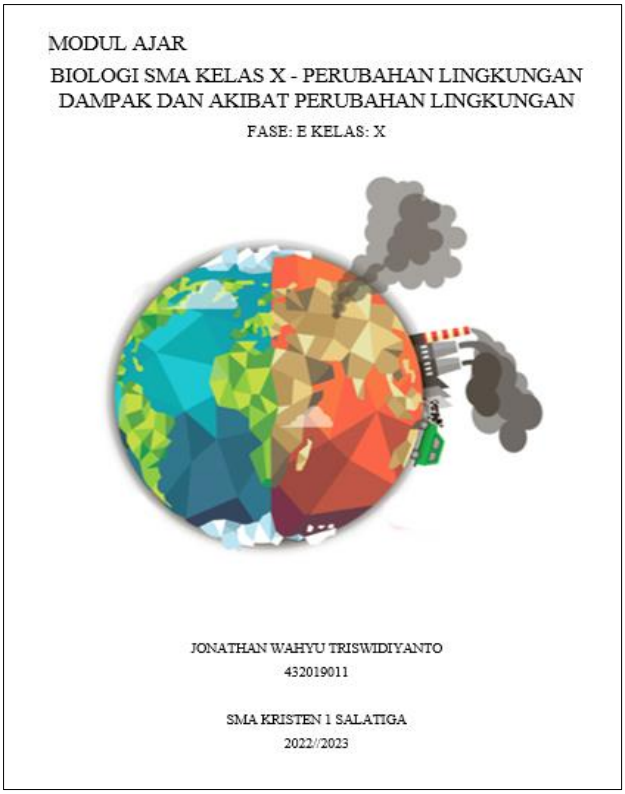

Figure 9 Teaching module after improvement (in Indonesian)

Table 8 Validation of learning module

Indicator	Score	Average
Compatibility of theory with the greenhouse concept	80%	80%
Suitability of learning	100%	100%
Material is contextualised	80%	80%
Average		**86,7%**
Category		**Very valid**

Table 9 Trial class score

Test class indicators	Average scores
Pre-test and post-test	54
Questionnaire response	82.2

Disseminate

After the "EGCA" KIT is declared valid by media and material experts and trialled, the "EGCA" KIT media is disseminated. This is the final stage of the 4D research model. At this stage, the "EGCA" KIT media was distributed to two classes of 56 students, and pre-and post-tests were conducted to determine students' learning outcomes using the N-Gain score test analysis.

Based on the pre-and post-test results in Table 10, the N-Gain value of the student's test results is classified as moderate. According to Rahmawati & Melisa (2016), N-Gain is classified as moderate, with an average of 0.6. In the results of the validation of Media KIT "EGCA," the results obtained were 82.2%, and the average N-Gain Score was 0.6.

Table 10 Result N-Gain score

Question indicators	N-Gain	
	X4	X6
Causes of global warming	0.75	0.75
Impact of global warming	0.71	0.69
Global warming prevention	0.62	0.51
Average	**0,69**	**0,65**

Figure 10 Students' poster (in Indonesian)

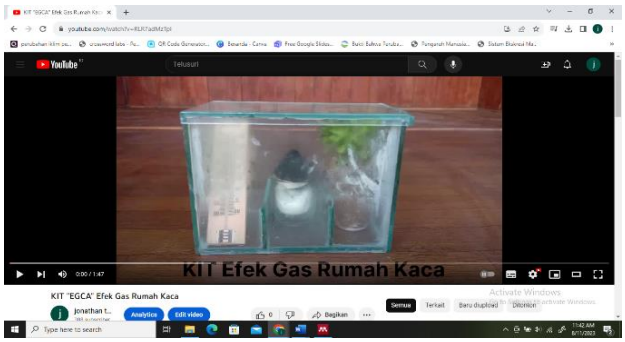

Figure 11 Introduction of KIT's video

A series of learning activities using the problem-based learning model with the "EGCA" KIT media can increase students' understanding and knowledge. When making observations and analysing problems, students could find and understand the phenomena of the greenhouse effect, such as rising temperatures and melting ice events. Later, students were able to come up with solutions that could be used to reduce the impact of the greenhouse effect. Table 10 shows that the "EGCA" KIT media can help improve learning outcomes, as shown in the N-Gain score results.

At the end of the activity, students made a poster as a result of students' analysis of how to prevent global warming due to the greenhouse effect. Figure 10 is the illustration of the student's poster. The two points of this poster are reducing and preventing global warming. Then, at the end of the dissemination stage, the media kit was disseminated through YouTube https://youtu.be/RLR7adMzTpI (Figure 11). This was done hoping that biology teachers could further develop the "EGCA" KIT media. In addition, creating "EGCA" KIT media is expected to inspire Biology students and teachers to make innovations in biology learning.

D. Conclusion

Based on the results of the study, most students are not familiar with SDGs, PBL, and KIT. The results of the validation test of KIT "EGCA" and learning modules obtained a very valid category, while the KIT "EGCA" instructions and student worksheets were valid. The results of the N-Gain calculation obtained a moderate category, which means that the developed product is effective. Although valid and effective for use in learning, further development is needed to make the product better, especially by using materials that are easier to find, and carbon dioxide simulations that are easier to understand according to the ability of students.

E. References

Ainurrohmah, S., & Sudarti, S. (2022). Analisis perubahan iklim dan global warming yang terjadi sebagai fase kritis. *Phi: Jurnal Pendidikan Fisika dan Terapan*, *8*(1), 1-10. DOI: http://dx.doi.org/10.22373/p-jpft.v3i3.13359

Astatin, G. R., & Nurcahyo, H. (2016). Pengembangan media pembelajaran biologi berbasis adobe flash untuk meningkatkan penguasaan kompetensi pada Kurikulum 2013. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 165-176. DOI: http://dx.doi.org/10.21831/jipi.v2i2.10966

Asyhari, A. (2018). Pengaruh pembelajaran biologi berbasis problem based learning (PBL) terhadap kemampuan metakognitif. *Journal of Biology Education*, *1*(2), 165–179. DOI: https://doi.org/10.22202/jp.2015.v8i1.375

Indriani, E., Sahputra, R., & Hadi, L. (2017). Pengembangan media komponen instrumen terpadu (KIT) ikatan kimia. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, *6*(10), 1–9. DOI: https://dx.doi.org/10.26418/jppk.v6i10.22695

Isdayanti, I., Wicaksono, A. T., & Rahmawati, H. (2022). Pengaruh penggunaan worksheet materi asam basa berbasis kearifan lokal terhadap hasil belajar siswa. *Al Kawnu : Science and Local Wisdom Journal*, *1*(2), 74–81. DOI: https://doi.org/10.18592/alkawnu.v1i1.6402

Juwita, R. (2015). Pengembangan KIT elektrokimia kelas XII SMA. *Jurnal Pelangi*, *8*(1), 1–12. DOI: https://doi.org/10.22202/jp.2015.v8i1.389

Krisna, B., Tandililing, E., & Arsyid, S. B. (2021). Deskripsi miskonsepsi peserta didik pada materi pemanasan global di SMA Negeri 1 Serawai. *JPPK: Journal of Equatorial Education and Learning*, *10*(12), 1–11. DOI: https://dx.doi.org/10.26418/jppk.v10i12.51074

Mukti, I. N. C., & Nurcahyo, H. (2017). Pengembangan media pembelajaran biologi berbantuan komputer

untuk meningkatkan hasil belajar peserta didik. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 137-149. DOI : https://doi.org/10.21831/jipi.v3i2.7644

Rahmawati, R., & Melisa, M. (2016). Pengaruh penerapan pendekatan kontekstual bermedia power point terhadap hasil belajar siswa pada materi sistem ekskresi pada manusia kelas VIII SMPN 4 Bireuen. *JESBIO: Jurnal Edukasi dan Sains Biologi*, *5*(1), 1–6. Retrieved from http://www.jfkip.umuslim.ac.id/index.php/jesbio/article/view/154

Riani, I. F., Sulaiman, S., & Mislinawati, M. (2017). Kendala guru dalammenerapkan model pembelajaran pada pembelajaran tematik berdasarkan Kurikulum 2013 di SD Negeri 2 Kota Banda Aceh. *Elementary Education Research*, *2*(2), 88–97. Retrieved from https://jim.usk.ac.id/pgsd/article/view/2536

Riduwan & Sunarto. (2013). *Pengantar statistika: Untuk penelitian pendidikan, sosial, ekonomi, komunikasi dan bisnis*. Bandung: Alfabeta.

Rima, R., Munandar, A., & Anggraeni, S. (2020). Pengembangan kegiatan praktikum pemodelan efek rumah kaca untuk siswa SMA pada materi perubahan lingkungan. *Assimilation: Indonesian Journal of Biology Education*, *3*(1), 34–38. DOI: https://doi.org/10.17509/aijbe.v3i1.23308

Safitri, D., Qudsi, R., Ariawan, R., & Herlina, S. (2022). Pengembangan perangkat pembelajaran berbasis problem based learning (PBL) terintegrasi karakter islami pada materi aritmatika sosial kelas VII MTs. *Jurnal PEKA (Pendidikan Matematika)*, *5*(2), 90–104. DOI: https://doi.org/10.37150/jp.v5i2.1406.Copyright

Sari, Y. A. (2020). Pengembangan lembar kerja siswa biologi sma berbasis pendekatan ilmiah untuk meningkatkan keterampilan berfikir siswa. *SINAU : Jurnal Ilmu Pendidikan Dan Humaniora*, *6*(2), 87–99. DOI: https://doi.org/10.37842/sinau.v6i2.34

Segara, N. B. (2015). Education for sustainable development (ESD) sebuah upaya mewujudkan kelestarian lingkungan. *SOSIO-DIDAKTIKA: Social Science Education Journal*, *2*(1), 22–30. DOI: https://doi.org/10.15408/sd.v2i1.1349

Sembung, F. Y., Arnyana, I. B. P., & Mulyadiharja, S. (2022). Pengembangan Media Pembelajaran Google Sites Berbasis STEM Materi Pencemaran Lingkungan Kelas X SMA Negeri Bali Mandara. *Jurnal Pendidikan Biologi Undiksha*, *9*(2), 174–186. DOI: https://doi.org/10.23887/jjpb.v9i2.49072

Seniwati, S. (2014). Pemanfaatan media KIT enzim dalam meningkatkan aktivitas belajar siswa kelas XII IPA5 di SMAN I Bontonompo. *Jurnal Nalar Pendidikan*, *2*(1), 554-557. DOI: https://dx.doi.org/10.26858/jnp.v2i1.1965

Sofianto, A. (2019). Integrasi target dan indikator sustainable development goals ke dalam perencanaan pembangunan daerah di Jawa Tengah. *Jurnal Litbang Provinsi Jawa Tengah*, *17*(1), 25–41. DOI: https://doi.org/10.36762/litbangjateng.v17i1.769

Sugiyanto, S. (2010). *Model-model pembelajaran inovatif.* Surakarta: Yuma Pressindo.

Sugiyono, S. (2016). *Metode penelitian kuantitatif, kualitatif dan kombinasi.* Bandung: Alfabeta.

Supiandi, M.I., & Julung, H. (2017). Pengaruh model problem based learning (PBL) terhadap kemampuan memecahkan masalah dan hasil belajar kognitif siswa biologi SMA. *Jurnal Pendidikan Sains, 4*(2), 60-64. DOI: https://doi.org/10.17977/jps.v4i2.8183.

Syarifah, S. (2019). Active learning teach like Finland. *Qiro'ah: Jurnal Pendidikan Agama Islam*, *9*(1), 85–99. DOI: https://doi.org/10.33511/qiroah.v9n1.%25p

Tapilouw, M. C. (2023, October). Environmental awareness of student and teacher: A little step to Sustainable Development Goals (SDGs). In *AIP Conference Proceedings,* (Vol. 2734, No. 1, p. 120011). AIP Publishing. DOI: https://doi.org/10.1063/5.0156061

Tapilouw, M. C., Firman, H., Redjeki, S., & Chandra, D. T. (2017, September). Junior high school students' perception about simple environmental problem as an impact of problem based learning. In *Journal of Physics: Conference Series,* (Vol. 895, No. 1, p. 012130). IOP Publishing. DOI: https://doi.org/10.1088/1742-6596/895/1/012130

Usmeldi, U., & Amini, R. (2021). Pelatihan penggunaan KIT IPA dan pengembangan LKPD berbasis praktikum untuk guru IPA. *Jurnal Abdimas Prakasa Dakara*, *1*(2), 56–65. DOI: https://doi.org/10.37640/japd.v1i2.1010

Vela, L. V. (2021). Validitas media pembelajaran e-learning berbasis edmodo dalam pembelajaran biologi pada sekolah menengah atas. *Jurnal Biologi dan Pembelajarannya (JB&P)*, *8*(1), 26–31. DOI: https://doi.org/10.29407/jbp.v8i1.15780

Wulandari, A. P., Salsabila, A. A., Cahyani, K., & Shofiah, T. (2023). Pentingnya media pembelajaran dalam proses belajar mengajar. *Journal on Education*, *5*(2), 3928–3936. DOI: https://doi.org/10.31004/joe.v5i2.1074

Yuliani, Y., Retnowati, R., & Djarot, P. (2023). Analysis of problem-based digestive system interactive e-module needs to improve students' critical thinking. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *5*(2), 204–210. DOI: http://dx.doi.org/10.20527/bino.v5i2.15651

Yulvinamaesari, Y., & Tenriawaru, E. P. (2017). Analisis kemampuan berpikir kreatif mahasiswa fisika ditinjau dari perbedaan multipple intelligence. *Jurnal Dinamika*, *8*(1), 41–55. Retrieved from https://www.journal.uncp.ac.id/index.php/dinamika/article/view/653