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Development of biodiversity subject-specific pedagogy (SSP) containing local potential and bio-economy to strengthen pancasila student profiles

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Biodiversity;
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Local potential;
Pancasila student profiles;
Subject-specific pedagogy

Abstract

The aims of this study was to develop biodiversity learning device as Subject-Specific Padagogy (SSP) containing local potential to strengthen Pancasila Student Profile. The researchers used Research and Development with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) design. The instruments used were interview sheets, validation questionnaires for curriculum experts, content experts and media experts to determine the validity of the product, as well as questionnaires for biology teachers and pre-service biology teachers as users to determine the suitability of the product with 4 Likert scales. The scores obtained were analyzed descriptively to determine the average value of product validity and feasibility. The research results show that the average validity value for the curriculum relevance aspect is 3.85, the content aspect is 3.61, and the media aspect is 3.70, with valid criteria. The results of trial assessment of biology teachers and pre-service biology teachers show that the criteria are suitable for use with average scores of 3.73 and 3.77. Other findings revealed that biodiversity SSP were developed more specifically to strengthen Pancasila Student Profiles, namely a project module with a local wisdom theme which focused on projects to preserve traditional food and an entrepreneurship theme which focused on the project of processing Muria coffee skin waste into more efficient products and selling value, as a form of optimizing local potential and developing the community's Bio-economy. The activities in this project module are seen as potential in strengthen Pancasila Student Profiles.

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Introduction

Indonesia has the highest biodiversity potential within the ASEAN and beyond (von Rintelen et al., 2017), also the second rank in the world after Brazil because of its uniqueness in terms of geology and geography. This biodiversity is related to the multicultural society in Indonesia. The multicultural and unique nature spread across Indonesia has the potential to be developed in order to increase development and the economy through optimizing the development of the potential of each region (Suryadarma, 2008). The importance of biodiversity, e.g., in agriculture and traditional medicine, is deep-rooted in Indonesian society. As for modern biodiversity pathways include new fields of application in pharmacy, technology and economy along with environmental or other policies (von Rintelen et al., 2017). Referring to the national education perspective, the diversity of regional potential is taken into consideration in planning educational policies, including in the independent learning curriculum (Ministry of National Education, 2013).

This provides a great opportunity for all educators to be able to raise issues or problems related to local potential and package them in an interesting learning implementation. However, teachers still experience difficulties in being able to integrate elements or problems related to local potential in learning due to several obstacles (Wilujeng & Zuhdan, Kun P Suryadarma, 2018). The main obstacle is related to the teacher's lack of understanding to be able to integrate local potential appropriately into a learning process (Alexon, 2010). Apart from that, another obstacle that also influences this is the lack of examples of models that can be adapted by teachers to be developed in learning activities or learning device (Suratsih, 2010).

Learning by integrating local potential is considered very important to do, especially to introduce and attract the interest of youth generation to proud and respect the diversity of local potential by linking the indigenous knowledge into scientific knowledge (Kamila et al., 2024). Through the integration of local potential in learning, the younger generation can also be directed to develop and optimize creativity in managing regional potential to produce creative and economically valuable products so that they can build and increase the economic value of their respective regions (Sulistyowati et al., 2020). This is also expected to foster a love for local products, have insight into the potential and value of local wisdom, think critically and also be innovative which is part of the Pancasila Student Profiles.

Integration of local potential can be implemented in groups of subjects (Ministry of National Education, 2013), including biology subjects. In biology subjects, local potential can be applied in learning about biodiversity because it is seen as contextual and related to real life, especially regarding the benefits of local potential related to the diversity of plants, animals or natural potential that can be explored and exported (Na'imah & Widiyaningrum, Priyantini Martuti, 2022; Sunarsih et al., 2020). Local potential holds scientific concepts that can be explored and are useful for the lives of students or society at large (Suastra et al., 2011). The issue of local potential in biodiversity learning can be packaged and presented, including through the development of learning device as Subject-Specific Pedagogy (SSP).

Teachers and educational professionals can use SSP to impart culturally specific knowledge, community issues, and local wisdom (Kartika et al., 2023). Learning device as SSP refer to all learning components that must be prepared by teachers to support the learning process (Noor & Wilujeng, 2015; Sastradika & Jumadi, 2018)Learning device that can be developed in biology learning include Lesson Plans, teaching materials, Student Worksheets and assessment instruments. Learning device need to be prepared by a teacher ideally referring to the basic competencies to be achieved and relevant to the utilization and development of local potential in each educational unit (Kahar & Fadhilah, 2017). Designing appropriate learning device plays an important role in helping teachers prepare learning that is creative, innovative, fun and can maximize students' potential to be actively involved in the learning process and achieve the expected competencies (Sriyati et al., 2021). Achieving the competency in question is related to the Pancasila student profile which contains competency standards for graduates who have global competence and are able to behave and act in accordance with the practice of Pancasila values. In order to support the achievement of Pancasila Student Profiles competencies, the implementation of the independent curriculum orients teachers to freely design learning tailored to the needs of students and also local potential that can be developed through learning in the hope of increasing faith and devotion, having noble character, global

diversity ,mutual cooperation, independence and developing critical and creative reasoning abilities in innovation (Nurasiah et al., 2022).

The results of a preliminary study through interviews revealed that teachers still encounter obstacles in designing learning device based on freedom curriculum, because they still lack knowledge about how to develop learning device or looking for examples of learning device that are oriented towards developing the competency of Pancasila Student Profiles. Whereas the development of learning device regarding biodiversity by integrating local potential has the potential to be developed in order to develop Pancasila Student Profiles (Afriatmei et al., 2023). However the application of it is adjusted to the teacher's creativity in implementing them through learning activities.

Integrate local potential as a part of learning can be related to bioeconomic development in a region. Bioeconomics refers to an economic system in terms of processing natural resources and renewable resources originating from land or sea to manage their potential to become food for humans, feed for livestock and the development of alternative and renewable fuels/energy sources (Iorgulescu, 2023). The bioeconomic approach refers to the integration of biotechnology and economic studies which are considered important to study in order to support economic development through transformative and inclusive innovation as a part of SDGs (Aguilar & Twardowski, Tomasz Wohlgemuth, 2019). The characteristics of transformative and inclusive innovation are related to various innovations carried out in the context of diversity management. Biodiversity can produce use values and benefits by being oriented towards future practices, the benefits of which can be enjoyed and accessed by all levels of society.

Referring to research articles indexed on Google Scholar by entering the keyword bioeconomic approach, research on the application of bioeconomics is largely related to fisheries bioeconomics, such as research conducted by Muawanah., Huda., Koeshenderajana., Nugroho., Anna., Mira & Ghofar (2017)., Akoit & Nalle (2018)., Dafiq., Anna., Rizal & Suryana, (2019). Utami., Kusumastanto, Zulbainarni & Ayunda (2020) and Irawati (2022) who researched the management of fisheries resources in various regions of Indonesia, the results of which generally illustrate whether there are practices in exploiting fisheries resources and optimizing fisheries utilization referring to the value of profits obtained. Apart from that, there is also research in agricultural bioeconomics who analyzed cassava side products as bioeconomic potential for future agriculture (Rozi & Poedjiastuti, 2019). However, research on educational bioeconomics that can be integrated into learning, especially regarding biodiversity learning, has never been carried out.

Referring to the Policy Brief "Mainstreaming Bio-economy in Indonesia" held by (Akademi Ilmu Pengetahuan Indonesia (AIPI), 2019) in Jakarta, it was revealed that Bio-economy is closely related to the utilization of natural resource potential and biodiversity that exists throughout Indonesia. The government's role as a facilitator and central regulator must be able to mobilize all elements of human resources in various fields according to their background and competence to strive to develop the Bio-economy in their respective regions through wise use and management of biodiversity, including in the field of education. This is aimed at increasing public awareness and concern regarding the importance of biodiversity.

Through the education sector, it is hoped that we can cultivate and hone the abilities of human resources, in this case teachers and students to be able to read and explore the potential

of biodiversity, so that learning about biodiversity requires continuous innovation at every level of education, from the most basic to high level. In higher education, biodiversity are no longer abstract but are a concrete form that can be managed in accordance with scientific knowledge. Thus, it is important to carry out further research on educational bioeconomics in terms of integrating bioeconomics in learning, especially biodiversity learning device. The combination of bioeconomic content and integration of local potential in the development of biodiversity SSP is expected to make an academic contribution in terms of providing examples of developing learning device that can be implemented in biodiversity learning by teachers in freedom curriculum in order to strengthen Pancasila Student Profiles. This research aims to determine the validity and feasibility of biodiversity learning containing local potential and bioeconomics in supporting Pancasila Student Profile which is developed so that it is suitable for use in learning activities.

Method

Researchers used research and development methods with the ADDIE version of the development model (Analysis, Design, Development, Implementation, Evaluation) (Aldoobie, 2015). At the Analysis stage, researchers analyzed teachers' needs in the field, problems found in biodiversity learning, and the learning device used by teachers. At the design stage, researchers drafted biodiversity learning device containing local potential and bioeconomics which included the design of the Learning Objectives Flow (ATP) and Teaching Module, Worksheet, Project Module for Strengthening Pancasila Student Profiles, and biodiversity teaching materials. Next, in the development stage, all biodiversity learning device that have been designed are validated by experts so that their validity can be determined. At the implementation stage of the learning device that have been validated, a feasibility assessment trial is then carried out on biology teachers and 20 pre-service biology teachers by analyzing the product and reflecting on the biodiversity learning activities that have been carried out. The results of this trial will be used as revision material to obtain learning device that can be implemented widely. The evaluation stage contains assessment activities to ensure the conformity of each step with the specifications. Data collection instruments used in this research include: (1) interview sheets to analyze user needs, (2) validation questionnaires for curriculum experts, content experts and media experts, and (3) user trial feasibility questionnaires with 4 Likert scales.

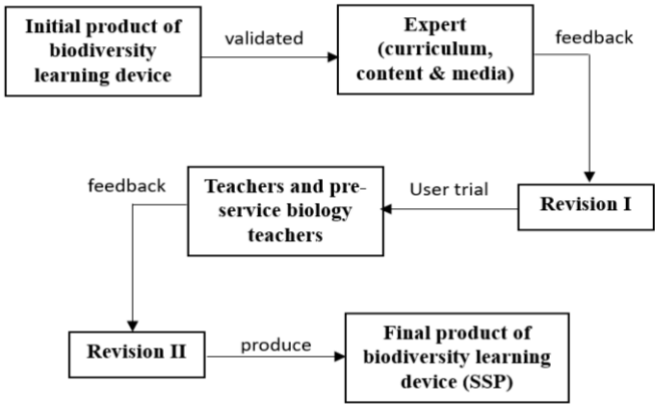


Figure 1. Scheme of Product Development

Data obtained from the product validity and feasibility questionnaire are then analyzed using the following formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} xi}{n}$$

Where:

$$xi = \frac{\text{sum of score}}{\text{maximum total score}} \text{X } 4$$

information:

$\bar{x}$: total average

xi : score for each item

n : sum of validator/user

The scores obtained are then compared with the following validity and feasibility criteria:

Table 1. Criteria for Validatity and Feasibility (Febriana, 2014)

Score	Category	Validity and feasibility criteria
3,26 - 4,00	high	Valid/feasible
2,51 -3,25	middle	
1,76 - 2,50	low	Not valid/not feasible
1,00 - 1,75	very low	

Results and Discussion

Based on the results of user needs analysis, biodiversity learning device containing local and bioeconomic potential has been developed which has been validated by curriculum experts, content experts and media experts.

1. Curriculum expert validation results

Curriculum validation refers to the conformity of the developed curriculum document with the reference curriculum document, namely Phase E Learning Achievements (CP), completeness of the content/components in the curriculum document, systematic presentation of the document content, and the logicality of the document content for implementation in learning activities. Analysis of the validation score calculations provided by curriculum expert validators obtained an average score of 3.85 with the criteria "valid to use".

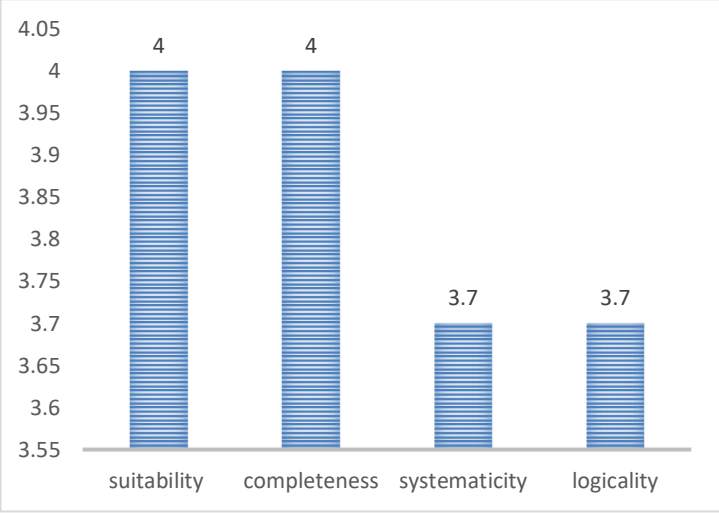
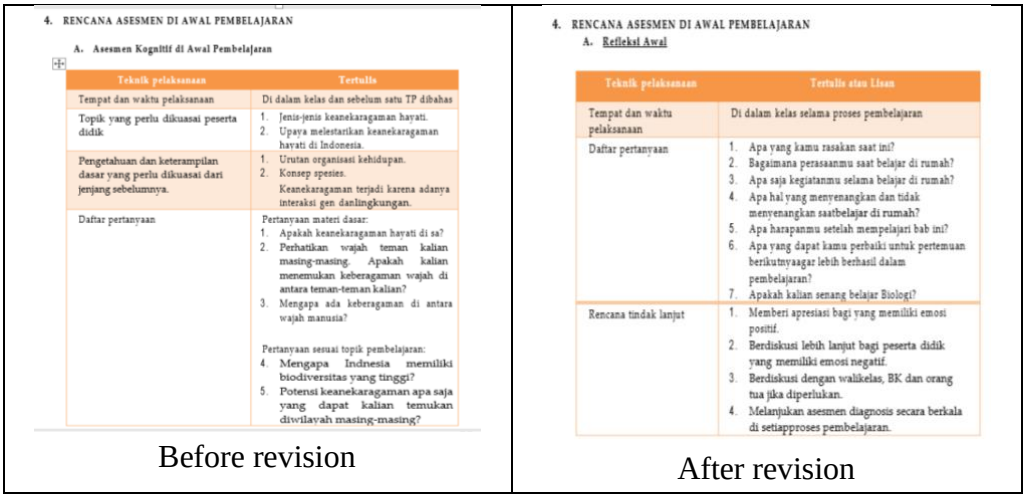


Figure 2. Curriculum Expert Validation Result

The results of the revision of the learning device according to input from the validator can be seen in **Figure 3**:



4. RENCANA ASESMEN DI AWAL PEMBELAJARAN

A. Asesmen Kognitif di Awal Pembelajaran

Teknik pelaksanaan	Tertulis
Tempat dan waktu pelaksanaan	Di dalam kelas dan sebelum satu TP dibahas
Topik yang perlu dikuasai peserta didik	1. Jenis-jenis keanekaragaman hayati. 2. Upaya melestarikan keanekaragaman hayati di Indonesia.
Pengetahuan dan keterampilan dasar yang perlu dikuasai dari jenjang sebelumnya.	1. Urutan organisasi kehidupan. 2. Konsep spesies. Keanekaragaman terjadi karena adanya interaksi gen danlingkungan.
Daftar pertanyaan	Pertanyaan materi dasar: 1. Apakah keanekaragaman hayati di sa? 2. Perhatikan wajah teman kalian masing-masing. Apakah kalian menemukan keberagaman wajah di antara teman-teman kalian? 3. Mengapa ada keberagaman di antara wajah manusia? Pertanyaan sesuai topik pembelajaran: 4. Mengapa Indnesia memiliki biodiversitas yang tinggi? 5. Potensi keanekaragaman apa saja yang dapat kalian temukan diwilayah masing-masing?

Before revision

4. RENCANA ASESMEN DI AWAL PEMBELAJARAN

A. Refleksi Awal

Teknik pelaksanaan	Tertulis atau Lisan
Tempat dan waktu pelaksanaan	Di dalam kelas selama proses pembelajaran
Daftar pertanyaan	1. Apa yang kamu rasakan saat ini? 2. Bagaimana perasaanmu saat belajar di rumah? 3. Apa saja kegiatanmu selama belajar di rumah? 4. Apa hal yang menyenangkan dan tidak menyenangkan saatbelajar di rumah? 5. Apa harapanmu setelah mempelajari bab ini? 6. Apa yang dapat kamu perbaiki untuk pertemuan berikutnyaagar lebih berhasil dalam pembelajaran? 7. Apakah kalian senang belajar Biologi?
Rencana tindak lanjut	1. Memberi apresiasi bagi yang memiliki emosi positif. 2. Berdiskusi lebih lanjut bagi peserta didik yang memiliki emosi negatif. 3. Berdiskusi dengan walikelas, BK dan orang tua jika diperlukan. 4. Melanjukan asesmen diagnosis secara berkala di setiapproses pembelajaran.

After revision

Figure 3. Revision of Asesmen Diagnostic

Figure 3. shows improvements in terms of diagnostic assessments contained in the biodiversity teaching module. Before being validated in the designed curriculum document, there was only a diagnostic assessment in the form of a cognitive assessment, and after validation, the researcher added a non-cognitive diagnostic assessment to be used as an instrument for student reflection at the beginning of learning.

2. Content expert validation result

Material validation refers to the conformity of the material with the curriculum, the quality of the material content, presentation, language, local potential content, bioeconomics and strengthening Pancasila Students Profiles in biodiversity learning device. Analysis of the validation score calculations given by two content expert validators obtained the average score for all aspects is 3.61 with the criteria "valid to use". The validation results by each validator can be seen in **Figure 4**:

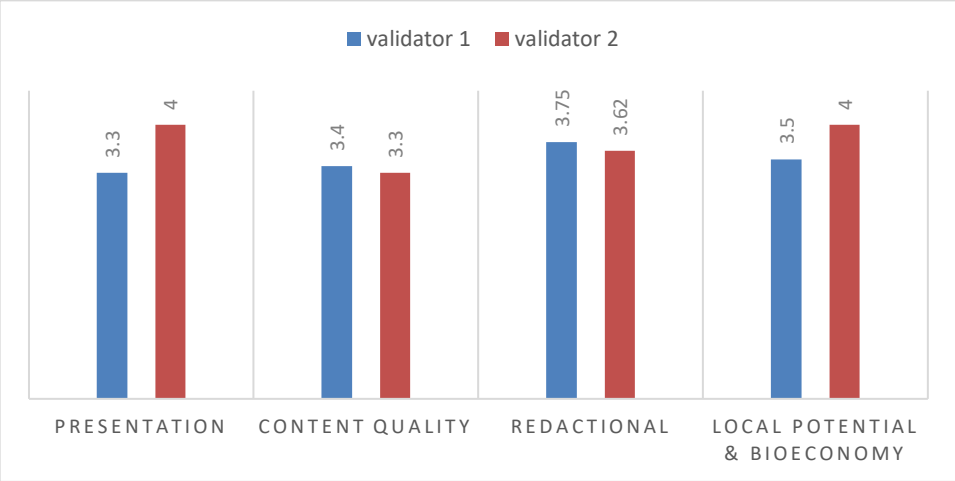
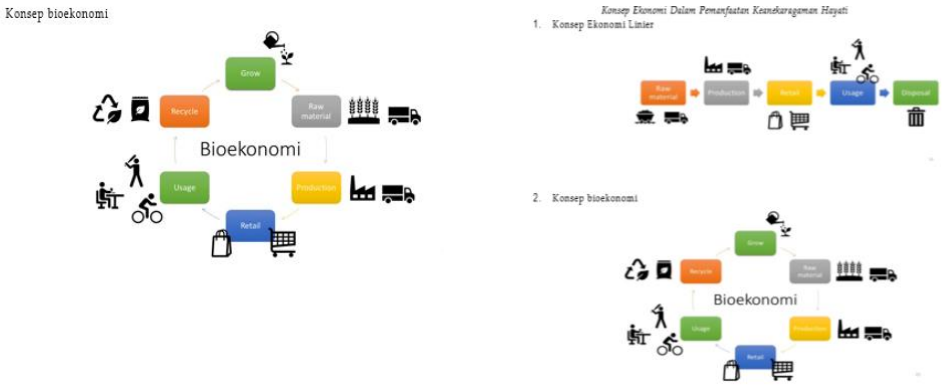


Figure 4. Content Expert Validation Result

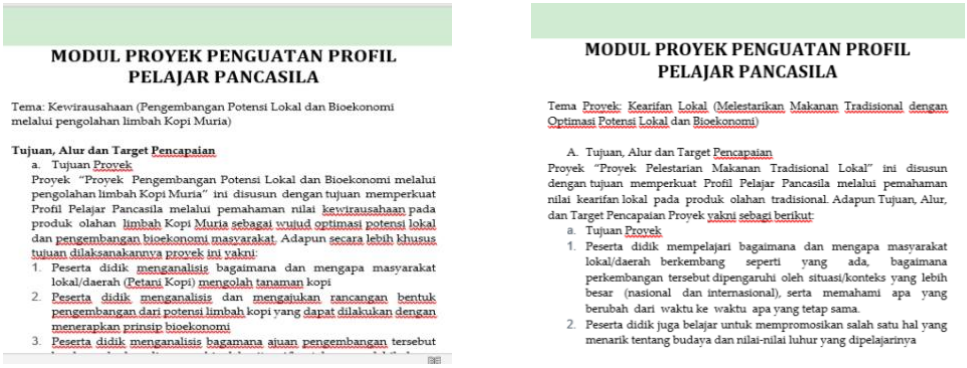
The results of the revision of learning device based on suggestions from content expert validators can be seen in **Figure 5**:



Before revision After revision

Figure 5. Revision of Bio-economy Concept

Improvements to the bioeconomic concept image before and after revision show changes in terms of image comparison. Before the validation was carried out, the researchers only included one image related to the bioeconomic concept, whereas after receiving input from experts, the researchers compared the bioeconomic concept image with the linear economic concept as a comparison, so that students could analyze the differences between the two images. The next suggestion from the content expert validator was to add local potential content related to traditional food in the project module



MODUL PROYEK PENGUATAN PROFIL PELAJAR PANCASILA

Tema: Kewirausahaan (Pengembangan Potensi Lokal dan Bioekonomi melalui pengolahan limbah Kopi Muria)

Tujuan, Alur dan Target Pencapaian

a. Tujuan Proyek

Proyek "Proyek Pengembangan Potensi Lokal dan Bioekonomi melalui pengolahan limbah Kopi Muria" ini disusun dengan tujuan memperkuat Profil Pelajar Pancasila melalui pemahaman nilai kewirausahaan pada produk olahan limbah Kopi Muria sebagai wujud optimasi potensi lokal dan pengembangan bioekonomi masyarakat. Adapun secara lebih khusus tujuan dilaksanakannya proyek ini yakni:

1. Peserta didik menganalisis bagaimana dan mengapa masyarakat lokal/daerah (Petarú Kopi) mengolah tanaman kopi
2. Peserta didik menganalisis dan mengajukan rancangan bentuk pengembangan dari potensi limbah kopi yang dapat dilakukan dengan menerapkan prinsip bioekonomi
3. Peserta didik menganalisis bagamana ajuan pengembangan tersebut

MODUL PROYEK PENGUATAN PROFIL PELAJAR PANCASILA

Tema Proyek: Kearifan Lokal (Melestarikan Makanan Tradisional dengan Optimasi Potensi Lokal dan Bioekonomi)

A. Tujuan, Alur dan Target Pencapaian

Proyek "Proyek Pelestarian Makanan Tradisional Lokal" ini disusun dengan tujuan memperkuat Profil Pelajar Pancasila melalui pemahaman nilai kearifan lokal pada produk olahan tradisional. Adapun Tujuan, Alur, dan Target Pencapaian Proyek yakni sebagi berikut:

a. Tujuan Proyek

1. Peserta didik mempelajari bagaimana dan mengapa masyarakat lokal/daerah berkembang seperti yang ada, bagaimana perkembangan tersebut dipengaruhi oleh situasi/konteks yang lebih besar (nasional dan internasional), serta memahami apa yang berubah dari waktu ke waktu apa yang tetap sama.
2. Peserta didik juga belajar untuk mempromosikan salah satu hal yang menarik tentang budaya dan nilai-nilai luhur yang dipelajarinya

Before revision After revision

Figure 6. Revision for Local Potential Contain

The addition of local potential content in the project module before and after the revision shows a change in terms of adding one theme to the designed project module, namely the theme of local wisdom which is linked to the diversity of traditional foods prepared from the potential of local natural ingredients in the respective archipelago. Before validation, researchers only included one project theme, namely entrepreneurship, with the Muria coffee husk waste processing project as a form of bioeconomic optimization for local communities.

3. Media Expert Validation Result

Media validation is used to determine the suitability of learning devices in terms of device appearance and ease of use. Analysis of the score calculation results from the three

validators obtained an average value of 3.7 with the criteria "valid to use". The validation results by the validator can be seen in the following graph:

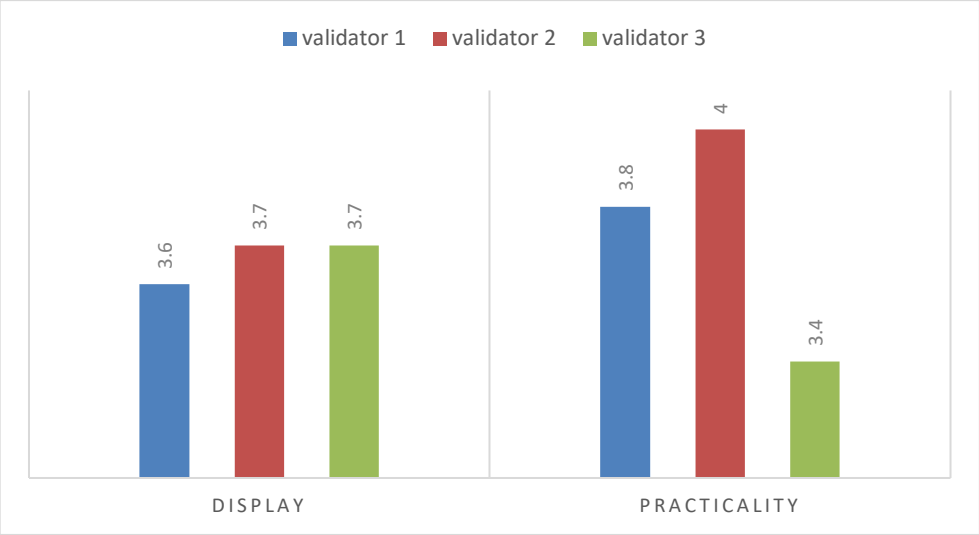


Figure 7 Media Expert Validation Result

The results of the revision of the learning device can be seen in the **Figure 8**:

Before revision After revision

Figure 8 Revision for Biodiversity Learnig Device Cover

Figure 8 displays improvements to the learning device cover before and after revision. The researcher responded to the validator's criticism and suggestions, namely removing the book title on the back cover and adding a quote from the meaning of the Koran verse relating to biodiversity, namely Surah Ar-Rahman verses 10-13. Suggestions for further improvements relating to the layout of information regarding biodiversity in Kudus can be seen in **Figure 9.**

Before revision After revision

Figure 9 Rearrangement of material information

Figure 9 displays the addition of a QR code and rearrangement (layout) of material/information about Muria coffee. Before validation, the researcher had not added a QR code for further information regarding the explanation of the material. The arrangement and addition of this QR code is intended to make it easier for users to access and use the teaching tools being developed.

After validation was carried out with curriculum experts, content experts and media experts, a trial assessment of Biology Teachers and Pre-service Biology Teachers who had implemented PPL in class.

a. Teacher Assessment Trials

The assessment from two biology teachers obtained an average score of 3.73 with the criteria "feasible to use". The teacher assessment results are presented in the **Figure 10**:

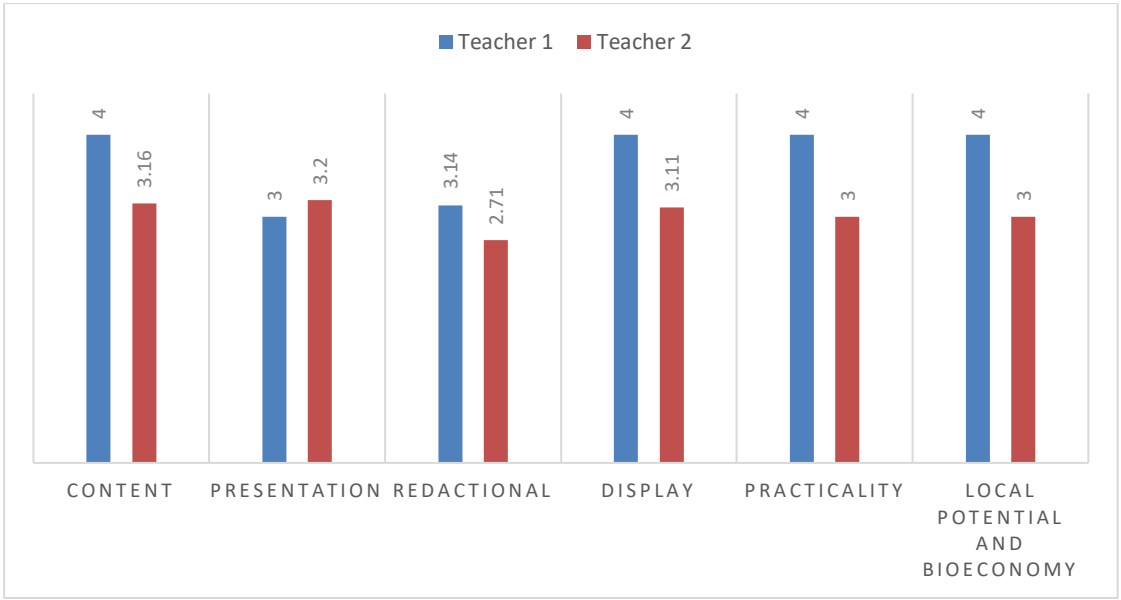


Figure 10. Biology Teacher Assessment

b. Pre-Service Teacher assessment trials

The product was tested on 20 pre-service biology teachers who had implemented Field Professional Program in senior high school and the average score of 3.77 was obtained with the criteria "feasible to use". The results are presented in **Figure 11.**

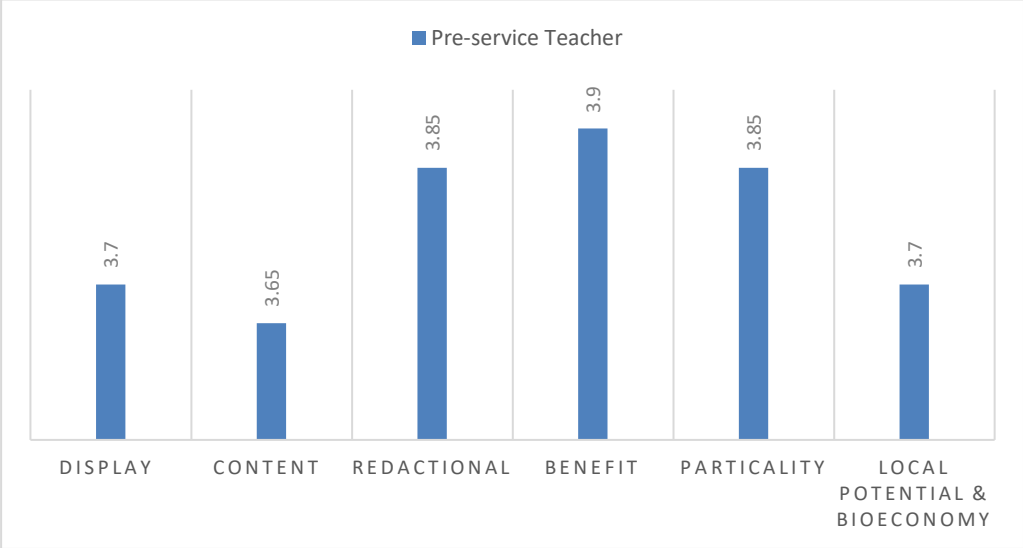


Figure 11. Pre-service biology Teachers Assessment Trials

Based on the results of research conducted, it is known that the biodiversity learning device as Single-Subject Pedagogy are valid and suitable for use in biodiversity learning in Phase E. The learning process carried out by a teacher ideally refers to learning device prepared and developed by the teacher that have been declared valid and suitable for used (Sriyati et al., 2021). There is biodiversity learning device developed more specifically to support co-curricular activities carried out to strengthen Pancasila Student Profiles, namely the project module. Pancasila Student Profile include: (1) faith and devotion and noble character, (2) global diversity, (3) mutual cooperation, (4) independence, (5) critical reasoning and (6) creativity. The projects carried out can raise themes that are in line with the references in freedom curriculum, namely: sustainable lifestyle, local wisdom, diversity, building mental and spirit, engineering and technology, and entrepreneurship. The themes in project modules developed in this learning devicel are local wisdom with a focus on projects to preserve traditional food and an entrepreneurship theme which focuses on the project of processing Muria coffee skin waste into products that are more efficient and marketable value. This is suitable with the research results that there is a lot of local potential available in various regions that can be used as a learning medium or integrated into learning resources (Kamila et al., 2024).

Beside that the integration of local potential and bioeconomic content in the development of this learning device also supports developing the character of students based on the achievement of various competencies as characterized in the Pancasila Student Profiles. This is match with research finding that learning based on local potential is effective in improving students' living values, such as responsibility and honesty (Sarah, 2014), which is closely related to noble morals as a part of Pancasila Students Profile.

Biodiversity learning device that has been developed containing local and bioeconomic potential is designed using the Canva application and also Microsoft Word. The form of developing this product consists of (1) opening section includes: front cover, foreword, table of

contents, (2) content section includes: Learning Objectives flow, teaching module, student worksheet, project module, biodiversity teaching materials, (3) closing section includes: reflection, summary, evaluation, reflection on answers, bibliography, and back cover.

This research not only producesthe products, but also obtains the validity and feasibility of biodiversity learning device so that they are suitable for use as examples of learning device that can be used by teachers to achieve Learning Outcomes (CP) in phase E. Based on the results, it can be seen that the validation results of these aspects are assessed by validators, curriculum experts, content experts, media experts, as well as biology teachers and pre-service biology teachers as product users, received an average score, all of which were in the valid and feasible for use. This is possible because in developing all learning device, researchers have designed an outline of the development plan by referring to clear indicators, as well as developing concepts carefully. This is accordance with the finding research that he most important phase in the design and development activities of a product, namely the concept development phase which must be made carefully and measurably (Irfan & Anzora, 2017). Researchers also carry out an evaluation stage to find out errors and justifications at each stage. This stage to to ensure that the product is developed feasible ang fit for use in the learning process. This is accordance with research finding that evaluation is very necessary in assessing learning programs or products that are developed comprehensively in educational institutions (Khairiah, Hasanah & Pertiwi, 2022).

Learning device that are developed by teachers themselves and whose suitability is known can support the achievement of learning objectives that suitable with students' needs, the learning process can be effective with supported by learning device, making it easier for students to understand the material. This is accordance with the findings (Laelasari, 2021; Nugraha & Widiyaningrum, 2015) that the suitability of a learning device product contributes to the success of the learning process. In line with the finding research (Ayu, 2021; Dina, 2023) that learning device that are declared valid, practical and effective have the potential to build, trigger and strengthen students' interest in learning independently and the learning process is more effective and efficient so that there is an increase in the quality of learning.

The effectiveness and quality of learning can also be related to the content of local potential in the biodiversity learning device that have been developed, especially in relation to the formation of student character which is closely related to the Pancasila Student Profile. This is fit the finding research that learning based on local potential is effective in improving students' living values, such as responsibility and honesty (Sarah, 2014). Regarding the effect of implementing local potential-based biology learning device on students' cognitive abilities, found that the biology learning device that have been developed are valid and suitable for implementation and have a significant influence on students' cognitive abilities (Hadiprayitno, 2019).

Conclusion

Biodiversity learning device as Subject-Specific Pedagogy containing local and bioeconomic potential that have been developed are valid and feasible for use in Phase E of freedom curriculum. Learning device have an average validity for curriculum relevance aspect of 3.85, content aspect validity of 3.61, and media aspect validity of 3.70. As for feasibility, based on the results of trials assessing biology teachers and pre-service biology teachers, the

criteria are feasible for use with average scores of 3.73 and 3.77. The development of Pancasila Student Profiles can specifically be found in the project module which has been developed with a local wisdom theme which focuses on projects to preserve traditional food and an entrepreneurship theme which focuses on the project of processing muria coffee skin waste into products that are more efficient and marketable value, as a form of optimization local potential and community bioeconomic development. Researchers recommend further research to apply this learning device developed on subjects or expanded trial samples, especially direct implementation to students in learning process.

Credit Authorship Contribution Statement

Iseu Laelasari: Coordinator Conceptualization, Methodology, Software, Visualization, Formal analysis, Writing – original draft, Writing – review & editing. **Muzayyidatul Habibah** Director Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review, project administration & editing.

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