Jurnal Kependidikan:
Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran
https://e-journal.undikma.ac.id/index.php/jurnalkependidikan/index

Vol. 9, No. 1 : March 2023
E-ISSN: 2442-7667
pp. 132-139
Email: jklppm@undikma.ac.id

Developing STEAM-based Students' Worksheet with the Ecoprint Technique in Biology Subject

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Abstract: This research aimed at developing a STEAM-based students' worksheet with the Ecoprint technique and analysing the developed product's validity, feasibility and practicality. This research used the 4D development method (Define, Design, Develop, and Disseminate). The research subjects were 102 students of the tenth-grade science class in Senior High School. The instruments employed expert validation tests and questionnaires. The data were analysed by processing validator response data with a Likert scale converted into qualitative data. The results showed that the STEAM-based students' worksheet with the Ecoprint technique obtained a moderate level for its validity, while the feasibility aspects were 90% based on the students' views and 91% from the teachers. The results of the practicality test were 87% from the teachers and 92% by students, respectively. It can be concluded that the STEAM-based students' worksheets with the Ecoprint technique are valid, feasible and practical to use as a supporting learning media of Biology. Steam-based students' worksheet with the Ecoprint technique is very suitable to be applied as an innovative learning media which is relevant to 21st century demands by emphasising 4C skills.

Article History
Received: 21-12-2022
Revised: 28-01-2023
Accepted: 10-02-2023
Published: 16-03-2023

Key Words:
STEAM; Students' Worksheet; Ecoprint.

How to Cite: Irdalisa, I., Amirullah, G., Hanum, E., Elvianasti, M., & Maesaroh, M. (2023). Developing STEAM-based Students' Worksheet with the Ecoprint Technique in Biology Subject. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, *9*(1), 132-139. doi:https://doi.org/10.33394/jk.v9i1.6775

https://doi.org/10.33394/jk.v9i1.6775

Introduction

The current curriculum has been revised to align with the demands of the 21st century. It does not only pay attention to core subjects but also emphasises life skills, learning & thinking skills, and literacy in information and communication technology (Widhy, 2013). The learning is oriented toward achieving the need for 4C skills, i.e., critical thinking, communication, collaboration, and creativity (Haifaturrahmah et al., 2020). Teaching and learning activities as a process refer to a system that cannot be separated from components interacting with one another (Melindawati, 2021). The design of learning activities by the teacher must be distinct from the use of learning media. The success of the learning process is inseparable from the teacher's ability to choose or develop proper learning models, methods and media (Nugraha et al., 2017). The use of learning media in class is so crucial that it cannot be ignored because it can realise practical benefits, such as clarifying messages and improving learning processes and outcomes (Muazizah et al., 2016). Using instructional media can enhance students' learning motivation and material understanding (Irdalisa et al., 2022).

But in reality, classroom learning mostly fails to present a meaningful learning process and the students find it difficult to understand the material. It urges teachers to develop interesting learning models and media to explore the surrounding environment as a learning resource (Nurrita, 2018), such as student students' worksheets (LKPD). It is a means

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to assist and facilitate teaching and learning activities to realise effective interactions between students and educators (Abdurrahman et al., 2019). Previous studies have found that LKPD as a learning medium can help students to have meaningful and effective learning (Melindawati, 2021).

A proper students worksheet determines students' interest in reading and writing. It can also give them meaningful feedback and flexible learning activities for student development (Patresia et al., 2020). It means that students' worksheets can improve motivation and foster students' curiosity about the material being studied by using appropriate models within the learning environment and student-oriented activities, such as the activities containing problems in students' real environment. By doing so, students can be trained to solve issues and develop their thinking skills (Utama et al., 2019). Therefore, a suitable students worksheet must be based on students' needs, characteristics, and current developments.

According to the demands and the challenges of the 21st century, it is necessary to redesign the students' students' worksheets, one of which is by integrating Science, Technology, Engineering, Art and Mathematics (STEAM). The STEAM approach allows students to develop scientific literacy (Adriyawati et al., 2020), which trains them to apply their knowledge to solve surrounding problems by utilising technology (Permanasari, 2016). It includes an innovative learning approach that facilitates students to gain meaningful learning experiences and trains them to think critically and creatively (Estriyanto, 2020). The students' worksheet is designed systematically based on the STEAM integration, which begins with concepts related to the surrounding environment and current developments, i.e., the 4C skills. The STEAM-based learning approach integrates several disciplines to train students' competence in critical and creative thinking for problem-solving (Nurhikmayati, 2019).

Material selection is a vital aspect of the learning process (Farichah et al., 2016), especially in Spermatophyta material that is classified as complicated material of biology subject for students because it discusses classification (taxonomy) and scientific nomenclature (Binomial Nomenclature) in Kingdom Plantae (Plants) or classification tables and scientific terminology. STEAM integration will provide opportunities for students to understand concepts more deeply through discussion activities and project creation. The implementation of STEAM has a positive impact because it can enhance students' creativity and help them to understand concepts (Amiruddin Mohd Zaini; Magfiroh Dhela Rochmatul; Savitri Irma; Rahman Sitti Maizatul, 2022). STEAM learning positively affected the students' conceptual understanding and lowered misconceptions (Ozkan & Topsakal, 2021). The learning process focuses on discovering ideas by linking various applications of technology related to the material with suitable techniques, so students can be taught to make simple tools related to the material. Art is associated with students' creativity and innovation in designing the products they make, while mathematics is related to calculations and equations based on the concept of matter. An innovative STEAM-based students' worksheet in learning is rarely combined with Ecoprint as a technique for cloth decoration by utilising the extract of natural colours from plants to form motifs or patterns (Fatmala & Hartati, 2020). This technique can produce beautiful pieces of work in fabrics.

Based on the observation results in Senior High School AL Azhar 19 Jakarta, it is found that teachers still use the students' worksheet which generally contains short material and exercises. Although it can support students learning process, those common students' worksheets are considered less effective. It can be seen from the low level of student activities, that it is failed to facilitate creative thinking. Moreover, the students' worksheet

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needs to be provided with learning activities that can assist students in discovering the learning concepts. Teachers are expected to be able to make their own students' worksheet that can be matched with students' characteristics and demands, but, in fact, it rarely happens (Haifaturrahmah et al., 2020). Similarly, the current students worksheet cannot facilitate students' scientific activities (Hairida & Setyaningrum, 2020). The use of students' worksheets as supporting media should optimise the learning process and encourage students to find out information related to the material being taught (Sa'adah, Ullyatus., 2022). Therefore, the efforts to overcome the above problems require the development of STEAM-based students' worksheets with the Ecoprint technique on Spermatophyta material. The purpose of this research is to develop STEAM-based students' worksheets using the the Ecoprint process and to analyse the validity, feasibility and practicality of the developed product. The indicators to measure the validity of the students worksheet consist of the qualified material, language and presentation support. Meanwhile, the feasibility aspects are based on several aspects, namely self-instructional, self-contained, adaptive, self-friendly aspects, and proper written language. For the practicality assessment, the indicators cover the easiness and presentation of the worksheet.

Research Method

The research employed Research and Development (R&D) design with a 4D development model, including define, design, develop, and disseminate stage (Choirudin et al., 2020). The research subjects were 102 students from the tenth-grade science class in State Senior High School AL Azhar 19 Jakarta. The sampling technique used simple random sampling. Instruments for data collection used expert validation to assess the validity of the developed students worksheet and questionnaires to measure their feasibility and practicality aspects. Expert validators consisted of material experts, language experts and media experts.

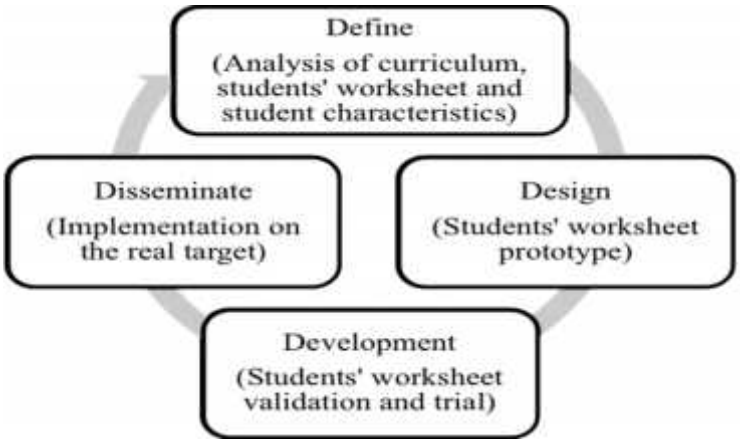

Figure 1. Students' Worksheet Research and Development Stages

Data analysis was carried out by processing validator response data with a Likert scale to convert it into qualitative data. The Likert scale involved four alternative answer choices, namely strongly agree (SA) with a score of 4, agree (A) – 3, disagree (D) – 2 and strongly disagree (SD) – 1, respectively. Other responses of the Likert scale for the feasibility aspects contained very good with a score of 4, good – 3, moderate – 2, and poor – 1, respectively. The criteria for the validity of the worksheet based on the Aiken index (V) can be seen in Table 1.

Table 1. Criteria for Validity of Students' Worksheet Using the Aiken Index

Index Validity (V)	Category
V > 0.8	Very valid

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$0.4 < V \leq 0.8$	Moderate
$V \leq 0.4$	Invalid

(Sabaruddin et al., 2022)

The criteria for interpreting the feasibility of the developed worksheet with the Likert scale is presented in Table 2.

Table 2. Worksheet Feasibility Criteria

Interval	Categories
81 - 100	Very Feasible
61 - 80	Feasible
41 - 60	Moderate
21 - 40	Quite Infeasible
0 - 20	Infeasible

Riduwan (2009)

Criteria for a practical interpretation of the developed worksheet based on the Likert scale can be seen in Table 3.

Table 3. Worksheet Practical Criteria

Interval	Categories
81 - 100	Very Practical
61 - 80	Practical
41 - 60	Quite Practical
21 - 40	Quite Impractical
0 - 20	Impractical

Riduwan (2009)

Results and Discussion

The development of STEAM-based students' worksheets with the Ecoprint technique uses a 4D development model consisting of the define, design, development and disseminate stages. At the define stage, an analysis of the curriculum, students' worksheets and characteristics was done. Curriculum analysis was carried out to identify suitable material for STEAM learning. The current students' worksheet is not relevant to the student's learning style. Developing students' worksheets that can encourage students' curiosity to enhance their learning motivation is necessary. The results of the define stage were used as a basis for designing the product. At the development stage, the researcher compiled STEAM-based students' worksheets using the ecoprint technique and the developed products were presented to experts for validation assessment. The developed product of the students' worksheet was measured for its validity with the expert agreement index based on the Aiken index (V). The results are presented in Table 4.

Table 4. Results of the Aiken Index

Statement items	V	Category
Material quality	0.59	Moderate
Language aspect	0.73	Moderate
Presentation	0.66	Moderate
Mean	0.66	Moderate

Based on Table 4, it can be seen that the STEAM-based students' worksheet obtained a moderate level of validity with the Aiken index value is > 0.4. The Cronbach's alpha coefficient results obtained a reliability of 0.907> 0.60. This shows that the reliability score is in the high category. The developed product is considered valid and reliable as learning media, so it was followed with the operational field tests among 102 students to ensure it is fit

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for use. The developed students' worksheet's feasibility assessment consists of several aspects that can be seen in Table 5.

Table 5. Results of Feasibility Tests by Students

Assessment aspects	Total	Percentage
Self Instructional	1541	94.42%
Self-Contained	1165	95.18%
Adaptive	1163	71.26%
User Friendly	757	92.77%
Written language	1152	94.12%
Mean		90%
Conclusion		Very Feasible

The feasibility assessment of the developed students' worksheet consists of several aspects, i.e., self-instructional, self-contained, adaptive, user friendly and written language. Table 5 shows the results of the feasibility test by students (90%) that can be categorised as very feasible.

Table 6. Feasibility Test Results of the Developed Students' Worksheet by Teachers

Assessment aspects	Total	Percentage
Self Instructional	86	89.58%
Self-Contained	68	94.44%
Adaptive	85	88.54%
User Friendly	69	95.83%
Written language	63	87.50%
Mean		91%
Conclusion		Very Feasible

Table 6 shows the results of the feasibility test by the teacher (91%) that can be categorized as very feasible. The results of the validity and feasibility tests show that the developed STEAM-based students' worksheet is feasible as a learning medium. The students' worksheet is considered good or valid if it meets the didactics, constructive and technical requirements (Agustina et al., 2021). The didactics requirements relate to effective learning using the students' worksheet, while construction covers language aspects. The technical specifications focus on the writing rules (Simanjuntak et al., 2021).

After the developed students' worksheet was declared valid, a practicality test was performed. The practicality test was done to test the learning tools among teachers and students in the learning process after the revision stages based on validator assessments (Rahayu et al., 2019). The practicality criterion refers to the assessment aspect, which consists of ease, usability and presentation. Overall, the results of the practicality test of the developed students' worksheet based on students' view can be seen in Table 7.

Table 7. Results of Usability Test among Students

Assessment aspects	Total	Percentage
The ease	2532	88.66%
Usability	2623	91.84%
Presentation	1163	95.02%
Mean		92%
Conclusion		Very Practical

Table 7 shows that the developed STEAM-based students' worksheet is declared very practical with a percentage of 92%. The results of the practicality test among the teacher obtained a rate of 87% which can be seen in Table 8.

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Table 8. Results of Practicability Test by Teachers

Assessment aspects	Total	Percentage
The ease	152	90.48%
Usability	144	85.71%
Presentation	62	86.11%
Mean		87%
Conclusion		Very Practical

It shows that the developed STEAM-based students' worksheet with the ecoprint technique is very practical according to teachers and students as users. The developed product contains a series of activities to re-discover lesson principles and procedures and can be used by students in groups and individually (Revita, 2019). Teachers can use the developed students' worksheet to support the learning process in building effective interaction between teachers and students (Tukan, et al, 2020). The students' worksheet trains students' independence in learning and is designed based on the learning competencies (Sari et al., 2019).

The developed students' worksheet is helpful for training students' independence, creativity, literacy and content understanding. The implementation of STEAM has a positive impact because it can enhance students' creativity and help students to understand concepts (Amiruddin Mohd Zaini; Magfiroh Dhela Rochmatul; Savitri Irma; Rahman Sitti Maizatul, 2022). Implementation of STEAM-based learning improves students' concept mastery and significantly impacts their creativity (Wandari et al., 2018). The STEAM-based students' worksheets with the ecoprint technique involve thinking processes, and work procedures and support students' autonomy in discovering concepts. Integrating STEAM into the learning process will help students collect, analyse and solve problems so that the developed students' worksheets can become beneficial support for students in developing 4C. Through STEAM integration, students collaborate to solve real-world problems and share their findings with others (Agustina et al., 2021).

Conclusion

The results of this study conclude that the developed STEAM-based students' worksheet with the ecoprint technique is declared valid based on the results of expert validation. Based on the feasibility test results, the developed STEAM-based is suitable for use as a learning medium. The developed STEAM-based students' worksheet with the ecoprint technique is considered practical based on the assessment from the respondents involving teachers and students.

Recommendation

STEAM-based worksheet with the ecoprint technique is very suitable to be applied as an innovative learning media aligning with the demands of the 21st century. Teachers who are intended to develop students' worksheets should refer to the students' needs analysis. The learning process should also be adjusted to the applied steps of the learning model to make them more enthusiastic and actively involve during the learning process. The developed worksheet must also be designed in creative ways so that students are interested and can provide meaningful learning for them. It will be beneficial for further research to focus on meaningful research based on the independent learning curriculum targets.

Acknowledgement

We would like to thank the Board of Diktilitbang PP Muhammadiyah and Research Institute Universitas Muhammadiyah Prof. Dr. Hamka for funding this research. Our gratitude also goes to State Senior High School AL Azhar 19 Jakarta for supporting the implementation of this study.

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