BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 12 No. 2 Tahun 2023 Hal: 388-402
https://ejournal.unesa.ac.id/index.php/bioedu

# THE DEVELOPMENT OF ELECTRONIC STUDENT WORKSHEET BASED ON MULTIPLE INTELLIGENCES ON HUMAN HEREDITY MATERIALS TO INCREASE LEARNING OUTCOMES FOR 12TH GRADE STUDENTS

## *Pengembangan E-LKPD Berbasis Multiple Intelligences pada Materi Hereditas Manusia untuk Meningkatkan Hasil Belajar Siswa Kelas XII*

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## Abstract

Human heredity material is difficult for some students because it is invisible and complex. Understanding difficulties can make students' experience in learning outcomes decreased. Therefore, learning media needed to increase motivation and adaptable to students' learning styles, such as the electronic student worksheet (*Lembar Kerja Peserta Didik Elektronik*/ e-LKPD) based on Multiple Intelligences. This study aimed to produce Multiple Intelligences e-LKPD on human heredity material, which is feasible in validity, practicality, and effectiveness to improve student learning outcomes. This study used 4D methods and tested on 20 students of 12th of SMAN 8 Surabaya students. The data was analyzed through the quantitative-descriptive technique. The research results got a very valid category with a 3.86 score for product validation and a 100% very valid category for the suitability of the material with the selected type of intelligence. Thepractical aspect got a very practical category with a 97.3% score. On the aspect of effectiveness, it is reviewed from four things, namely the N-gain test, the sensitivity of items, the completeness of multiple intelligences, and the students' response, with a score of 0.92, 0.66, 91.25%, and 99%, each categorized as high, sensitive, very high, and very effective category respectively. Thus, this e-LKPD can be used in the current learning process based on the students' specific multiple intelligence abilities and as an additional reference for teachers to teach human heredity material.

**Keywords:** E-LKPD, multiple intelligences, human heredity, learning outcomes.

### *Abstrak*

*Materi hereditas manusia dianggap sulit bagi sebagian peserta didik karena bersifat tidak dapat diindera dan kompleks. Kesulitan dalam memahami suatu materi dapat membuat peserta didik mengalami penurunan hasil belajar. Oleh karena itu dibutuhkan media belajar yang dapat meningkatkan motivasi dandisesuaikan dengan gaya belajar yang peserta didik miliki, contohnya Lembar Kerja Peserta Didik elektronik (e-LKPD) berbasis Multiple Intelligences. Penelitian ini bertujan untuk menghasilkan e-LKPD berbasis Multiple Intelligences pada materi hereditas manusia yang layak dalam aspek validitas, kepraktisan, dan keefektifan untuk meningkatkan hasil belajar peserta didik. Penelitian ini menggunakan metode 4D (Define, Design, Develop, dan Dissaminate) yang telah dilakukan uji coba pada 20 peserta didik kelas XII SMA Negeri 8 Surabaya. Data yang diperoleh dianalisis secara deskriptif kuantitatif. Hasilpenelitian pada aspek validasi memperoleh skor rata-rata 3.86 yang termasuk kategori sangat valid untuk validasi produk dan 100% dengan kategori sangat valid untuk validasi kesesuaian materi dengan jenis kecerdasan yang dipilih. Pada aspek kepraktiksan memperoleh skor 97,3% yang mana termasuk kategori sangat praktis. Pada aspek keefektifan ditinjau dari empat hal, diantaranya N-gain tes, sensitivitas butir soal, ketuntasan multiple intelligences, dan angket respon peserta didik yang mana mendapatkan perolehan skor 0.92. 0.66, 91.25%, dan 99% masin-masing termasuk kedalam kategori tinggi, sensitiv, tuntas, dan efektif. Dengan demikian, e-LKPD yang dikembangkan dapat digunakan dalam proses pembelajaran saat ini berdasarkan kemampuan jenis kecerdasan majemuk siswa yang spesifik dan dapat menjadi tambahan referensi bagi guru untuk mengajarkan materi keturunan manusia.*

***Kata kunci:*** *E-LKPD, multiple intelligences, hereditas manusia, hasil belajar.*

## INTRODUCTIONS

Education is one of the indicators that determine the quality of human resources in a country and is the spearhead of realizing the ideals of the nation through learning activities. Based on the Constitution of Education and Culture Ministry number 20 of 2003 concerning the national education system, learning activities have several aspects including active student participation, good interaction between teachers and students, and appropriate learning methods and media. The continuity of learning activities is guided by the applicable curriculum, namely the revised 2013 curriculum. The curriculum has been adapted to the needs of the industrial revolution 4.0 era which is implemented in 21st-century learning activities by taking into account the education standards of the Indonesian Partnership for 21st Century Skill Standards (IP-21CSS) (Fernandes, 2019). It is intended that students have the skills as a provision to compete globally.

Technology collaboration in learning activities was indirectly implemented thoroughly during the COVID-19 pandemic at the beginning of 2020. The pandemic made many countries, including Indonesia, enforce the Large- Scale Social Restriction (*Pembatasan Sosial Berskala Besar*/ PSBB) policy to reduce the number of transmissions. Education and Culture Ministry based on Epistle number 4 of 2020 ordered that learning activities continued to run as well as on online format. Learning cantake place through digital platforms such as Google Classroom, Zoom, or Google Meet to facilitate the delivery of material. The habitual shift from direct learning activities to virtual learning and in a short time reaps many problems both experienced by teachers and students. These problems are not only physical such as network limitations, internet quotas, and devices but can also be psychological, such as boredom and stress (Basar, 2021). Study saturation results in the low concentration power of students in absorbing the material presented by the teacher so that it affects the results of achievement and students tend to be apathetic (Arirahmanto, 2018). This is in accordance with the results of interviews conducted by researchers with one of the biology teachers at SMAN 8 Surabaya that students' enthusiasm and student achievement are relatively low.

The low learning achievement results are a sign that students have difficulty understanding material concepts (Juhji, 2017). This learning difficulty is considered very crucial because it is not only influenced by external factors, namely environmental factors but also internal factors such as the level of intelligence, memory, and motivation of the students themselves (Rahmawati, 2017).Teachers who have a big role to play directly are required to be responsive in dealing with these situations by innovating in determining appropriate learning media and what teaching methods can increase student motivation in learning. One of the innovations that can be done by teachers is to apply the electronic student worksheet (e-LKPD) in learning activities. This is in accordance with the research of Muthoharoh et al. (2017), that the application of multimedia-based LKPD can increase students' motivation and learning outcomes. The difference between ordinary LKPD and e-LKPD is that e-LKPD is packaged in digital form and can be equipped with photo, video, and link features so that it is more efficient in termsof space and time because it can be accessed via a smartphone or Personal Computer (PC) (Suryaningsih andNurlita, 2021).

Biology is one of the subjects that learn about the surrounding life which is considered difficult by some people. In previous research, learning difficulties in biology were caused because it contained processes and foreign terms (Zaputri and Lufri, 2021). Based on data on the national exam scores of SMAN 8 Surabaya students in2019, one of the biological materials that has the second low percentage of completeness is human heredity with a value of 56%. In this material, there is a test indicator that has the lowest value with a score of 26%, which predicts the possibility of a child/ grandchildren getting traits from both parents based on the genealogical map on the marriage diagram (Puspendik, 2019). The test indicators show that the difficulties faced by students in human heredity are the complexity of the material and the need for higher-order thinking skills. This is as expressed by Inayah et al. (2020), that human heredity material is considered difficult for students because the material is abstract and complex and applies counting skills. Therefore, the learning media, especially the developed e-LKPD, must be communicative and adapted to the learning styles of students to make it easier for students to understand concepts (Budi et al., 2021).

Everyone has their own learning style according to the dominant intelligence they have (Papilaya and Huliselan, 2016). According to Gardner (1983) in Şener and Çokçalışkan (2018), humans have nine types of intelligence or known as the theory of Multiple Intelligences. Every human being has all these types of intelligence, it's just that the difference is the dominance of each intelligence. The potential of human intelligence can be increased by maximizing the ability of the senses it has (Rofiah, 2016). According to Safitri et al. (2013),

the application of the theory of multiple intelligences in learning can improve student learning achievement because its application includes various activities that have been adapted to the intelligence that students have so that they feel confident and increase enthusiasm for learning. The theory of multiple intelligences can be implemented in a learning media, such as electronic student worksheets (*Lembar Kerja Peserta Didik Elektronik*/ e-LKPD). In previous studies, LKPD based on Multiple Intelligences has proven to be effective in improving student learning outcomes and can even hone critical thinking skills, an example is the development of multiple intelligences-based worksheets on viral material conducted by Zuhriyah and Trimulyono (2019) that showsa significant changes in the form of increasing student understanding after learning to use the worksheets. The same thing happened in research by Purwanto et al. (2020), which shows that LKPD based on Multiple Intelligences on Fluid material greatly affects the increase in high-level thinking skills in students.

The e-LKPD material for human heredity developed in this study is based on multiple intelligences by focusing on only four types of intelligence, namely spatial intelligence, verbal-linguistic intelligence, logical- mathematical intelligence, and naturalist intelligence. The selection of intelligence was based on pre-research in the form of multiple intelligences test results conducted on 20 students. The activities in the e-LKPD are adjusted to field conditions, namely distance restrictions due to the pandemic. Through this e-LKPD, it is hoped that it can improve student learning outcomes when implementing online learning and motivate teachers to be able to collaborate on learning with technological sophistication and involve multiple intelligences in learning activities. The purpose of this research is to produce e-LKPD and describe it in terms of validity, effectiveness, and practicality.

## METHODS

This research is development research using 4D research design that consists of define, design, develop, and disseminate. The define stage includes curriculum analysis, material analysis, indicator analysis, and learning objectives preparation. At the design stage, the activities carried out are making e-LKPD designs. The next stage is the develop stage which is in the form of activities to develop a proper e-LKPD both in terms of validity, practicality, and effectiveness. The last one, the disseminate stage is the stage of distributing e-LKPD. However, in this research, the distribution was only carried out on a limited scale, namely a sample trial of 20 of 12$^{th}$ grade students of SMA Negeri 8 Surabaya in March 2022. The data obtained were analyzed descriptively and quantitatively. The feasibility of e-LKPD in terms of validity, practicality, and effectiveness. The instruments used in this study include the product validation sheet developed, the material conformity validation sheet with the selected Multiple Intelligences, pre-test and post-test questions, student activity implementation questionnaire, and student response questionnaire sheets.

Product validation and material suitability validation were carried out by education expert lecturers, material expert lecturers, and biology teachers. Product validation includes didactic aspects, content feasibility aspects, linguistic aspects, and presentation aspects, while material validation includes the suitability of each activity with the type of intelligence. The values of the three validators are averaged. Furthermore, the average score is interpreted in several criteria like which is in Table 1.

**Table 1.** Interpretation Criteria for Product ValidationScore

| Average Score | Criteria |
|---|---|
| $3.26 \leq x \leq 4.00$ | Very Valid |
| $2.51 \leq x \leq 3.25$ | Valid |
| $1.75 \leq x \leq 2.50$ | Less Valid |
| $1.00 \leq x \leq 1.75$ | Invalid |

(adapted from Ratumanan and Laurens, 2011) The product is declared eligible if it is at least included in the valid criteria with an average score of 2.51 - 4.00. The preparation of the Multiple Intelligences e-LKPDmust contain activities with different elements of intelligence in each question and must be in line with the type of intelligence in question (Armstrong, 2013), so it is necessary to validate the suitabilty of the mareial and the type of multiple intelligences. In the validation of the suitability of the material, the assessment uses a score of 1 for the "yes" answer and 0 for the "no" answer. Furthermore, the score of each validator is averaged and apercentage. Then, the percentage score is interpreted in several criteria as in Table 2.

**Table 2.** Criteria for Interpretation of Material Validation Scores

| Average Score (%) | Criteria |
|---|---|
| 81 – 100 | Very Valid |
| 61 – 80 | Valid |
| 41 – 60 | Enough |
| 21 – 40 | Less Valid |
| 0 – 20 | Invalid |

(adapted from Riduwan, 2012) The practicality of e-LKPD is seen from the results of observations of the

implementation of learning activities carried out by four observers. The implementation assessment uses a score of 1 for "yes" answers and 0 for "no" answers. Furthermore, the scores of each observer were averaged and a percentage was then interpreted in several criteria as shown in Table 3.

**Table 3.** Criteria for Interpretation of Practicality Scores

| Average Score (%) | Criteria |
|---|---|
| 81 – 100 | Very Practical |
| 61 – 80 | Practical |
| 41 – 60 | Enough |
| 21 – 40 | Less Practical |
| 0 – 20 | Not Practical |

(adapted from Riduwan, 2012) The effectiveness of e-LKPD is seen from the completeness of learning outcomes and the completeness of each multiple intelligences intelligence. The thoroughness of learning outcomes reviewed includes the sensitivity of each question indicator and analysis of the N-gain value. The sensitivity of the question indicators is assessed by the number of students who answer correctly on each question indicator. The question indicator is quite influential if it gets a score of 0.3 (Aiken, 1987). In the analysis of the N-gain value, it is reviewed based on the difference in the pre-test and post-test scores of students which are then interpreted in several criteria. According to Hake (1999) the N-gain score which is included in the high criteria is 0.70 – 1.00, the moderate criterion is 0.70-0.30 and the criterion is low if it is below 0.30. On the completeness of the types of intelligence, the assessment is based on the pre-test and post-test results on each type of intelligence. The results of the analysis are interpreted as complete according to the minimum completeness criteria (*Kriteria Ketuntasan Minimum/* KKM) that the school has determined. Students are considered complete if the test score is 77. The calculation results are then averaged and percentage based on the type of intelligence and then interpreted in several criteria as shown in Table 4.

**Table 4.** Criteria for Interpretation of Completeness Score

| Average Score (%) | Criteria |
|---|---|
| 85 – 100 | Very High |
| 70 – 84 | High |
| 55 – 69 | Enough |
| 41 – 54 | Low |
| 0 – 40 | Very Low |

(adapted from Arikunto, 2010) In addition to being assessed from the completeness of learning, the effectiveness of the developed e-LKPD is also reviewed from the student response questionnaire. Analysis of student response data is presented in the form of the percentage of positive responses from students, which is then interpreted in several criteria as shown in Table 5.

**Table 5.** Criteria for Interpretation of Effectiveness Score

| Average Score (%) | Criteria |
|---|---|
| 88 – 100 | Very Effective |
| 75 – 87 | Effective |
| **Average Score (%)** | **Criteria** |
| 62 – 74 | Enough |
| 49 – 61 | Not Effective |

(adapted from Riduwan, 2013).

## RESULTS AND DISCUSSION

This research produces electronic student worksheets (*Lembar Kerja Peserta Didik Elektronik/* e-LKPD) based on multiple intelligences on human heredity material to improve learning outcomes. The indicators in the developed e-LKPD contain cognitive, affective, and psychomotor activities. These activities have been adapted to the intelligence and learning style chosen based on the results of the pre-research. These intelligence types include linguistic intelligence, spatial-visual intelligence, logical-mathematical intelligence, and naturalist intelligence. All of this intelligence is manifested in the form of activities including observing the physical characteristics of the family, analyzing human heredity events, calculating the percentage of possible offspring, making genealogical diagrams related to blood types, and presenting the results of the analysis related to human heredity events.

The developed e-LKPD is divided into three parts, namely: a)Introduction, consisting of an introduction, table of contents, mapping of basic competencies, explanation of e-LKPD, and explanation of features; b)Content, consisting of concept maps, human heredity materials, and assignments; c)Closing, contains a bibliography.

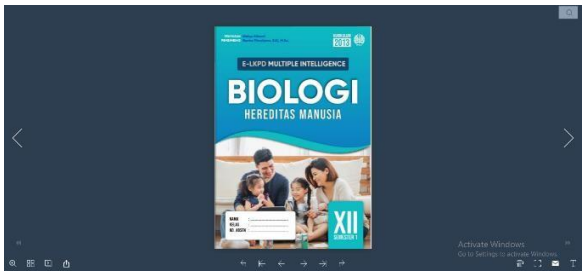



**Figure 1.** Front Cover of E-LKPD

**Figure 2.** Back Cover of E-LKPD

The developed E-LKPD contains short material related to human heredity and is equipped with pictures, hyperlinks, and videos to make it easier for students to understand the material presented.

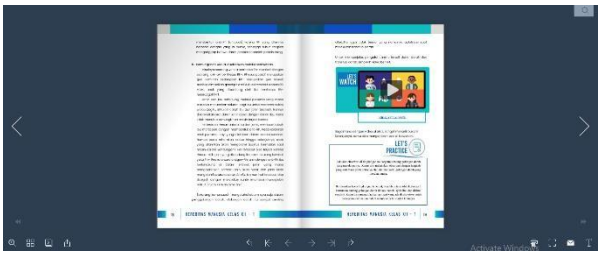
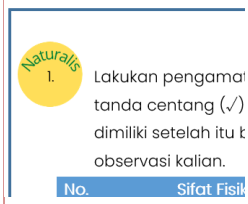
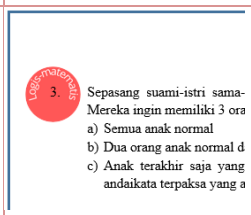


**Figure 3.** Display of the contents of the e-L

The developed e -LKPD also contains several features, including "Let's Read", "Let's Practice", "Let's Watch", and "Do You Know". The questions presented in the e- LKPD are made and adapted to the type of intelligence that has been selected. Each question has a sign to indicate what intelligence is being trained. An explanation of the features contained in the e-LKPD can be seen in Table 6.

**Table 6.** Features in e-LKPD

| No. | Picture | Information |
|---|---|---|
| | **Let's Read** | |
| 1. |  | This feature contains additional references in the form of articles related to human heredity. |
| | **Let's Watch** | |
| 2. |  | This feature contains additional references in videos that can help students understand the material. |
| | **Let's Practice** | |
| 3. |  | This feature contains questions to test students'understanding of human heredity. The questions in it have a sign to show what intelligence is being trained. |
| 4. |  | Questions that practice linguistic intelligence are marked with a blue circle accompanied by the name of the type of intelligence |

| No. | Picture | Information |
|---|---|---|
| | **Let's Practice** | |
| 5. |  | Questions that practice spatial intelligence are marked with a purple circle accompanied by thename of the type of intelligence. |
| 6. |  | Questions that practice naturalist intelligence is marked with a yellow circle accompanied by the name of the type of intelligence. |
| 7. |  | Questions that practice naturalist intelligence is marked with a yellow circle accompanied by the name of the type of intelligence. |
| 8. |  | This feature contains additional information that can add insight to students. |

Before the e-LKPD is tested on students, the e-LKPDmust be validated first to find out its validity. The developed e-LKPD validation includes didactic, presentation, content feasibility, and linguistic aspects. The recapitulation of the developed e-LKPD validation results can be seen in Table 7.

**Table 7.** Recapitulation of e-LKPD validation results

| No. | Aspects | Score | | | Avg | Criteria |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | | |
| **A. Didactic Aspect** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | E-LKPD can be used by students who have high abilities. | 4 | 4 | 4 | 4 | Very valid |
| 2. | E-LKPD can be used by students who have moderate abilities. | 4 | 4 | 4 | 4 | Very valid |

| No. | Aspects | Score | | | Avg | Criteria |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | | |
| **A. Didactic Aspect** | | | | | | |
| 3. | E-LKPD can be used by students who have low abilities. | 3 | 3 | 3 | 3 | Valid |
| **B. Content feasibility aspect** | | | | | | |
| The suitability of the material with the curriculum | | | | | | |
| 1. | Indicators of competency achievement are by basic competencies | 4 | 4 | 4 | 4 | Very valid |
| 2. | The concept presented is by the competency achievement indicators | 4 | 4 | 4 | 4 | Very valid |
| 3. | The learning objectives are presented by the indicators of competency achievement | 4 | 3 | 4 | 3.67 | Very valid |
| 4. | The concepts presented are in accordance with the learning objectives | 4 | 4 | 4 | 4 | Very valid |
| The suitability of the material with the concept | | | | | | |
| 1. | The material presented is a Biologylesson in the Human Heredity chapter | 4 | 4 | 4 | 4 | Very valid |
| 2. | The concept presented does not cause double meaning | 4 | 4 | 4 | 4 | Very valid |
| 3. | The material presented is based on the | 4 | 4 | 4 | 4 | Very valid |

| No. | Aspects | Score | | | Avg | Criteria |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | | |
| **B. Content feasibility aspect** | | | | | | |
| The suitability of the material with the concept | | | | | | |
| 4. | The conceptof the material is arranged systematically | 4 | 4 | 4 | 4 | Very valid |
| 5. | The suitability of the E-LKPD with the level of difficulty and abstraction of the concept to help students develop their cognitive abilities | 4 | 4 | 4 | 4 | Very valid |
| 6. | Compatibility of E- LKPD questions with basic competencie s and learning objectives | 4 | 4 | 4 | 4 | Very valid |
| E-LKPD Supporter | | | | | | |
| 1. | There is a concept map | 3 | 3 | 4 | 3.33 | Valid |
| 2. | There are pictures, videos, and supporting articles | 4 | 4 | 4 | 4 | Very valid |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3. | There are features in the E-LKPD to help students | 4 | 4 | 4 | 4 | Very valid |
| **C. Aspects of e-LKPD presentation** | | | | | | |
| E-LKPD Display | | | | | | |
| 1. | The image on the cover represents the contents of the e- LKPD | 4 | 3 | 4 | 3.67 | Very valid |
| 2. | Color, image layout and text have a good combination | 4 | 4 | 4 | 4 | Very valid |

| **No.** | **Aspects** | **Score** | | | **Avg** | **Criteria** |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | | |
| **C. Aspects of e-LKPD presentation** | | | | | | |
| E-LKPD Display | | | | | | |
| 3. | There is a cover identity for the education unit level and a complete type of e-LKPD | 4 | 4 | 4 | 4 | Very valid |
| 4. | The type and size of the text used is appropriate | 4 | 4 | 4 | 4 | Very valid |
| Use of e-LKPD | | | | | | |
| 1. | e-LKPD link can be accessed easily | 4 | 4 | 4 | 4 | Very valid |
| 2. | Animation of *flip* (backand forth) runs easily and smoothly | 4 | 4 | 4 | 4 | Very valid |
| 3. | Material links can be accessed easily | 4 | 4 | 4 | 4 | Very valid |
| 4. | Videos can play well | 4 | 4 | 4 | 4 | Very valid |
| 5. | The E-LKPD answer sheet can be downloaded from the link provided | 4 | 4 | 4 | 4 | Very valid |
| 6. | E-LKPD can be zoomed in and zoomed out | 4 | 3 | 4 | 3.67 | Very valid |
| E-LKPD Layout | | | | | | |
| 1. | The text on the E-LKPD is legible | 4 | 4 | 4 | 4 | Very valid |
| 2. | Suitable font | 4 | 4 | 4 | 4 | Very valid |

| **No.** | **Aspects** | **Score** | | | **Avg** | **Criteria** |
|---|---|---|---|---|---|---|
| | | V1 | V2 | V3 | | |
| E-LKPD Layout | | | | | | |
| 3. | Color pictures and videos | 4 | 4 | 4 | 4 | Very valid |
| 4. | Images and videos with sources | 4 | 4 | 4 | 4 | Very valid |
| 5. | Proportional text and image layout | 3 | 3 | 3 | 3 | Very valid |
| 6. | In the *footer* there is the title of E-LKPD and the page | 4 | 3 | 4 | 3.67 | Very valid |
| E-LKPD Supporter | | | | | | |
| 1. | E-LKPD display has good resolution | 4 | 4 | 4 | 4 | Very valid |
| 2. | E-LKPD can be accessed via *smartphone* or PC | 4 | 4 | 4 | 4 | Very valid |
| **D. Linguistic Aspect** | | | | | | |
| Language use | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | The language used is in accordance with PUEBI | 4 | 4 | 4 | 4 | Very valid |
| 2. | The language used is in accordance with the students' thinking level | 4 | 4 | 4 | 4 | Very valid |
| 3. | Sentences represent the content of the message to be conveyed | 4 | 4 | 4 | 4 | Very valid |
| 4. | Sentences do not have a double meaning | 4 | 4 | 4 | 4 | Very valid |
| **No.** | **Aspects** | **Score** | | | **Avg** | **Criteria** |
| | | V1 | V2 | V3 | | |
| **D. Linguistic Aspect** | | | | | | |
| Language use | | | | | | |
| 5. | The sentence does not contain elements of SARA | 4 | 4 | 4 | 4 | Very valid |
| 6. | The sentences used are clear and operational | 4 | 4 | 4 | 4 | Very valid |
| Usage of Terms | | | | | | |
| 1. | Correct writing of biological terms | 4 | 4 | 4 | 4 | Very valid |
| 2. | Use of biological terms to support concept delivery | 4 | 4 | 4 | 4 | Very valid |
| 3. | Consistent use of the term | 4 | 4 | 4 | 4 | Very valid |
| 4. | Consistent use of symbols/ symbols | 4 | 4 | 4 | 4 | Very valid |
| | **Average** | | | | **3.9** | **Very valid** |

Description:
V1 = Validator 1
V2 = Validator 2
V3 = Validator 3

Based on Table 7, the three aspects of the developed e-LKPD are categorized as very valid and deserve to be tested. These three aspects are a form of the conditions that must be met in developing a student worksheet. The conditions in question are didactic requirements, construction requirements, and technical requirements. The didactic requirements of a teaching material must be effective and universal, which means that the teaching material can stimulate students' understanding in forming concepts and pay attention to their various abilities of students (Aini et al., 2019). This requirement is containedin the didactic aspect and the feasibility aspect of the content with an average score of 3.67 and 3.92, both of which have very valid criteria. Construction requirements relate to the use of language, sentence structure, and level of difficulty. This requirement is contained in the linguistic aspect with the acquisition of 4 very valid criteria. According to Prastowo (2015), the use of correct sentences and grammar can make it easier for students to understand the material in the LKPD. The last requirement is the technical requirements contained in aspects of the presentation. These aspects relate to images, writing, and appearance. LKPD which is only full of writing, gives an unattractive impression and makes students bored while reading. Illustrations or pictures in the LKPD can also support students' understanding (Umbaryati, 2016).

In addition to being reviewed from these three aspects,the e-LKPD developed must also be validated in terms of the suitability of the material with the selected multiple intelligences. The data recapitulation of the results of the validation of the suitability of the material with multiple intelligences can be seen in Table 8.

**Table 8.** Recapitulation of the results of the validation of the suitability of the material with Multiple Intelligences

| **No.** | **Indicator** | **Score** | | | **Avg** | **Percentage (%)** |
|---|---|---|---|---|---|---|
| | | **V1** | **V2** | **V3** | | |
| | **Naturalist** | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | Observing the physical properties possessed by parents and themselves then students are asked to make conclusions | 1 | 1 | 1 | 1 | 100 |
| 2. | Analyzing the events of human heredity, especially the inheritance of physical traits based on the videos that have been provided | 1 | 1 | 1 | 1 | 100 |
| **Linguistics** | | | | | | |
| 3. | Explaining diseases/ disorders related to sex determination based on the provided article | 1 | 1 | 1 | 1 | 100 |
| **No.** | **Indicator** | **Score** | | | **Avg** | **Percentage (%)** |
| | | **V1** | **V2** | **V3** | | |
| **Linguistics** | | | | | | |
| 4. | Analyzing diseases/ disorders related to sex determination based on the articles that have been provided | 1 | 1 | 1 | 1 | 100 |
| 5. | Presenting the results of the analysis related to diseases/ disorders in determining sex | 1 | 1 | 1 | 1 | 100 |
| **Spatial** | | | | | | |
| 6. | Analyzing the inheritance of genosome-linked diseases based on Queen Victoria's family tree map | 1 | 1 | 1 | 1 | 100 |
| 7. | Determining the genotype of genotype-linked hereditary diseases based on a 3-generation pedigree map | 1 | 1 | 1 | 1 | 100 |
| 8. | Make a family tree map of 3 generations of each student about blood groups and alleles | 1 | 1 | 1 | 1 | 100 |
| **Logical-Mathematic** | | | | | | |
| 9. | Calculates the percentage probability | 1 | 1 | 1 | 1 | 100 |
| **No.** | **Indicator** | **Score** | | | **Avg** | **Percentage (%)** |
| | | **V1** | **V2** | **V3** | | |
| **Logical-Mathematic** | | | | | | |
| | of the 3 expected events in autosomal-linked hereditary disease | 1 | 1 | 1 | 1 | 100 |
| **Average** | | | | | | **100** |

Description:
V1 = Validator 1
V2 = Validator 2
V3 = Validator 3

Based on Table 8, the developed e-LKPD obtained an average score of 100% which is included in the very valid category. There are four types of intelligence to choose

from. Linguistic intelligence is intelligence related to language and sentence structure. Students who have this intelligence prefer reading, telling stories, and writing, so the recommended teaching strategies are brainstorming, teaching using voice recordings, telling stories, and discussing (Yaumi, 2015). In the developed e-LKPD, intelligence is trained in the form of presentation activities on the results of the analysis of articles that have been provided about diseases/disorders of determining human sex. Furthermore, visual-spatial intelligence is related to the ability of students to analyze pictures, diagrams, and videos. Teaching strategies that can be chosen include drawing, visualizing a reading in a sketch, and making a mind map (Salindri et al., 2020). The activities chosen to be included in this e-LKPD are listening to videos as a medium for supporting students' understanding, analyzing Queen Victoria's hereditary disease diagrams, and making family blood group gonosomal diagrams as well as skills competency bills.

The next type of intelligence is logical-mathematical. This intelligence is related to numeracy skills. The part of the brain that works when processing numbers is the left front and right parietal lobes (Mariana, 2018). Learning activities that support this intelligence are counting, assessing, classifying or categorizing (Armstrong, 2013). In the human heredity material, logical-mathematical intelligence is also needed by students when calculating the percentage of the possibility of passing a trait to the next generation.

The last type of intelligence is naturalist intelligence. Naturalist intelligence is related to nature and the living things around it. Activities such as Eco-Study, planting, and practicum using real objects are activities that are in accordance with this type of intelligence (Nurhidayati, 2015). Naturalist intelligence is in this e-LKPD in the form of observing activities. Students are asked to observe the physical characteristics of family members, such as hair shape, nose shape, ear lobes, and so on. In addition, students are also asked to observe the blood group of their family, which is then described in the form of a diagram.

Practicality is also carried out to determine whether the developed e-LKPD is practical or not. The practicality of the e-LKPD was reviewed based on the results of observations of the implementation of student activities carried out by observers using observation questionnaires. The data recapitulation of the implementation results can be seen in Table 9.

**Table 9.** Recapitulation of the results of the implementation of e-LKPD

| No. | Implementation Aspect | Percentage (%) | Criteria |
|---|---|---|---|
| 1. | Read and study the e-LKPD user guide | 100 | Very Practical |
| 2. | Use the features well | 97.5 | Very Practical |
| 3. | Read the material carefully | 100 | Very Practical |
| 4. | Make observations related to physical characteristics in the family environment | 100 | Very Practical |
| 5. | Analyzing the events of human heredity | 95 | Very Practical |
| 6. | Analyzing the relationship between sexually transmitted diseases/disorders and sex determination in a person | 100 | Very Practical |
| 7. | Presenting the results of the analysis related to venereal disorders/diseases | 75 | Practical |
| 8. | Analyzing autosomal-linked hereditary diseases based on pedigree maps | 100 | Very Practical |
| 9. | Analyze and determine the gonosomes on the pedigree map | 100 | Very Practical |
| 10. | Predicting the percentage probability of the three expected events in descending disease | 100 | Very valid |
| 11. | Observing blood type in the family environment | 100 | Very Practical |
| 12. | Make a pedigree map of three generations related to blood type | 100 | Very Practical |
| **Average** | | **97.3** | **Very Practical** |

Based on Table 9, it can be seen that the average practicality of the developed e-LKPD is 97.3%. The result shows that students are actively involved in learning activities. From the twenty-one activities, there is one activity that has the lowest percentage, which is presenting the results of the analysis related to

diseases/disorders in determining gender. This activity was only carried out by15 students. The low percentage of the implementation of these activities is due to the limited learning time possessed by students. The learning time for biology subjects is only 1 hour due to the implementation of activity restrictions during the covid-19 pandemic. Another factor is the respondents in which 12th grade students have a short timeline due to having to run variouskinds of graduation exams. Overall, students participate actively in learning activities. Activeness in learning can make it easier for students to find material concepts. This is in accordance with Legowo (2017) that the learning process using stimulation in the form of multiple intelligences pays more attention to learning styles, strengths, ease of learning, and real learning experiences

The developed e-LKPD is also reviewed in terms of effectiveness. The calculated effectiveness includes increasing learning outcomes in the form of N-gain scores, the sensitivity of question indicators, completeness of multiple intelligences, and student responses. Learning outcomes are said to be complete if they are above the minimum completeness criteria Biology of 12th grade (≥77). The following is a recapitulation of the data on thecompleteness of learning outcomes. The data recapitulation of learning completeness results can be seenin Table 10.

**Table 10.** Recapitulation of learning outcomes completeness data

| Students | Pre-test | | Post-test | | Gain score (criteria) |
|---|---|---|---|---|---|
| | score | Category | score | Category | |
| 1 | 20 | N | 100 | A | 1.00 (H) |
| 2 | 30 | N | 90 | A | 0.85 (H) |
| 3 | 30 | N | 90 | A | 0.85 (H) |
| 4 | 20 | N | 90 | A | 0.87 (H) |
| 5 | 20 | N | 100 | A | 1.00 (H) |
| 6 | 30 | N | 100 | A | 1.00 (H) |
| 7 | 20 | N | 90 | A | 0.87 (H) |
| 8 | 20 | N | 90 | A | 0.87 (H) |
| 9 | 50 | N | 100 | A | 1.00 (H) |
| 10 | 10 | N | 80 | A | 0.78 (H) |
| 11 | 50 | N | 100 | A | 1.00 (H) |
| 12 | 40 | N | 100 | A | 1.00 (H) |
| 13 | 20 | N | 90 | A | 0.87 (H) |
| 14 | 10 | N | 80 | A | 0.78 (H) |
| 15 | 20 | N | 90 | A | 1.00 (H) |
| 16 | 20 | N | 90 | A | 0.87 (H) |
| 17 | 30 | N | 100 | A | 1.00 (H) |
| 18 | 20 | N | 100 | A | 1.00 (H) |
| 19 | 20 | N | 100 | A | 1.00 (H) |
| 20 | 20 | N | 80 | A | 0.87 (H) |
| **Average** | **25** | **N** | **93** | **A** | **0.92 (H)** |

Description:

N = Not Achieved

A = Achieved

H = High

Based on Table 10 shows that there is an increase in each student when compared between the pre-test and post-test scores. The purpose of giving the pre-test is to measure the initial understanding of students, while the post-test aims to measure the cognitive changes of students. In addition, conducting a post-test at the end of each meeting helps students remember the material they have learned (Efendy, 2016). In Table 10, the pre-test results of all students were declared partial, both individually and the average was only 25. Meanwhile, the post-test results showed a very significant increase. Students get scores above the average, with the smallest score of 80. The results of the N-gain analysis in Table 5 show that each student experienced a high increase in which the average N-gain score was 0.90 and included in the high criteria. The increase in scores shows that the developed multiple intelligence e-LKPD greatly affects students' understanding of the material being studied. The same thing happened to the research conducted by Sultan and Bancong (2017) about the effect of learning multiple intelligences on changes in attitudes and learning

outcomes of physics students in class XI SMA Negeri 11 Makassar. Based on this research, shows that there is a positive influence in the form of an increase in both learning outcomes and students' affectiveness.

Learning outcomes also need to be analyzed in terms of sensitivity in order to determine whether there is an influence of learning on students' understanding. Recapitulation of item sensitivity data can be seen in Table 11.

**Table 11.** Recapitulation of item sensitivity data

| No. | Indicator | Ra | Rb | S | Average |
|---|---|---|---|---|---|
| **Naturalist** | | | | | |
| 1. | Analyzing the events of human heredity, especially physical traits | 2 | 19 | 0.85 | 0.85 (sensitive) |
| 2. | Observing physical traits inherited from parents | 11 | 20 | 0.45 | 0.45 (sensitiv e) |
| **Linguistics** | | | | | |
| 3. | Describe diseases/disor ders related to sex determination | 3 | 19 | 0.80 | 0.80 (sensitive) |
| **Linguistics** | | | | | |
| 4. | Analyzing diseases/disor ders towardssex determination | 10 | 20 | 0.50 | 0.50 (sensitive) |
| 5. | Presenting the results of the analysis of diseases/ disor ders related to sex determination | 4 | 19 | 0.75 | 0.75 (sensitive) |
| **Spatial** | | | | | |
| 6. | Analyzing genosome-linked hereditary diseases based on Queen Victoria's family tree map | 5 | 20 | 0.75 | 0.75 (sensitive) |
| 7. | Determining the genotypeofa genosome-linked hereditary disease based on a familytree map of 3 generations | 10 | 19 | 0.45 | 0.45 (sensitive) |
| 8. | Make a family tree map of 3 generations of inherited traits, especially blood type and alleles | 4 | 17 | 0.65 | 0.65 (sensitiv e) |
| **Logical – Mathematical** | | | | | |
| 9. | Calculates the percentage probability of the 3 expected events in inherited disease against autosomes | 1 | 17 | 0.80 | 0.75 (sensitiv e) |
| | | 2 | 16 | 0.70 | |
| **Average** | | | | | **0.66 (sensitiv e)** |

Description:
MI = Multiple Intelligences
Ra = The number of students who answered correctly on the pre-test
Rb = The number of students who answered correctly on the post-test
S = Sensitivity score

Based on Table 11, nine-question indicators are considered sensitive, with an average acquisition of 0.66. This is also in line with the results of learning completeness of each student. Learning outcomes in students can be influenced by internal factors and external factors. One example of internal factors is the

psychological factor of students both intellectually and non-intellectively (Syafi'i et al., 2018). Learning style is one of the non-intellective psychological factors of students. According to Marpaung (2015), the ignorance of students in recognizing their learning style makes their learning achievement poor, therefore the teacher has an important role to direct students in recognizing their learning style. Learning with the multiple intelligences approach makes teachers more creative in applying various teaching methods in order to achieve harmony between teaching styles and learning styles. If teaching styles, learning resources, and learning tools are adjusted to the learning styles of students, their academic achievement of students can increase (Astutie, 2013).

Completeness of learning outcomes is also reviewed based on the selected multiple intelligences. Recapitulation of the results of multiple intelligences completeness can be seen in Table 12.

**Table 12.** Data recapitulation of multiple intelligences

| No. | Kind of Intelligences | No. question | Percentage (%) | Category |
|---|---|---|---|---|
| 1. | Naturalist | 1 and 2 | 97 | Very High |
| 2. | Linguistics | 3, 4, and 9 | 96 | Very High |
| 3. | Spatial – Visual | 5, 6, and 10 | 93 | Very High |
| 4. | Logical-Mathematical | 7 and 8 | 82 | High |
| **Average** | | | **91.25** | **Very High** |

Based on Table 12, the completeness of multiple intelligences has an average of 91.25% which is a high criterion. Of the four types of intelligence, there is one intelligence that gets the lowest score, namely logical- mathematical intelligence, which is 82%. In the human heredity material contains the theory of probability. According to Sopwatillah (2021), probability theory is considered difficult because of its complexity and requires high reasoning abilities on contextual problems. The application of multiple intelligences theory in biology that focuses on logical-mathematical intelligence can also be found in the research conducted by Murdiyani (2012), namely the application of multiple intelligences-based e- learning methods to human movement systems. In this study, researchers used concept maps as a medium to hone spatial and logical-mathematical intelligence which could improve student learning outcomes.

Furthermore, the type of spatial-visual intelligence which gets a score of 93% with high criteria. In this type of intelligence, students are asked to analyze and visualize in the form of diagrams. The ability to represent an image in written form or vice versa is needed to understand learning, one of which is biology because most of them study bioprocesses. The accuracy of the representation is a factor that determines students' understanding of a concept. This ability also helps broaden the views of students in solving problems (Handayani and Nurdin, 2021). The application of activities that hone spatial-visual intelligence in learning is proven to be able to help students understand a concept which has been proven in previous research by Junianti and Widianti (2015), which in their research developed a mind mapping-based pocketbook as a medium for learning mushroom material. The next intelligence is linguistic intelligence. This type of intelligence gets a score of 96% with high criteria. The activity in this e-LKPD is to present the results of the discussion. Based on research by Mitasari and Prasetiyo (2016) about the application of the presentation and discussion method, students indirectly seek answers by reading, brainstorming, and being motivated to appear confident when expressing opinions in public.

The last intelligence is naturalist intelligence. This intelligence obtained the highest score of 97%, with activities in the form of analyzing and observing the nature of the crosses. These activities make students have real experience and train students' thinking in solving factual problems that exist in the field by applying the material they have learned. Learning activities that hone naturalist intelligence not only train the cognitive but also affective domains, one of which is caring for the environment. Based on research conducted by Sriningsih (2012), it is explained that observation or practicum activities are considered to be able to hone naturalist intelligence and improve learning outcomes in the cognitive, affective, and psychomotor domains.

Effectiveness is not only assessed from completeness but also from student responses. Student responses are considered important to know the responses related to the developed e-LKPD. The data on the results of the student response questionnaires can be seen in Table 13.

**Table 13.** Recapitulation of student response questionnaire data

| No. | Criteria | Score (%) | Category |
|---|---|---|---|
| 1. | Content eligibility | 100 | Very effective |
| 2. | Language eligibility | 100 | Very effective |
| 3. | Serving eligibility | 97 | Very effective |

| | | | |
|---|---|---|---|
| 4. | The intelligence in it | 100 | Very effective |
| **Average** | | **99** | **Very effective** |

The student response questionnaire contains four aspects, including aspects of content feasibility, language feasibility, presentation feasibility, and intelligence in it. Of the four aspects, the presentation feasibility aspect got the lowest score, namely 97%. In this aspect, there are criteria that not all students meet because they are constrained by the network when accessing the e-LKPD and watching video material. The developed e-LKPD can be accessed online or offline, but the weakness of offline is that the developed e-LKPD file is large and can only be accessed via a laptop. But overall, the developed e-LKPD received a positive response and was very effective in improving student learning outcomes, which was shown by the average score of 99%. The implications of this data acquisition can be used to map the components of multiple intelligences that can be specifically focused on, make adjustments to other appropriate forms of intelligence, and develop more comprehensive learning tools.

## ACKNOWLEDGMENTS

Thanks are conveyed to Dr. Isnawati, M.Si., Dr. Sifak Indana, M.Pd., and Ari Mujiati, S.Pd. who gave insight and advice for this research, and also to students of SMA Negeri 8 Surabaya, especially XII IPA 5 who have participated in this research.

## CLOSING

### Conclusion

This research produces e-LKPD based on Multiple Intelligences on human heredity material that is feasible both in terms of validity, practicality, and effectiveness. The developed e-LKPD got an average score of 3.86 which is included in the very valid category. In terms of practicality, in terms of observing the implementation of activities, which got a score of 97.3% in the very practical category. On the aspect of effectiveness in terms of completeness of learning outcomes with an average score of N-gain 0.92 which is in the high category, item sensitivity with a score of 0.66 which is included in the sensitive category, completeness of multiple intelligences with a score of 91.25% which is including the very high category, and the student response questionnaire with a score of 99% which is included in the very complete category. So, it can be concluded that the developed e- LKPD can be used for both teachers and students as a supporting media in teaching and learning activities that focus on students' specific intelligence.

### Suggestion

The developed e-LKPD was only tested on a limited scale, so it needs to be applied on a larger scale in order toimprove student learning outcomes, especially in human heredity material with the application of Multiple Intelligences theory.

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