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E-STUDENT WORKSHEET BASED ON QR CODE ASSEMBLR EDU: THE DEVELOPMENT OF GEOGRAPHY LEARNING SOURCE IN THE ERA OF DIGITALIZATION

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ABSTRACT

One of the challenges in using student worksheets lies in their limited visual appeal, minimal interactivity, unclear instructions, and lack of technological integration, all of which fail to promote higher-order thinking skills and consequently reduce the effectiveness of learning and its relevance to contemporary students' needs. This study aims to develop electronic student worksheets (e-student worksheets) based on the Assemblr Edu QR code that are valid and practical for students. This research employs the ADDIE model, which comprises five stages: analysis, design, development, implementation, and evaluation. The selection of the Research and Development (R&D) method was based on the need to design, validate, and produce a feasible digital learning product that aligns with the demands of technological innovation in the geography learning process. The study involved 184 Grade X students of SMAN 8 Banjarmasin, with data collected through observations and questionnaires. The research instruments included validation and product-effectiveness sheets. Validation was conducted by experts in materials, language, and media/learning technology, while teachers and students implemented effectiveness testing. The developed QR Code–based Assemblr Edu LKPD obtained material validation of 90.90% (very feasible), language validation of 95% (very feasible), and media/technology validation of 95.83% (very feasible). Product effectiveness reached 95.29% from teachers (very feasible) and 78.02% from students (feasible). These results indicate that the QR Code–based Assemblr Edu LKPD is highly appropriate for use in learning, particularly in geography instruction.

Keywords: *development; student worksheet (LKPD); assemblr edu or code*

INTRODUCTION

Education is a sector that aggressively creates technological innovations to support the teaching and learning process in the digital era of 4.0. The learning system in the 4.0 era requires students to master skills in technology,

information, and communication, as well as other career-supporting skills (Putri, Sriartha, & Suastika, 2023). The COVID-19 pandemic, which occurred a few years ago, has played a role in accelerating the process. The COVID-19 pandemic compelled the government to transition from a face-to-face learning system to a blended learning system, a combination of offline and online learning approaches. This change in the learning system requires educators to master the use of technology to support the learning process in the classroom (Mulyono, 2022). This opinion is that increasingly sophisticated technological developments should be utilised in learning (Prastiyono et al., 2021).

The integration of technology in the field of education leads to adjustments in various ways, including the design of learning resources. Learning resources can take various forms, including textbooks, print media, electronic media, resource persons, the surrounding natural environment, and others, which can enhance the effectiveness of the learning process. Varied learning resources will provide an excellent experience to students (Fögele, Hofmann, & Mehren, 2014). Student Worksheets are one of the learning resources that help facilitate the learning process, fostering effective interaction between educators and students. Student Worksheets, as a learning resource, can also increase student activity and enhance learning achievement. Student Worksheets are designed and developed according to the conditions and situations of school learning activities.

The advantage of using student worksheets is that it makes it easier for educators to carry out the learning process. Students can learn independently, quickly understand the material, and complete a written task. Learners obtain notes on the material learned through learning activities. Student Worksheets can also help students add information about the concepts learned through systematic learning activities.

Student Worksheets contain written guidelines and evaluation tools designed to help students discover learning concepts within their abilities, thereby achieving learning objectives (Meutia, Nurdin, & Winarni, 2021; Zainil & Kenedi, 2022). The purpose of using student worksheets is to motivate students to learn independently, tailored to their interests and abilities. Using student worksheets is expected to build

interaction between students and the surrounding environment. In addition to containing appropriate methods or approaches, student worksheets must be packaged with consideration for technological advances. The goal is that learning is exciting and engaging, hindering the knowledge transfer process by teachers and students (Khastini, Rohmah, & Sahida, 2023; Susanti & Widowati, 2022).

Based on observations and interviews with teachers at SMAN 8 Banjarmasin, it was found that most teachers use student worksheets provided by the school. The student worksheets are still in print and only contain a summary of the material, examples, and practice questions. In addition, the LKPD used contains more non-pictorial or monotonous text (Berlian, Dinda, & Vebrianto, 2023). The display of Lembar Kerja Peserta Didik (LKPD), which is still printed, also differs from technological advances in the digital era 4.0 and the interests of students. Therefore, the preliminary analysis results indicate that the development of teaching materials, such as digital LKPD, is necessary. This need for innovative, technology-enhanced learning materials underscores the importance of aligning instructional resources with the pedagogical characteristics of the geography curriculum.

Learning geography in the Independent Curriculum has several characteristics, including (a) being cross-disciplinary by integrating natural, social, cultural, economic, political, and environmental sciences to understand geosphere phenomena; (b) being contextual by connecting learning materials with real situations at local, national, and global levels; (c) being inquiry-oriented by encouraging students to think critically, analytically, and reflectively through questioning, data collection, data analysis, inference, and presentation; and (e) being applicative by enabling students to apply geographical concepts to solve real-world problems related to the earth, humans, and their interactions (Kurniawan, Eva, & Dafip, 2020; Sahrina et al., 2022; Schaal, 2020). One of the essential competencies in geography is to guide students in analysing, thinking critically, organising theories, elaborating studies, and examining relationships among geosphere phenomena. Exogenous energy is one of the topics included in the geosphere phenomenon theme. It is taught in Grade X, Phase E, where

students are expected to identify and understand the basic concepts of geography, maps, geographic inquiry, and geosphere processes. To effectively achieve these competencies, learning resources must be aligned with the curriculum's emphasis on inquiry, contextual learning, and the application of higher-order thinking skills. In this context, the development of digital student worksheets becomes essential, particularly those enhanced with QR Code–based Assemblr Edu features that enable interactive visualisation, multimodal content access, and augmented reality–supported exploration.

Such technological affordances provide learning experiences that strengthen conceptual understanding and inquiry processes, ensuring that instructional media are pedagogically compatible with the characteristics of geography learning in the Kurikulum Merdeka (Chaniago, Yeni, & Setiawati, 2022; Pratama, Fazera, Fortunata, & Fadilah, 2024; Sobirin, Asiyah, & Hartono, 2024). Therefore, the integration of QR Code–based digital LKPD is necessary to bridge curriculum expectations with classroom practice and to support students in achieving the intended learning outcomes of phase E.

Furthermore, although previous studies have examined the use of digital worksheets and QR Code–supported instructional tools, none have specifically integrated the augmented reality (AR) capabilities of Assemblr Edu into LKPD development for geography learning. Prior research tends to focus on flipbook-based e-LKPD, conventional multimedia, or QR Code applications without AR-enhanced spatial visualisation (Mileva & Stoyanova, 2017). This gap indicates the absence of instructional materials that combine LKPD, QR Codes, and AR technology to strengthen students' conceptual and spatial reasoning in geosphere-related topics. Assemblr Edu's ability to present three-dimensional models, immersive environments, and multimodal content makes it pedagogically valuable for geography, particularly in supporting inquiry, visualization of landform dynamics, and contextual understanding of geomorphological processes (Law & So, 2010) The selection of QR Code-based Assemblr Edu was also strengthened by a needs analysis that showed that the majority of students

have an audiovisual learning style and prefer digital LKPDs. Previous research confirms that QR Codes increase the interactivity and accessibility of learning resources, while AR helps explain abstract concepts more easily through three-dimensional visualisation (Mowafi, Abumuhfouz, & Redifer, 2019). Thus, the integration of the two provides a more meaningful learning experience, aligning with the demands of 21st-century competencies. Thus, integrating Assemblr Edu into LKPD development is crucial for producing innovative, technology-integrated learning resources that align with the demands of geography learning in the Kurikulum Merdeka.

A review of several types of literature revealed that research on developing LKPD based on QR Code Assemblr Edu for geography materials had never been conducted before. The novelty of this research lies in the simultaneous integration of digital LKPD, QR Code technology, and AR visualisation through Assemblr Edu. This approach has not been previously explored in research, particularly in the development of geographic LKPD on the topic of exogenous energy. Therefore, this research offers innovations in the form of presenting geomorphological materials through 3D objects and interactive multimedia that can improve students' conceptual understanding and analytical abilities (Mileva & Stoyanova, 2017; Sebastián-López & de Miguel González, 2020) Therefore, this study aims to develop and produce a QR Code–based Assemblr Edu student worksheet (LKPD) designed to address the limitations of conventional printed worksheets, which lack interactivity and technological integration.

The development process is directed toward creating a pedagogically sound digital learning product that aligns with the curriculum's characteristics and enhances students' conceptual understanding of geosphere phenomena. Furthermore, the achievement of the development goals is evaluated through a comprehensive assessment of the product's validity and practicality, which serve as the primary success criteria in determining the quality and feasibility of the resulting LKPD for classroom implementation.

MATERIALS AND METHODS

This research uses research and development methods. Research and development methods encompass the

output of a particular product. The model used in the development of the QR Code-based LKPD Assemblr Edu is the ADDIE model (Sugiyono, 2017). The development model includes five sequential, systematic stages: analysis, design, development, implementation, and evaluation. This development model is widely used to prepare learning resources, including LKPD. What underlies the use of the ADDIE model is that creating and developing teaching materials follows a logical and systematic sequence; therefore, this development model is considered suitable for developing LKPD.

This research was conducted at SMAN 8 Banjarmasin in June 2023. Among the 13 public senior high schools in Banjarmasin, SMAN 8 Banjarmasin was selected as the research site because both teachers and students predominantly use printed worksheets that are concise and lack interactivity, making them misaligned with the demands of learning in the digital era. This condition highlights the need to develop technology-enhanced worksheets, making SMAN 8 Banjarmasin an ideal setting for evaluating the effectiveness of the QR Code–based Assemblr EDU student worksheet.

Expert validators conducted the feasibility test of the QR Code-based LKPD Assemblr Edu and continued to the research subject. Material experts, media/learning technology experts, and linguists validate LKPD based on the Assemblr Edu QR Code. The subjects of the eligibility test for LKPD, based on QR Code Assemblr Edu, were 184 Grade X students of SMAN 8 Banjarmasin, along with geography teachers from SMA 8 Banjarmasin.

To ensure the robustness of the research instruments, both validity and reliability testing were conducted prior to data collection. Content validity was examined through expert judgment involving material, language, and media/technology specialists who evaluated the alignment, clarity, and relevance of each item using a Likert-scaled validation sheet (Isromi, Malik, & Maru, 2022; Maqdisiana, Widodo, & Pargito, 2023). Reliability testing employed Cronbach's Alpha, a commonly used measure for internal consistency in educational research, with an acceptable value of $\alpha \geq 0.70$ (Sugiyono, 2017). All instruments (including the needs analysis questionnaire, expert validation sheet, and feasibility questionnaire for teachers

and students) met the required validity and reliability thresholds.

To enhance procedural clarity, the study followed the ADDIE framework through five stages: Analysis, Design, Development, Implementation, and Evaluation, reflecting best practices in instructional design (Bonfield, Salter, Longmuir, Benson, & Adachi, 2020). The data collection instrument used in this development research is a questionnaire. The questionnaires included a needs analysis questionnaire, an expert validation sheet, and an LKPD feasibility questionnaire, all of which were based on the Assemblr Edu QR Code. The instrument indicators on the questionnaire assess the suitability and feasibility of LKPD based on the Assemblr Edu QR Code in terms of material aspects, learning media/technology, and language. The following are presented product assessment instruments for expert validators. The components of the expert assessment instrument (materials, linguists, and media) are shown in **Table 1**, **Table 2**, and **Table 3**. Meanwhile, the components of the assessment instruments for teachers and students are presented in **Tables 4** and **5**.

Table 1. Material Expert Assessment Instruments

Assessment Aspect	Assessment Items
A. Material Suitability	1. Completeness of the material
	2. Breadth of material
	3. Depth of material
B. Material Accuracy	1. Accuracy of concepts and definitions
	2. Accuracy of data and facts
	3. Image/illustration accuracy
	4. Accuracy of terms
C. Clarity of Material	1. Suitability of the material to scientific developments
	2. Examples of images/illustrations that correspond to phenomena / real appearances in nature
	3. Using examples of images/illustrations that are of the real phenomenon / Appearance
D. Practice Questions	1. Use of question/command sentences
	2. Straightforwardness of questions/commands
	3. Ease of understanding of questions/commands

Source: (Isromi et al., 2022; Maqdisiana et al., 2023)

Table 2. Linguist Assessment Instrument

Assessment Aspect	Assessment Items
A. Simple	1. Sentence structure accuracy
	2. Sentence effectiveness
	3. Standards of terms
B. Interactive	4. Ability to motivate students
	5. Ability to encourage critical thinking
C. Compliance with Language Rules	6. Grammatical accuracy
	7. Spelling accuracy
D. Communicative	8. Understanding of messages or information

Source: (Isromi et al., 2022; Maqdisiana et al., 2023)

Table 3. Media/learning Technology Expert Assessment Instrument

Assessment Aspect	Assessment Items
A. Visual Display	1. The layout elements on the cover are presented harmoniously and consistently.
	2. Displays a good centre of view
	3. The colour of each component of the layout clarifies the function.
	4. The font colour contrasts with the background colour.
	5. Describe the content/material and reveal the character of the object.
	6. The shape, colour, size, and proportions of objects according to reality
B. Font usage	7. Not using too many fonts.
	8. The use of font variations (bold, italic, all capital, small capital) is not excessive.
	9. Normal text arrangement width
	10. Spacing between lines of standard text arrangement
	11. Spaces between letters are normal.
C. Digital display criteria	12. Consistent placement of layout elements based on patterns
	13. Clear separation between paragraphs
	14. Placement of Title, objectives, and learning outcomes
	15. Illustration and caption
D. Ease of Use	16. The display encourages interest in learning and makes it easier to use
E. Visual Display	17. The graphic display of technology does not affect the design of LKPD.
F. Ease of Access	18. Can be accessed with an internet network
	19. Can communicate with students through computer / mobile media
G. Add engagement	20. Ability to motivate students
	21. Ability to encourage critical thinking
	22. Creating a new learning atmosphere
H. Proper application	23. Save learning time
	24. Can summarise a learning material well

Source: (Isromi et al., 2022; Maqdisiana et al., 2023)

Table 4. Teacher Response Instrument

No	Assessment Indicators
1.	Student Worksheets (LAQAS) help the learning process.
2.	Student Worksheets (LAQAS) help students understand the material.
3.	Students interested in using Student Worksheets (LAQAS)
4.	The use of QR CODE technology supports interactive Student Worksheets (LAQAS)
5.	3D material in Student Worksheets can increase students' desire to learn
6.	Student Worksheet Development (LAQAS) brings a positive impression.
7.	The desire to always use Student Worksheets (LAQAS) in the learning process in the classroom.
9.	The language used is simple and easy to understand
10.	The letters used are easy to read.
11.	Attractive Student Worksheet Display (LAQAS)
12.	The use of Student Worksheets (LAQAS) assists teachers in teaching.

Source: (Isromi et al., 2022; Maqdisiana et al., 2023)

Table 5. Student Response Instrument

No	Assessment Indicators
1.	Student Worksheets (LAQAS) explain concepts using illustrations of problems related to real conditions.
2.	Student Worksheets (LAQAS) use examples of questions related to real conditions.
3.	The presentation of material in Student Worksheets (LAQAS) starts from easy to difficult and from concrete concepts to abstract ones.
4.	Student Worksheets (LAQAS) have several sections to find your concepts.
5.	The Student Worksheet (LAQAS) contains questions that encourage me to think.
6.	The presentation of material in Student Worksheets (LAQAS) motivated me to discuss with other friends.
7.	The material on the Student Worksheet (LAQAS) added to my curiosity.
8.	The Student Worksheet (LAQAS) contains formative tests that can test my understanding of exogenous labour material.
9.	The language used is simple and easy to understand
10.	The letters used are easy to read.
11.	The Student Worksheet Display (LAQAS) is very interesting.
12.	Student Worksheets (LAQAS) make me enjoy studying Geography.
13.	Using Student Worksheets (LAQAS) can increase the desire to learn independently.
14.	Using Student Worksheets made my understanding of the material more direct and coherent.
15.	The illustrations in each material motivate students to study the material independently.
16.	QR Code technology provides an interactive experience for learning the material.
17.	Student Worksheets (LAQAS) make learning geography non-boring

Source: (Isromi et al., 2022; Maqdisiana et al., 2023)

Assessment of validation instruments on questionnaires using the Likert scale. The criteria and scores on the Likert scale shown in **Table 6**.

Table 6. Likert scale

Score	Criteria	Symbol
5	Excellent	SB
4	Good	B
3	Good enough	CB
2	Bad	TB
1	Very unkind	STB

Source: (Isromi et al., 2022)

Data analysis employed descriptive percentage techniques, which are widely used in R&D studies to assess product feasibility through expert and user evaluations (Sugiyono, 2017). The percentage scores obtained were interpreted using established feasibility classifications to determine the revision needs. The formula used is shown in **equation 1**.

$$\text{Score Percentage} = \frac{\text{Total Score}}{\text{Max Score}} \times 100\% \quad (1)$$

Source: (Sugiyono, 2017)

Based on the formula above, a value will be obtained indicating the feasibility level of the Assemblr Edu QR Code-

based LKPD development product, as classified in **Table 7**.

Table 7. Product Eligibility Criteria

No	Percentage	Criteria	Category
1	85 – 100	Very decent	No revision required
2	65 – 84	Proper	Slight revision
3	45 – 64	Not worth it	Revision
4	0 – 44	Very unworthy	Revision

Source:(Isromi et al., 2022)

RESULTS AND DISCUSSION

1. Analysis

The analysis is conducted to identify the issues that necessitate the development of LKPD. There are three things in the analysis stage: needs analysis, student characteristics analysis, and curriculum needs analysis. A needs analysis is conducted to identify the problem and formulate the research and development to be undertaken. The needs analysis results showed that 93% of students chose digital LKPD. The analysis of student characteristics revealed that as many as 87% of the study subjects employed an audiovisual learning style. The selection of LKPD based on QR Code Assemblr Edu was developed because it can facilitate student learning styles, as it features audio and visual facilities. The QR Code-based LKPD Assemblr Edu can be accessed through gadgets/mobile phones and laptops connected to the internet. This form of LKPD, based on the Assemblr Edu QR Code, makes it easy for users to learn in any condition. Creating LKPD based on Assemblr Edu QR Code is very interesting, as it motivates students to learn independently and in groups.

The results of the curriculum analysis show that SMAN 8 Banjarmasin has implemented the Kurikulum Merdeka, where exogenous energy material is included in theme 04, Geography (Geosphere Phenomena). The following are the objectives and indicators of learning outcomes of geographical phenomena in the independent curriculum: (a) Knowing the concept of economics, human needs, and many geographical concepts; (b) explaining the benefits of studying geography; (c) Using the concepts studied as a way of making observations and recognizing geosphere phenomena; (d) Collect some examples of geosphere phenomena in everyday life by the material that has been studied; (e) Conclude observations on some problems of geosphere

phenomena and solve these problems; and (f) Prepare various forms of assignment reports based on the material that has been studied.

2. Design

QR Code-based electronic LKPD design is carried out on exogenous power materials at this stage. The design includes preparing the structure and content of the LKPD, selecting QR Code technology, and preparing links and additional materials that will be accessed through the QR Code. The material is also developed with a 3-dimensional design. The design was also developed with consideration for the characteristics of students and the curriculum used at SMAN 8 Banjarmasin. This research is based on electronic technology, so manufacturing devices are needed for hardware and software. The hardware used in the making of this is laptops and smartphones. The software used includes Canva, Web Live Worksheets, ME QR, Assemblr Studio, and MyURLs.Bio. The content of the Assemblr Edu QR Code-based LKPD comprises various materials, including videos, infographics, images, links, and graphics.

3. Development

This stage embodies the design that has been made before. The results of the development of the Assemblr Edu QR Code-based LKPD are presented in the form of cover designs, usage instructions, material descriptions, multimedia content (including images, sound, video, and animation), and evaluation reports. The QR Code-based LKPD Assemblr Edu developed in this study was named LAQAS. The name LAQAS is taken from the Banjar language term (*lakas*), which means fast. The meaning of LAQAS is that students can more quickly understand the subject matter through LKPD, based on QR Code Assemblr Edu. An example of an Assemblr Edu QR Code-based LKPD display can be seen in **Figure 1**, **Figure 2**, and **Figure 3**.

At this stage of development, the product is also validated by expert validators of materials, learning media/technology, and language with instruments that have been made. The results of expert validation of the Assemblr Edu QR Code-based LKPD are presented in **Table 8.**

Figure 1. LKPD based on QR Code Assemblr Edu
source: Development Results, 2024

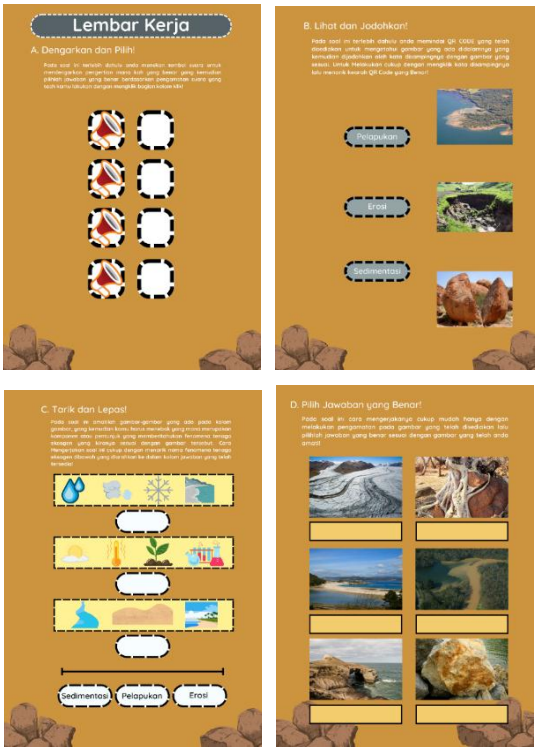

Figure 2. LKPD based on QR Code Assemblr Edu
Source: Development Results, 2024

Figure 3. LKPD based on QR Code Assemblr Edu
Source: Development Results, 2024

Table 8. Expert Validation Results

Assessment aspect		Number of Scores	Total score	Percentage (%)	Criteria
Material Validator	Material suitability Accuracy of the material Clarity of the material Suitability of the question	60	66	90,90	Very decent
Language Validator	Simple Interactive Compliance with Language rules Communicative	38	40	95	Very decent
Media/Technology Validator	Visual display Font usage Digital display Ease of Use Accessibility Interactive Application precision	115	120	95,83	Very decent
Average percentage				93,91	Very decent

Source: Research Analysis, 2024

Based on **Table 8**, it is evident that the average percentage of expert validators is 93.91%, where the Assemblr Edu QR Code-based LKPD development product falls under the category of being very feasible for use in the learning process. Although this product is very feasible, there is some advice from expert

validators. Suggestions from expert validators (materials) include adding guidelines for completing practice questions, creating a student attendance menu, and incorporating multiple-choice questions. Advice from linguists includes correcting punctuation and improper sentence structure.

Media/learning technology experts advise using *myULRS to separate material links, making three-dimensional acces*s lighter. Based on the advice of validators, researchers have implemented the suggested improvements.

4. Implementation

The final stage of this development is implementation. At this stage, product trials were conducted on research subjects, specifically grade X students of SMAN 8 Banjarmasin (**Figure 4**). Students are asked to review LKPD products based on the Assemblr Edu QR Code. Furthermore, students respond to questionnaires that have been prepared.

Figure 4. Limited trial of LKPD based on Assemblr Edu QR Code at SMAN 8 Banjarmasin

Source: Development Results, 2024

This trial aims to gather suggestions and input from students and educators regarding the use of LKPD based on the improved Assemblr Edu QR Code. After the data is obtained, an analysis of the data is carried out. The results of the trial questionnaire, including data from educators and students, are presented in **Table 9**.

Table 9. Results of teacher and student responses

User	Number of scores	Total score	Percentage (%)	Criteria
Teacher	81	85	95,29	Very decent
Students	57	60	95	Very decent
Average percentage			95,15	Very decent

Source: Research Analysis, 2024

5. Evaluation

The final stage of the ADDIE development model is evaluation. This stage evaluates all data obtained, including both expert validation and feedback from educators and learners. Activities at the evaluation stage include improving Assemblr Edu-based student worksheet products so that the developed products are suitable for use. Based on the data produced, it is evident that the development of Assemblr Edu-based student worksheets, particularly those incorporating exogenous energy materials, is feasible for implementation in Geography learning.

The results of this development research are presented in the form of an Assemblr Edu-based LKPD, which has undergone several stages: analysis, design, development, implementation, and evaluation. The results of material expert validation indicate that the product is highly feasible for use in the learning process. In the material aspect, the conformity value of the material ensures that the concepts are presented correctly, systematically, and contain important ideas that students need to know.

The high validation scores—covering material aspects (90.90%), language (95%), and media/technology (95.83%)—demonstrate not only the feasibility of the LKPD content but also its alignment with students' cognitive needs in understanding exogenous energy concepts. These findings align with previous studies, which emphasise that integrating AR visualisation through Assemblr Edu enhances the clarity of geomorphological processes that were previously difficult for students to comprehend, thereby contributing significantly to improved conceptual understanding (Kalogiannakis & Papadakis, 2017; Purwanto et al., 2024). They perceived the integration of QR Codes as a means of simplifying access to learning materials and improving instructional efficiency. At the same time, students reported that the 3D models enabled them to understand landform features and exogenous processes more concretely. This finding is consistent with previous research, which demonstrates similar benefits of interactive and visual-based learning tools (Mileva & Stoyanova, 2017). The research indicates that interactive technology enhances both engagement and spatial understanding. A comparative illustration of expert validation results alongside teacher and

student responses is presented in **Figure 5**.

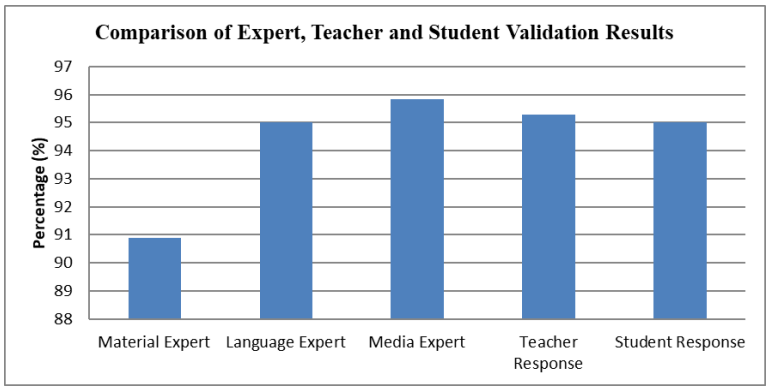

Figure 5. Limited trial of LKPD based on Assemblr Edu QR Code at SMAN 8 Banjarmasin

Source: Development Results, 2024

Compatibility with the development and ability of children by using examples of pictures and videos, according to the child's ability, containing interesting and fun material. The examples used in LKPD are the concept of the material. This aligns with Susanti & Widowati (2022), Wali & Omaid (2020), and Zainil & Kenedi (2022), who suggest that LKPD needs to be designed attractively to stimulate students' interest in learning. One of the advantages of the Assemblr Edu-based LKPD developed in this study lies in its concept, which enables students to understand better the importance of developing deep literacy skills. Assemblr Edu-based LKPD incorporates elements of collaboration to train students' collaboration skills and hone the spatial intelligence needed in geography learning, as it contains materials and questions that require students to be more analytical rather than just evaluative. Geographical literacy is related to the ability to think creatively, as dynamic geography has an educational value that enables humans to think critically and be responsible for decision-making related to global problems and their interactions with diverse living organisms and phenomena that continue to evolve in response to changing times (Sahrina et al., 2022).

Digital-based LKPD is designed to produce practical, reasonable, and attractive standards (Mileva & Stoyanova, 2017). The Assemblr Edu-based LKPD, which has been designed and tested, is quite informative, relevant, and current. It has gone through the stages of reflection and evaluation, and can motivate students to create new

knowledge and experiences. This is also due to the urgency of online digital learning in the era of technology 4.0 as a support for the learning process (Bonfield et al., 2020). Applying QR Codes in learning makes it easy for teachers to adjust to the class's needs. QR Codes enable users to embed various types of information (De Pietro, 2013), such as text, images, videos, and links, about teaching materials, which can also facilitate learning both inside and outside the classroom (Pérez-Sanagustín, Parra, Verdugo, García-Galleguillos, & Nussbaum, 2016). This is also supported by research on the use of QR Codes in learning, which shows that children can have an interactive and fun learning experience (Mowafi et al., 2019). Research conducted by Mahoney & Hall (2017) shows that the use of QR Codes can increase children's independence in learning.

Additionally, the use of QR codes facilitates easier engagement in learning activities for students, educators, and parents (Oh-Young, 2022). The use of QR Code media at various stages of the model is an interactive and innovative medium that embodies the characteristics of 21st-century learning. According to Qashlim & Hasruddin (2015), the presence of QR Codes allows students to interact through media by scanning data equipped with cameras on mobile devices and QR code reader software.

The results of this study align with those of Widati (2021), which suggest that digital LKPD can serve as a stimulus to spark interest and curiosity, thereby increasing students' excitement and motivation. A needs analysis also determines the need for LKPD to help learners improve their learning outcomes. Therefore, researchers have developed a digital-based LKPD that can eliminate student saturation, considering the current times, where learning resources are not only focused on books but also digital-based. This LKPD has integrated voice, video, as also demonstrated by Vonitsanos, Moustaka, Doukakis, & Mylonas (2024), as well as text, images, and games (Sobirin et al., 2024). So that the information conveyed is richer than the thematic books used by students, or the LKPD developed by several previous researchers in their studies.

The characteristic of this LKPD is that it is based on a QR Code that can be directly connected to YouTube, allowing students to easily learn the material

clearly through the presented videos. Wijaya, Gunawan, Setyaningsih, Kusuma, & Miranti (2023) stated that QR codes are used for various purposes, including accessing websites, making phone calls, reproducing movies, opening text documents, and storing data. Utilising media is hoped to facilitate the maximum utilisation of students' senses, thereby enhancing student learning outcomes (AlNajdi, 2022). QR Codes in education offer several benefits, including ease of use, attractiveness, direct access, and the ability to access a wide range of content (Güleç & Çoklar, 2021). The use of QR Codes is successful in helping students meet all three domains of learning (Smith, Segura-Totten, & West, 2018).

Assemblr Edu-based LKPD is also designed to provide easy understanding to students. In LKPD, there is a practicum that can make students more active in their learning. The LKPD developed is not only designed to present material and materials for practicum activities but also to stimulate skills and think critically about a problem obtained. Ismail, Eraku, and Lahay (2025) stated that LKPD teaches the content in a way that allows students to learn it independently, enabling them to be more involved in solving current problems through group discussion activities, practicums, and exercises to address daily life problems.

CONCLUSIONS

The product developed in this research is an Assemblr Edu–based student worksheet (LKPD) on exogenous energy content. Expert validation shows that the product meets the “highly feasible” criteria, with feasibility scores of 90.90% from material experts, 95% from linguists, and 95.83% from media or learning technology experts. Teacher and student responses also indicate high feasibility, at 95.29% and 95% respectively, demonstrating that the Assemblr Edu–based LKPD is engaging, practical, and capable of enhancing students’ motivation in geography learning. The product is accessible via smartphones and laptops, supporting its usability in digital learning environments.

Despite these positive results, the study is limited by its implementation in a single school context and its focus on a single instructional topic, which may constrain the generalizability of the findings. Therefore, future research is recommended to expand the trial across

multiple schools and curriculum topics, and to examine long-term learning impacts to strengthen the broader applicability of the Assemblr Edu–based LKPD.

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