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Development of indigenous knowledge-based teaching materials on water cycle topic

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ABSTRACT

This study aims to develop indigenous knowledge-based teaching materials on water cycle topics. The method used in this research is the type II developmental research consisting of the exploration and evaluation stages. The developed materials are intended to integrate local cultural perspectives with scientific concepts to enhance student understanding and engagement. This research was conducted in two cycles of evaluation. The analysis combined quantitative validation and readability tests, showing the instructional materials were valid and easy to understand, with qualitative feedback from validators guiding improvements. The results of the development of teaching materials were tested for validity by 5 validators, readability was tested to sixteen students using the gap test. Based on the research results, the validation value for the development of the teaching materials was 4.36 which falls into the very valid category. The readability test results were 91.17% and when converted using Bormuth criteria, it means that the product is easy to understand. In conclusion, this teaching material applies to junior high school students, particularly the water cycle topic. It is recommended to implement the indigenous knowledge-based teaching materials on the water cycle in junior high schools, as they have been validated as very effective and easy to understand.

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INTRODUCTION

Water is essential for living things on Earth since any of their activities depended on the availability of water (UN, 2023; Wang et al., 2019). The availability of water on earth is around 1,386 million km 3, 97.5% of which is salt and only 0.8% of which is fresh water that is not ice in the poles (Kodoatie & Widiarto, 2016) . Fresh water availability is much lower compared to saltwater, even though it is the water that is usable for everyday life (Mishra, 2023). If water use is not maximally done, then the earth will experience water scarcity (He et. al., 2021; Rahmasary et al., 2021).

Given the pressing issue of scarce access to clean water projected for future Indonesians (Nugroho et al., 2022; Adhariani, 2021), it becomes imperative to enhance public awareness and understanding of water conservation efforts (Mulyana & Prasojo, 2020). Despite efforts to raise awareness, there remains a significant gap in understanding among the populace regarding the intricacies of Earth's water systems (Novic et al., 2022). Addressing this knowledge gap through effective educational interventions, including comprehensive teaching materials on the water cycle, is crucial for fostering a culture of water conservation and ensuring the sustainability of water resources for future generations (Santos et al. 2023).

The community's understanding of the water cycle, shaped by their local experiences and knowledge, is linked to their limited awareness of water supply. According to Meilinda et al. (2023), misconceptions about the water cycle are common despite being considered a straightforward subject in schools. For instance, some students incorrectly believe that water is always abundant, influenced by Indonesia's tropical climate, which brings continuous rain and frequent flooding. A study found that junior high school students often misunderstand key water cycle processes like evaporation, condensation, and dissolution (Ben-zvi-Assarf and Orion, 2005; Lee et al., 2019; Ursavas & Genç, 2021). Many students fail to see the connection between atmospheric and underground water cycles, mistakenly view underground water as static, and do not link ocean size to regional rainfall. Further confirmed that misconceptions about the water cycle (Suharto et al., 2019)

In other words, misunderstandings prevent students from successfully learning new material (Irani et al., 2020). misunderstandings act as barriers to the acceptance and assimilation of newly learned knowledge. Misconceptions can be brought on by some things, including the education that students receive from their teachers, the knowledge they gain from books, and the early knowledge that children acquire from their immediate surroundings (Ginting et al., 2022; Nisa' et al., 2022; Yuliati, 2017). Indigenous knowledge refers to environmental information that is understood and passed down from generation to generation in traditional societies. Knowledge can contribute to misunderstandings in addition to influencing student learning outcomes and creativity (Pamungkas et al., 2017).

A study finds that there is a connection between pupils in junior high schools and Indigenous knowledge; as a result, Indigenous knowledge cannot be disregarded (Meilinda et al., 2023). The creation of instructional materials is one technique to rectify students' misconceptions. The study will examine the creation of instructional materials based on indigenous knowledge using the Model of Education Reconstruction (MER), which helps students understand it by contrasting it with knowledge gleaned from the outside world, particularly traditional knowledge (IK). As a result, it is essential to create educational materials on the water cycle to broaden and increase students' knowledge. The study conducted is anticipated to be beneficial for science class VII in KD 3.10. describing the earth's layers, volcanoes, earthquakes, and risk-reduction techniques before, during, and after a disaster based on the local threat level. The study provides a valuable framework for developing culturally relevant curriculum materials. Other researchers can adapt this framework to incorporate indigenous knowledge into various scientific and non-scientific topics, promoting a more inclusive and diverse educational approach.

METHODS

Research Design

This study employed the Richey & Klein (2005) Type II of development research, which consists of two stages: the exploration stage and the trial stage. The Model of Educational Reconstruction (MER) structure developed by Duit et al. (2012) was the foundation for the Seels & Richey (1994) framework used in this study. It was done in three accredited (types A, B, and C) SMPs (Junior High Schools). The research was conducted from October 2021 to February 2022. The initial data collection during the

exploratory stage was completed in October 2021, followed by readability testing and validation data collection in February 2022.

Subject

102 students from 3 accredited A, B, and C schools served as the research subjects for the exploratory part of the misconceptions test. Due to data collecting taking place in odd semesters at this point, the research subjects were class VIII pupils. Additionally, 16 students, from an A-accredited school, served as the research subjects for the readability test's trial phase.

Instrument

The research instruments used were validation sheets and gap test sheets. The validation instrument consists of material, presentation, and language aspects, each of which is assessed using several indicators on a scale of 1-5 in Table 1. Validation sheets were given to 5 validators consisting of 3 lecturers and 2 subject teachers.

Table 1
Validation instrument for assessing water cycle teaching materials

No	Aspect	Indicator
1	Material	In accordance with applicable KI and KD
		The order of the material is clear
		The assignment form/instructions are written clearly
		Local materials support the water cycle topic
		According to students' needs
		In accordance with the needs of teaching materials
		Presentation of material substance is correct and accurate
		Useful in increasing insight
2	Presentation	Goals and indicators are presented clearly
		Providing motivation and attraction for students
		Placement of titles and images according to the material
		Contains complete information
		There are practice questions according to misconceptions
		There is a table of contents
		There is a list of terms
		Include sources clearly
3	Language	In accordance with Indonesian language rules (EYD)
		Use effective and efficient language
		Use interactive language
		Use language that is appropriate to the development of students
		The language used is easy to understand
		Contains clear information
		Use terms according to the concept

The validator filled out the validation sheet with the available scale. A column of comments and recommendations for improving instructional materials was located after the validation page. Students then completed the gap test sheet. This sheet was important for determining whether the developed instructional materials were straightforward for students to understand.

Procedure

Stage 1: Exploration

To formulate propositions, an examination of science material was performed in the exploration stage using textbooks based on the Core Competencies and Basic Competencies that pertain to the updated 2013 curriculum with the theme of the water cycle. Furthermore, a study of the students' conceptions was performed to identify the misconceptions that arise, so that they might subsequently provide practical concepts in the construction of instructional materials.

Stage 2: Trial

During the trial stage, the activities performed included examining the design and evaluating the learning environment by designing instructional materials, learning activities, and their sequence. The data collected during the investigation stage is utilized to create training materials based on indigenous knowledge (preliminary construction). The validator subsequently validates the produced instructional materials, yielding the findings of the validation as well as criticism and suggestions (final construction). Trials were carried out on 16 class VII students after the teaching materials were improved based on feedback and recommendations from the validator, giving rise to the term "cycle process," which means the accumulation of field trials on a small number of students (Akker et al., 2006). The procedure can be seen in Figure 1.

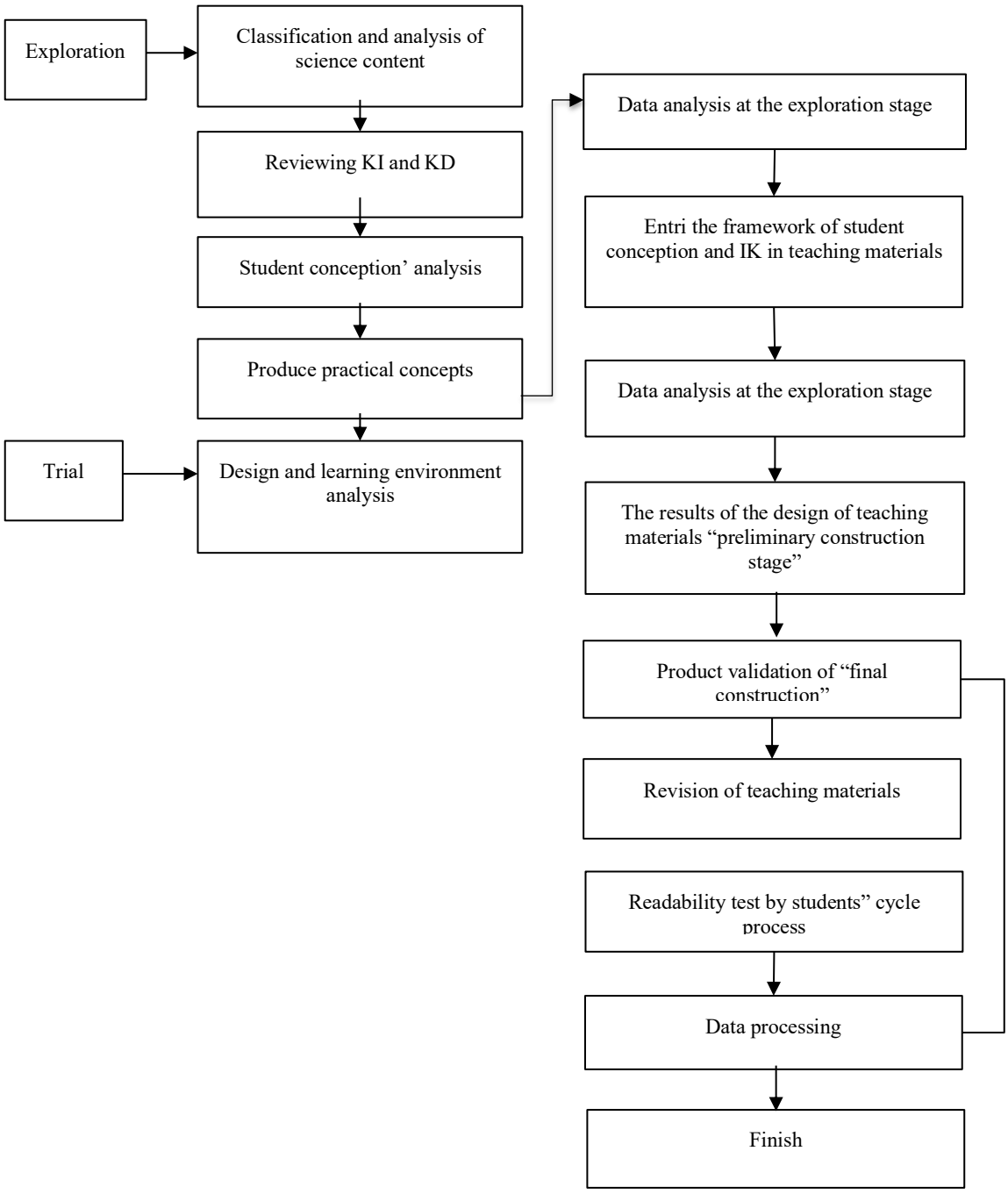


Figure 1. Research Procedure

Data Analysis Techniques

1. Quantitative Data

Quantitative data contains validation and readability test results. The validation sheet contains 5 assessment categories. The validation score categories: "Very Good," "Good," "Fair," "Poor," and "Very Poor." Each category is associated with specific assessment alternatives, ranging numerically from 5 to 1. This categorization scheme serves as a standardized framework for evaluating the quality and validity of assessed materials or processes, providing clarity and consistency in assessment practices (Sugiyono, 2011). Validation sheets were distributed to five validators, which included three lecturers and two teachers. The data acquired from the validation findings were then averaged and transformed to the format shown in Table 2.

Table 2

Conversion of Validation Score

Achievement level	Percentage	Quality	Validation Category
4.1 – 5	0 – 20 %	Very Good	Strongly valid
3.1 – 4	21 – 40 %	Good	Valid
2.1 – 3	41 – 60%	Fair	Fairly valid
1.1 – 2	61 – 80%	Poor	poorly valid
0 – 1	81 – 100%	Very Poor	Very poorly valid

Source: Riduwan (2005)

Following the receipt of the validation findings, adjustments were made in response to the validator's comments and suggestions. The results of the correction of the teaching materials were then used to create a gap test to determine the percentage value of the readability test of the teaching materials. The gap test sheet was distributed to 16 class VII students to determine the readability of the developed instructional materials. The average percentage value of the readability test of instructional materials was transformed as stated in Table 3 using Bormuth's criterion (Widodo, 1995).

Table 3

Conversion Readability Test Score

Percentage	Criteria
< 37%	Teaching materials are difficult to understand
37% - 57%	Teaching materials have met the readability requirements
>57%	Teaching materials are easy to understand

Validity and readability tests were used in data collection. Data analysis procedures included the conversion of quantitative data in the form of validation and readability test results. In addition, qualitative data in the form of validator comments and suggestions, as well as readability test results, were descriptively evaluated.

2. Qualitative Data

Validator comments and suggestions on teaching material validation sheets provided the qualitative data. It also included descriptive analyses of the outcomes of validity and readability testing.

RESULTS AND DISCUSSION

Water cycle material was included in indigenous knowledge-based teaching materials based on students' misconceptions. Valid teaching materials were developed as a result of research into teaching materials development. This study was undertaken in two stages: exploration and trial. In the exploration stage, researchers delved into the cognitive processes underlying students' misconceptions, conducting thorough analyses to inform targeted interventions.

The exploration stage is the initial stage in which appropriate KI and KD were selected for the water cycle material during the exploration stage, specifically KD 3.10 explaining the layers of the earth, volcanoes, earthquakes, and risk mitigation actions before, during, and after a disaster based on the threat of disasters in the area. Apart from that, propositions were developed at this point based on textbooks that became the research reference, particularly general biology books by Neil A. Campbell and Jane B. Reece and supported by the book Menjaga Kedaulatan Air by Robert J. Kodoatie and Widiarto

(2016). The results of the students' misperception test were acquired once the proposition had been prepared. Figure 2 depicts the resulting hypotheses and misconceptions.

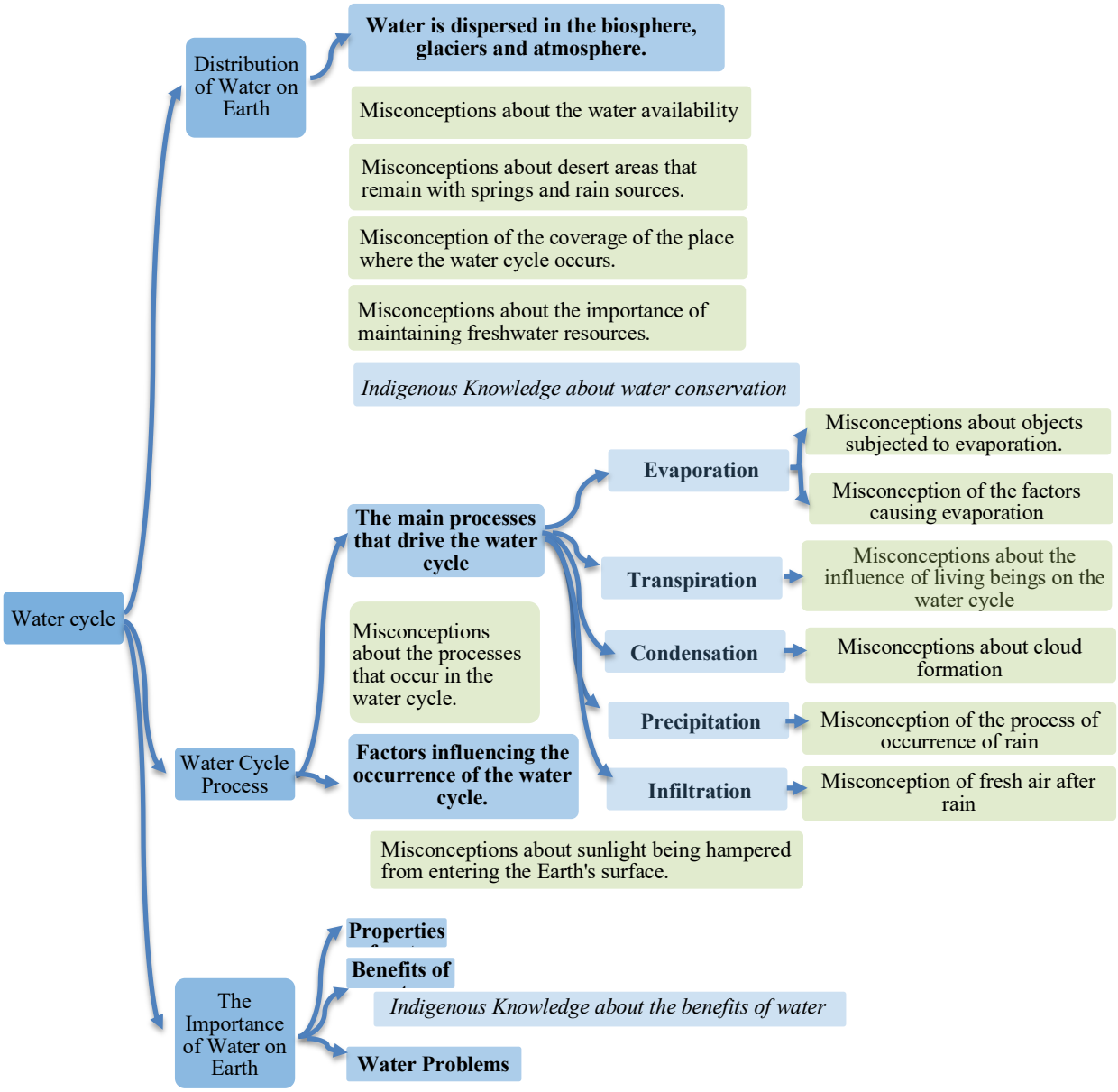


Figure 2. Propositions and Misconceptions Chart

The following stage was development (trial). The trial phase produced a design for developing teaching materials that included titles, prefaces, table of contents, proposition and misconception charts, instructions for using teaching materials, learning competencies, learning objectives, learning materials, summaries, competency tests based on misconceptions, glossary of terms, bibliography, index, and author identity. According to the Ministry of National Education (2008), instructional materials should comprise titles, study guides, KD, activities, and assessments. At this point, the results of the validation of teaching materials were also acquired, indicating that the teaching materials generated were classified as very valid.

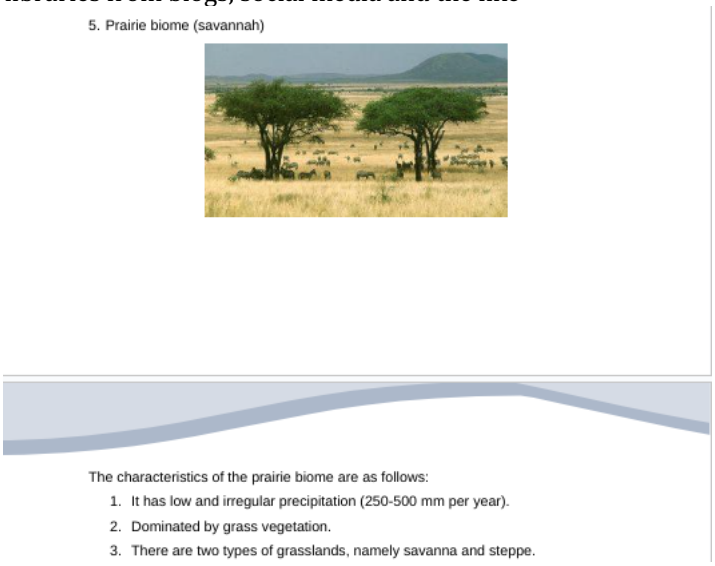
Table 4
Validator Teaching Materials Validators

No.	Validator	Achievement	Category
1	Lecturer I	4,35	Strongly Valid
2	Lecturer II	4,57	Strongly Valid
3	Lecturer III	4,13	Strongly Valid
4	Teacher I	4,22	Strongly Valid
5	Teacher II	4,52	Strongly Valid
	Mean	4,36	Strongly Valid

The validation results presented in Table 4 which were carried out by a panel consisting of 5 experts consisting of 3 lecturers and 2 teachers produced an average validation score of 4.36 with the material category being "very valid". This shows that the teaching materials developed meet the language, media and content qualification criteria. A high validation score indicates that the material is suitable and effective for use in the learning process. The validation process involves scrutiny by field experts to ensure that the materials align with educational standards and pedagogical principles. With these validation achievements, it can be concluded that teaching materials are well-designed, comprehensive, and reliable resources to facilitate student learning. They are ready to improve the quality of teaching and positively contribute to students' educational experience (Toy et al., 2018). Therefore, educators can confidently utilize these materials in their teaching practice, knowing that they have been thoroughly validated and deemed suitable for use in educational settings. Achieving valid validation is very important because teaching materials will be used during the learning process to achieve learning objectives (Setianita et al., 2023)

After obtaining the validation results of teaching materials, revisions were made based on comments and suggestions from the validator. Criticism and suggestions from the validator are contained in Table 5.

Table 5
Comments and Suggestions from Validators

No.	Validator	Comments and Suggestions
1	Lecturer I	1. Errors in writing letters in the source please be corrected 1. The title of the proposition should be changed to “Chart of Propositions and Misconceptions” 2. Please correct the word affix Pay attention to spacing and paragraphs 3. Adjust the proportions of the image 4. Avoid libraries from blogs, social media and the like
2	Lecturer II	 5. Avoid truncated typing 6. Improve the writing of the bibliography in the body text and bibliography

No.	Validator	Comments and Suggestions
		7. It is better to include the supervisor's name as the next name if there is brainstorming from the supervisor 8. At the end it is okay to add the author's identity
3	Lecturer III	It is necessary to add material related to indigenous knowledge that is more detailed or provides an earlier explanation regarding indigenous knowledge, examples of its application in people's lives and how it is sustainable
4	Teacher I	Add basic competence 4.10 and learning objectives must contain A, B, C and D.
5	Teacher II	Teaching materials based on indigenous knowledge on the topic of the water cycle are good and can be used in the learning process.

Based on the feedback from validators, revisions were made to enhance the quality of the teaching materials. Supervisor I pointed out errors in the citation format, which were corrected to ensure accuracy and consistency. Supervisor II provided several suggestions, including changing the title to "Chart of Propositions and Misconceptions," correcting affix usage, paying attention to spacing and paragraphing, adjusting image proportions, avoiding sources from blogs and social media, improving bibliography formatting, and including the supervisor's name if their ideas were incorporated. These suggestions were implemented in the revisions, along with adding the author's identity at the end of the document. Supervisor III recommended adding more detailed material on Indigenous knowledge or providing an earlier explanation of it, including examples of its application in society and its sustainability. The revisions addressed this feedback by adding detailed content on Indigenous knowledge, including explanations and practical examples.

Teacher I suggested adding basic competence 4.10 and ensuring learning objectives cover Audience, Behavior, Condition, and Degree. Revisions incorporated these suggestions by adding the required basic competence and updating learning objectives accordingly. Teacher II stated that teaching materials based on indigenous knowledge of the water cycle were suitable for use without requiring specific revisions based on their feedback. Therefore, the revisions aimed to improve clarity, accuracy, and educational value, ensuring the teaching materials are comprehensive and effective for the learning process.

After modification, the title of the proposition section is changed to "Proposition and Misconception Chart" because the chart contains both propositions and misconceptions. Then, KD 4.10 is included in the section of basic competence where the KD incorporates skill components. The learning objectives that were not initially in compliance with the learning objectives writing rules, which require elements A, B, C, and D, are changed to the writing rules, allowing the learning objectives to be more structured in the end. Furthermore, the truncated pages in the table are updated so that they are not truncated. It is supplemented in the indigenous knowledge portion by its application in everyday life, allowing students to gain a more detailed understanding of the content (Nggia et al., 2023) . Other criticisms and recommendations surround the inclusion of indexes and author identities in educational materials. The teaching materials were then examined utilizing the gap test on 16 class VII students. Table 6 shows the results of the readability test using the gap test.

Table 6
Teaching Material Readability Test Results

No.	Students	Score
1	P1	96.45%
2	P2	97.16%
3	P3	96.45%
4	P4	96.45%
5	P5	97.16%
6	P6	96.45%
7	P7	95.00%
8	P8	97.87%
9	P9	96.45%
10	P10	92.19%
11	P11	55,31%
12	P12	95.74%
13	P13	63.12%

No.	Students	Score
14	P14	93.61%
15	P15	96.45%
16	P16	92.90%
	Mean	91.17%

According to table 7, with an average readability test of 91.17% converted based on Bormuth criteria, teaching materials with a percentage value of > 57% are classified as easy to understand (Widodo, 1995). The results of a small group of learners showed an average gain of 91.17%. This means that the teaching material is qualified, so that it can be used according to the required revision.

The importance of readability tests in the development of teaching materials cannot be overstated, as they are indicators of how well information can be absorbed by learners (Fajarianingtyas et al., 2019). High readability ensures that the material taught is informative and easy to digest, which is crucial for successful learning outcomes (Sarip et al., 2022). Furthermore, the results from a small group of learners showing an average gain of 91.17% indicate that the teaching materials are not only easy to understand but also effective in enhancing students' comprehension of the water cycle. This high gain signifies a significant improvement in students' understanding after using the developed teaching materials. It demonstrates that these materials can effectively and efficiently convey information. In the context of developing indigenous knowledge-based teaching materials, integrating local cultural perspectives with scientific concepts is crucial for enhancing student engagement and understanding (Lestari et al., 2019; Pieter et al., 2023). Teaching materials that are easy to understand and effective will support this goal well, ensuring that students can connect new knowledge with their local context, making learning more relevant and meaningful.

CONCLUSION

Based on the development of indigenous knowledge-based teaching materials on the water cycle topic in junior high schools using the developmental research method. Type II, the teaching materials developed are valid and simple to understand. The materials, validated by five experts and tested for readability with sixteen students, were rated as very valid (4.36) and highly comprehensible (91.17%). Consequently, these materials are recommended for implementation due to their effectiveness and ease of understanding. As a result, the researcher suggests that other researchers carry out similar study on different themes.

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