Jurnal Inovasi Pendidikan IPA dan Etnosains (JIPIE)
Volume 1, Number 2, 2026 pp. 109-119
Open Access: https://ejournal.bbg.ac.id/jipie

NEEDS ANALYSIS FOR DEVELOPING INTERACTIVE MEDIA TO REMEDIATE TEMPERATURE AND HEAT MISCONCEPTIONS IN SENIOR HIGH SCHOOLS

Khadijah Azahra[1], Fuji Hernawati Kusumah[2]
[1,2]*Department of Physics Education, UIN Syarif Hidayatullah Jakarta*

* Corresponding Author: khadijahazahra26@gmail.com

ARTICLE INFO

Article history:
Received : 14 July 2026
Revised : 20 Aug 2026
Accepted : 21 Oct 2026
Available online : 31 Oct 2026

Keywords:
Diagnostic feedback, interactive learning media, misconceptions, remediation, temperature and heat.

ABSTRACT

Misconceptions Regarding temperature and heat are a major challenge in physics education because they can hinder students' conceptual understanding and their ability to apply concepts in everyday contexts. This study aims to analyze the need for developing interactive learning media based on immediate feedback to remediate high school students' misconceptions about temperature and heat. The study employed a convergent mixed-methods design integrating quantitative and qualitative data to obtain a comprehensive description of learning needs and existing learning conditions. Quantitative data were analyzed of the 2025/2026 academic year at three senior high schools, involving 40 eleventh-grade students selected through purposive sampling and three physics teachers as qualitative informants. Data were collected using a validated four-point Likert-scale questionnaire, semi-structured teacher interviews, non-participant classroom observations, and curriculum document analysis. Quantitative data were analyzed using descriptive percentages, while qualitative data were analyzed through data condensation, data display, and conclusion drawing and verification. The findings indicate that 97.5% of students needed learning media capable of explaining conceptual errors and providing immediate feedback, while 95.0% needed immediate responses to support independent learning. Qualitative findings identified misconceptions related to the distinction between temperature and heat, thermal expansion coefficients, and phase changes based on Black's principle. The integration of quantitative and qualitative findings indicates the need for interactive media incorporating visual material presentation, interactive activities, diagnostic questions, immediate feedback, and contextual problems. These findings provide a basis for determining the characteristics and specifications of interactive learning media for misconception remediation in temperature and heat.

This is an open access article under the CC BY-NC license.
Copyright © 2026 by Author. Published by Universitas Bina Bangsa Getsempena

INTRODUCTION

Physics learning at the senior high school level still faces challenges in developing students' conceptual understanding. Learning that emphasizes lectures and mechanical problem solving may lead students to focus on using formulas without understanding the physical meaning of the concepts being studied (Fitriyah & Kholiq, 2024). This condition can limit student engagement and hinder the development of higher-order thinking skills, which are important in science learning (Permatasari et al., 2023). Adequate conceptual understanding is essential for students to explain natural phenomena and apply physics concepts in everyday life (Hara et al., 2023). Difficulties in developing conceptual understanding are also found in thermal concepts, which are often influenced by students' prior understanding based on everyday experiences (Wiser & Amin, 2001).

Temperature and heat are among the topics that frequently cause conceptual difficulties. These concepts are fundamental because they are closely related to various phenomena in everyday life and provide a foundation for understanding advanced topics, such as kinetic theory of gases and thermodynamics (Kapul et al., 2023). Several concepts related to temperature and heat are also abstract because they involve processes at the particle level that cannot be directly observed. This condition may encourage students to rely on everyday experiences when constructing their understanding, which can develop into misconceptions (Sofianto & Irawati, 2020). Conceptual difficulties in this topic include distinguishing temperature, heat, and energy transfer (Wiser & Amin, 2001; Hitt & Townsend, 2015). Despite receiving formal instruction, misconceptions about temperature and heat are still found at relatively high levels (Asmin & Rosdianti, 2021; Tanggira et al., 2022).

A misconception refers to an understanding that is inconsistent with scientifically accepted concepts (Kapul et al., 2023). Such understanding may develop from everyday experiences, inaccurate prior knowledge, or learning processes that have not effectively corrected students' existing ideas (Firmanto et al., 2021). In temperature and heat, misconceptions may include viewing temperature and heat as the same concept, assuming that the diameter of an object decreases when it expands, and assuming that heat flows from water to iron in Black's principle (Kapul et al., 2023). Students may also assume that a substance with a higher latent heat of fusion undergoes a faster phase change (Asmin & Rosdianti, 2021). These misconceptions require attention because they can interfere with the relationships among concepts and affect students' understanding of subsequent physics topics.

The extent of this problem is reflected in findings from various learning contexts. Asmin and Rosdianti (2021) reported that 66.5% of students experienced misconceptions in temperature and heat, while only 12.3% demonstrated conceptual understanding. Tanggira et al. (2022) found that 43.4% of students experienced misconceptions at a moderate level. Meanwhile, Hara et al. (2023) reported that students' conceptual mastery was at a moderate level of 55%, with no students reaching the high conceptual mastery category. Misconceptions about temperature and heat have also been identified among students from different educational backgrounds (Gürçay & Gülbaş, 2015). These findings indicate that misconceptions in temperature and heat require appropriate and targeted remediation strategies.

Various strategies have been implemented to remediate misconceptions in physics learning. Firmanto et al. (2021) applied the *Predict-Observe-Explain* (POE) strategy assisted by video and reported a 44% reduction in misconceptions. Alfisyahrina et al. (2014) applied *Problem-Based Learning* (PBL), resulting in a 23.45% reduction in misconceptions, while Kapul et al. (2023) reported that the *Mindscaping* model reduced misconceptions by up to 85.7%. Conceptual change-oriented approaches can also help students improve their understanding of temperature and heat (Baser & Geban, 2007). Although these strategies have produced positive results, their implementation still largely depends on the teacher's role. Students have limited opportunities to independently identify conceptual errors and engage in remediation. Therefore, learning media are needed not only to present instructional content but also to help students recognize conceptual errors and receive appropriate feedback.

The development of digital technology provides opportunities to address this need. However, the use of digital media in physics learning remains suboptimal. Fitriyah and Kholiq (2024) reported that technology-based media use was dominated by *PowerPoint* at 59.46%, while the use of interactive media such as *PhET Simulation*, *e-books*, and *Quizizz* remained limited at 8.11%. Non-digital media, such as whiteboards, were also widely used, reaching 80.58%. Several studies have developed interactive media for temperature and heat, including media based on *iSpring Suite* and *Webquiz Kahoot*, which were reported to be valid and practical (Yulia et al., 2023), as well as *Physics Domino Cards*, which were effective in improving students' learning outcomes (Nuraziza et al., 2025). Digital games and computer simulations also have potential to reduce misconceptions about temperature and heat (Chaudhry et al., 2021). However, these media generally focus on content delivery, practice, or improving learning outcomes and are not specifically designed to provide remediation based on students' conceptual errors.

The research gap lies not only in the limited use of interactive media but also in the lack of integration of diagnostic and remediation functions within learning media. Previous studies have demonstrated the effectiveness of various remediation strategies and interactive media, but research specifically examining students' and teachers' needs for media that can identify misconceptions, provide feedback based on conceptual errors, and support independent remediation in temperature and heat remains limited. In addition, previous media development studies have generally focused on product design and testing, while empirical information regarding the features required by users as a basis for media development remains limited. Therefore, a needs analysis is necessary to ensure that the developed media is not only technologically interactive but also relevant to students' misconceptions and learning needs.

Based on this gap, this study aims to analyze the need for developing interactive learning media to remediate senior high school students' misconceptions about temperature and heat. The analysis covers students' misconceptions and the needs of students and teachers for media that can identify conceptual errors, provide feedback, and support independent remediation. The findings provide a basis for determining media features that integrate interactive, diagnostic, and remedial feedback functions to support the improvement of students' conceptual understanding.

RESEARCH METHODOLOGY

This study employed a convergent mixed-methods design to obtain a comprehensive understanding of the needs for developing interactive learning media to remediate misconceptions about temperature and heat. In this design, quantitative and qualitative data were collected during the same phase of the study, analyzed separately, and integrated during interpretation. The integration of both data sets enabled the researchers to compare and confirm findings from different sources, thereby providing a more comprehensive basis for determining the characteristics and specifications of the proposed learning media. The study was conducted during the second semester of the 2025/2026 academic year at three senior high schools. The quantitative participants consisted of 40 eleventh-grade students selected through purposive sampling by considering variations in academic ability. Qualitative data were obtained from three physics teachers with 1–6 years of teaching experience who served as research informants.

Data were collected using four research instruments, namely a student needs questionnaire, semi-structured interview guidelines, classroom observation sheets, and a document analysis matrix. Prior to implementation, all instruments were evaluated

through expert judgment involving three experts in physics education to assess content and construct validity. The student questionnaire demonstrated excellent internal consistency, with a Cronbach's Alpha coefficient of 0.96, indicating that the instrument was highly reliable for data collection. The first instrument was a student needs analysis questionnaire using a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1), consisting of 17 statements. The second instrument was a semi-structured interview guide for physics teachers used to obtain information about students' learning difficulties, misconceptions identified during instruction, remediation practices, and teachers' needs for learning media. The third instrument was a non-participant classroom observation sheet used to describe learning activities and the use of learning media in the classroom. The fourth instrument was a document analysis matrix used to examine the Learning Objective Flow (ATP), teaching modules, and textbooks used for teaching temperature and heat.

Quantitative data from the student questionnaire were analyzed using descriptive statistics in the form of percentages. The percentage was calculated by comparing the obtained score with the maximum possible score using the following formula:

$$P = \frac{\text{Skor yang diperoleh}}{\text{Skor maksimal}} \times 100\%$$

The results were interpreted using five categories: very high (81–100%), high (61–80%), moderate (41–60%), low (21–40%), and very low (0–20%). This analysis was used to determine the level of students' needs for interactive learning media and the characteristics of the required features.

Qualitative data from teacher interviews, classroom observations, and document analysis were analyzed through data condensation, data display, and conclusion drawing and verification based on Miles, Huberman, and Saldaña (2014). Quantitative and qualitative findings were subsequently integrated through a convergence and gap analysis process. Areas of agreement, complementarity, and discrepancy between quantitative and qualitative findings were identified to determine the actual learning conditions, expected learning conditions, and the features required in the proposed learning media. The integrated results served as the foundation for establishing media specifications and development priorities by comparing existing learning conditions with expected conditions to identify learning needs. The integrated findings were used to determine the specifications of the interactive learning media, including visual materials, interactive activities, diagnostic questions, immediate feedback, and contextual problems as the basis for the subsequent development stage.

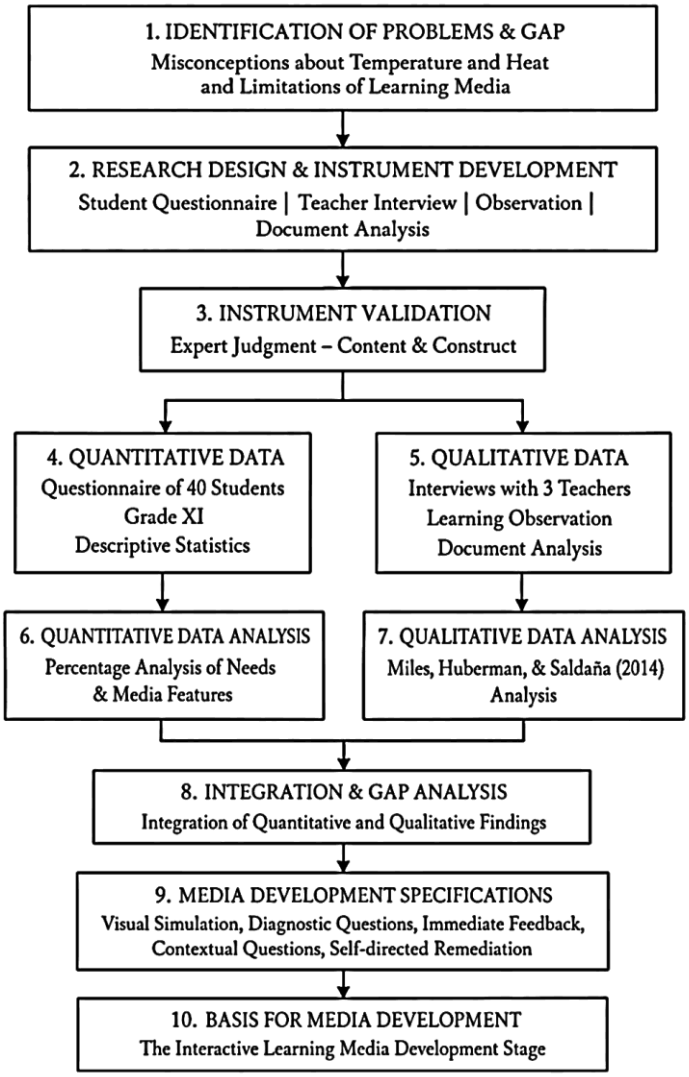


Figure 1. Illustrates the sequence of activities carried out during the needs analysis stage, from problem identification to the determination of interactive media specifications.

RESULT AND DISCUSSION

The findings were obtained from four data sources: the student needs questionnaire, interviews with physics teachers, classroom observations, and learning document analysis. These data sources were used to describe students' needs, conceptual difficulties identified during instruction, existing classroom conditions, and the availability of learning components that support misconception remediation. The findings from each data source are presented separately and then synthesized to determine the needs and characteristics of the interactive learning media to be developed.

1. Student Needs Analysis

The student needs analysis was conducted through a questionnaire administered to 40 eleventh-grade students from three senior high schools. The questionnaire consisted of 17 statements using a four-point Likert scale and was

designed to identify students' perceptions of learning and their needs for misconception remediation media. The main findings are presented in Table 1.

Table 1. Student Needs for Interactive Media Development for Misconception Remediation

No	Need Indicator	Percentage (%)	Category
1.	Need media that can explain the location of conceptual errors	97.5	Very High
2.	Need contextual explanations when making errors	97.5	Very High
3.	Need repeated conceptual explanations	95.0	Very High
4.	Need immediate responses or feedback to answers	95.0	Very High
5.	Interest in using technology-based interactive learning media	87.5	Very High

Table 1 shows that all five indicators were categorized as very high. This finding can be explained through the conceptual change perspective, which emphasizes that misconceptions cannot be corrected merely by informing students that their answers are incorrect. Students require explicit explanations that challenge their existing conceptions and guide them toward scientifically accepted concepts. Therefore, immediate feedback accompanied by conceptual explanations plays a crucial role in supporting conceptual change and misconception remediation. Meanwhile, 95.0% of students needed repeated conceptual explanations and immediate feedback, indicating the importance of responsive support during remediation.

Furthermore, 87.5% of students expressed interest in technology-based interactive learning media, indicating strong acceptance of technology in learning. Therefore, the proposed media should integrate conceptual presentation, interactive activities, and immediate feedback rather than function solely as a content delivery tool.

2. Teacher Interview

Interviews were conducted with three physics teachers to obtain information about students' learning difficulties, misconceptions identified during instruction, remediation practices, and teachers' needs for learning media. The main findings are presented in Table 2.

Table 2. Teacher Interview Findings on Misconceptions and Media Needs

Aspect	Interview Findings	Media Needs
T emperature and heat	Students have difficulty distinguishing temperature from heat and tend to associate the degree of hotness with the amount of heat	Conceptual and visual explanations of temperature and heat

Black's principle and phase changes	Students have difficulty determining the appropriate heat concept in processes involving temperature and phase changes	Process visualization and diagnostic questions
Thermal expansion	Students confuse linear, area, and volume expansion coefficients	Visual representations and contextual examples
Remediation practices	Teachers use repeated explanations and additional exercises	Structured remediation
Feedback	Individual feedback is limited by available instructional time	Immediate feedback
Technology use	Technology can support independent learning with appropriate guidance	Structured interactive media

The interviews identified difficulties in distinguishing temperature from heat, applying Black's principle to phase changes, and understanding linear, area, and volume expansion coefficients. Although teachers used repeated explanations and additional exercises for remediation, limited instructional time constrained individual support, highlighting the need for media that provides explanations and immediate responses during independent learning.

3. Classroom Observation

Non-participant classroom observations at the three participating schools showed that instruction was mainly teacher-centered, supported by presentations and simple demonstrations. The learning media primarily served to present content and example problems, while activities for diagnosing and remediating misconceptions remained limited. Some students also required additional guidance when solving problems that differed from previously discussed examples, indicating difficulties in applying concepts to new situations.

The observations further showed that individual feedback was constrained by limited instructional time. Although learning activities included materials and exercises, they did not provide a systematic remediation sequence that enabled students to identify errors, receive explanations, and retry problems independently. This finding highlights the need for more stru structured interactive remediation media.

4. Learning Document Analysis

Document analysis was conducted on the Learning Objective Flow (ATP), teaching modules, and textbooks used for temperature and heat instruction in the three schools. The analysis examined the alignment of learning content and the

availability of components supporting the identification and remediation of misconceptions.

Table 3. Learning Document Analysis Findings

Document	Findings	Identified Gap
Learning Objective Flow (ATP)	Temperature and heat content is included in the learning objectives according to the curriculum	Does not specifically include a misconception remediation strategy
Teaching modules	Include learning content, activities, and exercises	Do not provide a systematic diagnostic and remediation sequence
Textbooks	Provide conceptual explanations, examples, and exercises	Limited visualization and feedback mechanisms for conceptual errors

The document analysis showed that the ATP, teaching modules, and textbooks covered temperature and heat content and aligned with the learning objectives, but did not systematically integrate diagnostic questions, misconception identification, or feedback-based remediation. This indicates a gap between the availability of instructional content and the need for structured support for independent misconception remediation.

5. Implications for Interactive Media Development

The synthesis of the questionnaire, interviews, observations, and document analysis identified consistent needs for misconception remediation. Students needed conceptual explanations, contextual support, immediate feedback, and interactive technology, while teachers reported conceptual difficulties and limited time for individual remediation. Therefore, the proposed media should integrate visual concept presentation, interactive activities, diagnostic questions, immediate conceptual and contextual feedback, and technology-based independent learning.

This study was limited to 40 eleventh-grade students and three physics teachers from three senior high schools. Therefore, the findings may not fully represent the needs and characteristics of students in different educational contexts. In addition, this study focused exclusively on the needs analysis stage and did not evaluate the practicality or effectiveness of the proposed learning media. Consequently, further studies are required to develop, validate, and test the effectiveness of the media in reducing students' misconceptions regarding temperature and heat.

CONCLUSIONS AND SUGGESTIONS

Based on the questionnaire, teacher interviews, classroom observations, and document analysis, this study identified a high need for interactive learning media to remediate misconceptions in temperature and heat. A total of 97.5% of students needed media that could explain conceptual errors and provide contextual explanations, 95.0% needed repeated explanations and immediate feedback, and 87.5% expressed interest in technology-based interactive learning media. The interviews and observations also revealed students' difficulties with several temperature and heat concepts and limitations in providing individual remediation. Document analysis further showed that the available learning materials did not systematically integrate misconception diagnosis and remediation. Therefore, the proposed media should integrate visual concept presentation, interactive activities, diagnostic questions, immediate feedback, and conceptual and contextual explanations to support independent learning.

Based on these findings, further development is recommended to realize the media according to the identified needs and incorporate structured diagnostic and feedback mechanisms. Physics teachers may use diagnostic media as a supporting tool to identify and address students' misconceptions. Future research should conduct validation, practicality testing, and effectiveness testing to determine the quality of the developed media and its effect on reducing students' misconceptions.

BIBLIOGRAPHY

Alfisyahrina, F., Djudin, T., & Mursyid, S. (2014). Remediasi miskonsepsi siswa pada materi suhu dan kalor menggunakan model PBL di MAN. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa, 4*(2), 1–10.

Asmin, L. O., & Rosdianti, R. (2021). Analisis miskonsepsi siswa SMA Negeri 04 Bombana dengan menggunakan CRI pada konsep suhu dan kalor. *Konstan: Jurnal Fisika dan Pendidikan Fisika, 6*(2), 80–87. https://doi.org/10.20414/konstan.v6i2.93

Başer, M., & Geban, Ö. (2007). Effectiveness of conceptual change instruction on understanding of heat and temperature concepts. *Research in Science & Technological Education, 25*(1), 115–133. https://doi.org/10.1080/02635140601053690

Firmanto, F., Djudin, T., & Arsyid, S. B. (2021). Remediasi miskonsepsi siswa pada materi suhu dan kalor menggunakan strategi predict-observe-explain. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa, 10*(2), 1–10.

Fitriyah, L., & Kholiq, A. (2024). Analisis kebutuhan media pembelajaran fisika SMA berbasis teknologi dan non teknologi pada era revolusi industri 4.0. *Inovasi Pendidikan Fisika, 13*(3), 162–167.

Gürçay, D., & Gülbaş, E. (2015). Development of three-tier heat, temperature and internal energy diagnostic test. *Research in Science & Technological Education, 33*(2), 197–217. https://doi.org/10.1080/02635143.2015.1018154

Hara, A. K., Astiti, K. A., & Lantik, V. (2023). Analisis penguasaan konsep fisika pada materi suhu dan kalor pasca pembelajaran online di kelas XI SMA Negeri 12 Kota Kupang. *Jurnal Ilmu Pendidikan STKIP Kusuma Negara, 14*(2), 118–126.

Kapul, M., Lantik, V., & Astiti, K. A. (2023). Analisis miskonsepsi siswa dan alternatif remediasinya pada konsep suhu dan kalor. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia, 13*(1), 17–23.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Muttasyabiha, M., & Mufit, F. (2024). Analysis of the needs of cognitive conflict-based teaching materials integrated with augmented reality on heat. *Physics Learning and Education, 2*(3). https://doi.org/10.24036/ple.v2i3.151

Nuraziza, N., Takda, A., & Galib, L. M. (2025). Pengembangan media pembelajaran kartu domino fisika pada materi suhu dan kalor kelas XI SMA. *Jurnal Penelitian Pendidikan Fisika, 10*(1), 26–33.

Permatasari, E. C., Hermawan, A., Supriyadi, Masturi, & Linuwih, S. (2023). Efektivitas media pembelajaran audio visual berbasis Kinemaster bermuatan STEM terhadap kemampuan berpikir kritis peserta didik pada materi suhu dan kalor. *Unnes Physics Education Journal, 12*(2), 127–137.

Riduwan. (2010). *Belajar mudah penelitian untuk guru-karyawan dan peneliti pemula*. Alfabeta.

Sofianto, E. W. N., & Irawati, R. K. (2020). Upaya meremediasi konsep fisika pada materi suhu dan kalor. *Southeast Asian Journal of Islamic Education, 2*(2), 106–124. https://doi.org/10.21093/sajie.v2i2.2194

Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif dan R&D*. Alfabeta.

Tanggira, T., Subagiyo, L., & Hakim, A. (2022). High school students' misconceptions on materials of temperature and heat using three-tier diagnostic tests assisted by live worksheets. *Berkala Ilmiah Pendidikan Fisika, 10*(1), 1–8. https://doi.org/10.20527/bipf.v10i1.11378

Wiser, M., & Amin, T. (2001). "Is heat hot?" Inducing conceptual change by integrating everyday and scientific perspectives on thermal phenomena. *Learning and Instruction, 11*(4–5), 331–355. https://doi.org/10.1016/S0959-4752(00)00036-0

Yulia, R., Surahman, E., & Nana. (2023). Development of interactive multimedia using Android-based iSpring Suite and integrated web quiz Kahoot for temperature and heat material. *Jurnal Ilmiah Pendidikan Fisika, 7*(3), 544–557. https://doi.org/10.20527/jipf.v7i3.9000

Zulfira, R., Halim, A., Khaldun, I., Mahzum, E., Nazar, M., & Kasli, E. (2024). The effect of interactive learning media using Visual Basic for Application Excel spreadsheet to reduce misconception in physics learning. *Jurnal Penelitian Pendidikan IPA, 10*(1), 28–36. https://doi.org/10.29303/jppipa.v10i1.6387