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GENIALLY BASED LEARNING MEDIA USING POSNER'S CONCEPTUAL CHANGE THEORY TO ADDRESS MISCONCEPTIONS ABOUT HEAT

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Abstract :
This research aims to develop Genially based learning media and refers to Posner's theory of conceptual change to address misconceptions about heat. This development research refers to the 4D model (Define, Design, Develop, Disseminate), with respondents of SMA Negeri 2 Tanjung Jabung Barat class XI IPA students who have studied heat material. The research instruments include a five-tier diagnostic test, materials, and media expert validation sheets. Based on validation by media and materials experts, the developed product achieved excellent results, with an average score of 91.96% for media experts and 90.18% for materials experts, respectively. The effectiveness test using the Wilcoxon Signed Ranks Test method showed a significant decrease in misconceptions, with a significance value of p = 0.010 (<0.005). The novelty of this research lies in the development of Genially-based learning media, combined with Posner's Conceptual Change Theory, to reduce misconceptions specifically in heat-related material. The implication of this research shows that this media is not only effective in reducing misconceptions but also has the potential to be applied more widely in digital literacy-based physics learning, as well as a reference for developing similar media on other materials that are prone to misconceptions.

Keywords: Genially, Heat, Misconception

INTRODUCTION

Misconceptions or misunderstandings of concepts occur when students' initial understanding of concepts differs from recognized scientific concepts, leading to an incorrect understanding of new ideas and concepts (Maison et al., 2023; Nasir, 2020; Putri st al., 2020). This erroneous understanding can hinder further learning, because inappropriate initial concepts become the basis for the formation of subsequent knowledge (Sadiah et al., 2023; Yohanes et al., 2025).

Misconceptions are usually formed from incorrect personal experiences, inaccurate teacher explanations, inaccurate textbooks, ambiguous use of everyday language, or social interactions with peers (Maison et al., 2022; Rohmah et al., 2023). To identify misconceptions, diagnostic tests are used that are able to detect the location of students' misconceptions and become the basis for improving learning strategies (Maison et al., 2021; Nur et al., 2023; Rahman et al., 2019; Unaida et al., 2024).

One of the physics materials that often causes misconceptions is the temperature and heat material (Cahyaningtyas et al., 2023; Kapul et al., 2023). Based on research Yuliana et al. (2023) students experience misconceptions on temperature, heat, and heat transfer (conduction, convection, and radiation). Misconceptions that occur are not limited to one level of education, but are found at the junior high to high school level (Putri et al., 2024).

The use of inappropriate media and learning models exacerbates this problem further. Misconceptions can arise from students' initial understanding (preconceptions) and teaching methods that only emphasize the truth of one perception (Latifah et al., 2020). If not immediately reduced, misconceptions can continue to be carried to higher education levels and interfere with the understanding of advanced concepts (Ginting et al., 2022). Sustainable misconceptions, if not immediately addressed appropriately, will cause problems in further learning (Rohmah et al., 2021).

One of the efforts that can be made is to use the Conceptual Change Model, which is a learning approach that helps students change their false understanding into correct scientific concepts (Rohmah et al., 2021). According to Rachmawati et al. (2021) The use of the Conceptual Change model was successful in reducing misconceptions, resulting in a 17.5% decrease and a 0.65-point increase in the N-gain score (medium category), demonstrating the model's effectiveness in addressing misconceptions. Although the *Conceptual Change* model has been proven effective in reducing misconceptions, few studies specifically test the effectiveness of applying media integration and the model, especially for heat-related materials.

The concept change model used in this study refers to the theory developed by Posner et al. in 1982, which aims to understand students' interactions with the concepts taught and help them overcome conceptual misconceptions. According to Posner et al., (1982) four conditions must be met for conceptual change to occur, namely: (1) dissatisfaction, where students feel that the old concepts they have are inadequate to explain the phenomena studied; (2) clarity, namely the new concept introduced must be easily understood by students; (3) logicality, the new concept must appear more logical and coherent than the old concept so that it is considered reasonable; and (4) success, namely the new concept must be useful and provide benefits.

The combination of the *conceptual change* model (Posner et al., 1982) and the use of interactive digital media is believed to enhance learning effectiveness, as it presents cognitive conflict, dynamic visualization, and immediate feedback.

One of the potential media is Genially, an online learning media that can help teachers create creative and innovative teaching materials, both in the form of presentation materials, learning videos, and other forms (Enstein et al., 2022; Putra, 2023). In addition, Genially is a free online application that is able to bring learning content to life interactively and supports three student learning modalities, namely visual, auditory, and kinesthetic (Afni et al., 2024; Permatasari et al., 2021). Research by Ratniati et al. (2022) shows that Genially based learning media is considered feasible by experts, with the average validation score reaching the “Feasible” to “Very Feasible” category.

Based on this description, this research aims to develop Genially-based interactive learning media using Posner’s Conceptual Change Theory approach to address misconceptions about heat. It is expected to contribute to efforts to improve the quality of physics learning, especially in terms of improving students' conceptual understanding.

RESEARCH METHOD

Research Design

This research employs the research and development (R&D) method to create new learning media in the form of Genially media, grounded in Posner’s conceptual change theory on heat material. The development model used is a 4D model proposed by (Thiagarajan, 1974), which includes the stages of Define, Design, Develop, and Disseminate. The reason for choosing the 4D model is that this model is very simple, but in its procedures, it contains all aspects that exist in other development models, and its implementation is systematic (Idiajir et al., 2021).

Research Target/Subject

Respondents in this study were students of SMA Negeri 2 Tanjung Jabung Barat class XI IPA who had learned the heat material. The sampling technique used was purposive sampling, with the criteria of students who have completed learning the material in class. The instruments used in this research include a five-ti*er* diagnostic test to identify misconceptions, validation sheets from material and media experts, and literature studies for needs analysis.

Research Procedure

The research procedure begins with the define stage, which involves initial analysis to identify student misconceptions through literature studies, task analysis to understand the material's scope, concept analysis to determine key concepts prone to misconceptions, and analysis of learning objectives to formulate learning indicators. At the design stage, the storyboard is created and the appropriate Genially media format is selected, based on the characteristics of the material and the student's characteristics. The development stage involves the development of learning media, product validation by material experts and media experts, product revision based on feedback, and limited trials on small groups of students. The trial design used was a one-group pre-test-post-test design. The reason for using this research design is that there is only one group or class used in the research, so there is no group used as a comparison group (Sriyanti et al., 2021; Yuliana et al., 2021). Students were given a pre-test before treatment and a post-test after using learning media to measure the reduction of misconceptions.

Instruments and Data Collection Techniques

The instruments used in this study consisted of diagnostic tests, expert team validation sheets, and pre-test and post-test questions. The diagnostic test used is in the form of a five-tier diagnostic test, which aims to identify students' misconceptions on heat material. This instrument was adopted from Maison et al. (2019), which has been tested for validity and reliability. Researchers adopted eight pre-test questions and eight post-test questions. The sub concepts in the heat material that were found to have misconceptions were then used as the basis for developing Genially learning media based on Posner's theory of conceptual change.

Data analysis technique

The data collected includes the results of validation by material and media experts, as well as the results of limited trials involving students. The trial was conducted in three stages: pre-test, use of Genially-based learning media, and post-test. Quantitative data analysis was conducted to identify students' misconceptions using the Five-Tier Diagnostic Test. Each student's answer was analyzed from the first to the fourth tier to calculate the average percentage of misconceptions in each sub concept. The category of student understanding was determined based on the classification of answers, while the percentage of misconceptions was calculated using the formula:

$$\boldsymbol{P = \frac{f}{n} x 100\%}$$

Based on this percentage, the student misconceptions are categorized as follows.

Table 1. Misconception Percentage Categories

Percentage	Category
0 % - 30 %	Low
31 % - 60 %	Medium
61 % - 100 %	High

Additionally, quantitative data analysis is employed to process the results of validation questionnaires from media experts and material experts. The questionnaire instrument uses a Likert scale, with four answer options. The Likert scale used in the preparation of research instruments can be made in the form of checklists or multiple-choice choice (Widodo et al., 2023).

Table 2. Likert scale

Answer Scale	Value
Disagree	1
Less Agree	2
Agree	3
Strongly Agree	4

The percentage of questionnaire results is calculated using the formula

$$P = \frac{\Sigma R}{N} \times 100\%$$

Based on the results of the percentage, the level of validity of the product is classified

Table 3. Criteria for the Validity of Questionnaire Data

No	Achievement level (%)	Qualification
1	81-100%	Very good
2	61-80%	Good
3	41-60%	Good enough
4	21-40%	Not Good

Furthermore, to measure the effectiveness of using learning media, the Wilcoxon Signed-Rank Test was employed. The Wilcoxon test is one of the non-parametric statistical tests used to test whether there is a significant difference between the same two conditions in the pre-test and post-test samples (Alya Mukhbita et al., 2025; Muhid, 2019) .

Qualitative data analysis was conducted on input from validators, including comments, criticisms, suggestions, and recommendations related to content improvement, media design improvement, and other technical suggestions. The descriptive analysis technique was used to categorize the data based on the type of input given. The results of this analysis served as the basis for revising and improving Genially-based learning media before further trials were conducted.

RESULTS AND DISCUSSION

This development research produces a product in the form of Genially learning media based on Posner's conceptual change theory to address misconceptions about heat. The teaching materials are also equipped with five-tier questions as an instrument to analyze students' misconceptions on heat. This test can also monitor student learning progress because its scores are valid and reliable, enabling it to measure the percentage of students who understand the material. In this test can also distinguish between students who experience misconceptions and do not understand the concept (lack of knowledge), with the addition of student confidence questions, from the previous question (Leoni, L., Maison, M., & Muslim, 2020). The model used in this study is 4D, consisting of 4 stages, namely: (1) Define, (2) Design, (3) Develop, and (4) Disseminate.

Define

At the Define stage in the development of Posner's Conceptual Change Theory-based Genially learning media on heat material, several important steps are taken to support the effectiveness of the developed media. Initial analysis was conducted through a literature study to identify students' misconceptions. A task analysis was conducted to ensure the suitability of the material in relation to basic competencies, particularly in the concepts of temperature, heat, and heat transfer, aiming to reduce misconceptions through an interactive presentation. Furthermore, the concept analysis focuses on sub concepts such as temperature changes during shape changes, heat transfer mechanisms, and the effect of color on heat absorption, which will be presented through animations, simulations, and digital experiments. Finally, the goal analysis identified learning indicators that emphasized reducing

misconceptions and enhancing conceptual understanding through active and exploratory learning, utilizing visual and interactive approaches.

Design

The design stage in the development of this learning media aims to create Genially based interactive media integrated with Posner's Conceptual Change Theory to reduce student misconceptions about heat material. Broadly speaking, this design stage includes three steps, namely media selection, media format selection, and initial media design (Rahmi et al., 2021).

The eligibility criteria were prepared referring to the material and media expert validation indicators, which included substance aspects such as content conformity with basic competencies, concept accuracy, clarity, and depth of material, as well as design aspects such as display aesthetics, interactivity, ease of use, and visual appeal. These criteria are designed so that the media not only meet the requirements of correct content but also captivate students' attention and facilitate understanding through interactive visualization.

The media format was designed to present the material in a systematic and engaging manner. The arrangement of content combines various interactive elements to help students understand the main sub concepts that are prone to misconceptions, such as temperature changes during shape changes, heat flow, the effect of temperature on heat flow, and the effect of color on heat absorption. The presentation of the material is developed based on Posner's conceptual change steps, starting with raising dissatisfaction with the initial understanding, providing clarity and logicality to new concepts, and emphasizing their usefulness in everyday life. Evaluations were included to measure student understanding after using the media, and content development was carried out directly in Genially by utilizing the various interactive features available. Finally, the initial design of the media was organized in the form of a table detailing the structure of the display and content, as a guide for media development to support the correction of students' misconceptions about heat.

Through this systematic design, the learning media produced is expected to help students identify, evaluate, and correct their misconceptions while creating an interesting and meaningful learning experience.

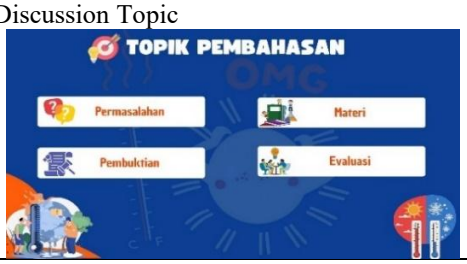
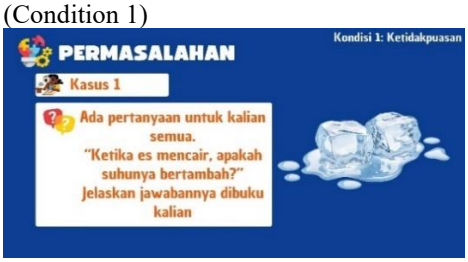
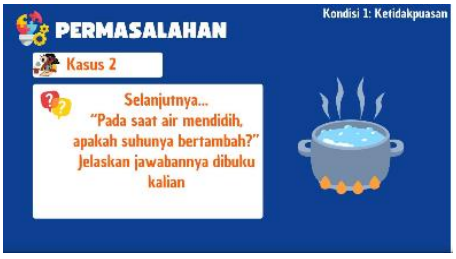
Develop

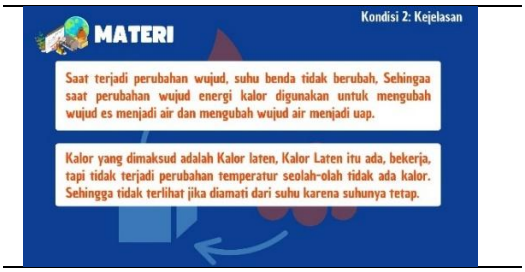
The development stage is the stage of producing development products. This stage is carried out through two steps, namely expert assessment, followed by revision, and development trials (Mesra, 2023; Winaryati et al., 2021). The author develops the form of Genially learning media from its initial design into a learning medium ready for use in learning activities. This media was developed comprehensively in accordance with the research objectives, specifically to reduce student misconceptions. The process of developing this learning media is carried out through several steps, including designing initial layouts, creating accounts and accessing the Genially platform, and compiling media within Genially.

At this stage, the initial design begins with creating a media design that includes an introductory section, such as the title of the material and a content structure that outlines the stages of conceptual change according to Posner's theory. To create an account and access the Genially platform, users visit the official Genially website at www.genially.com and register by selecting the "Sign Up" option. At this stage, users select the "Teacher" category and can register using a Google, Microsoft, Facebook account, or an active email address.

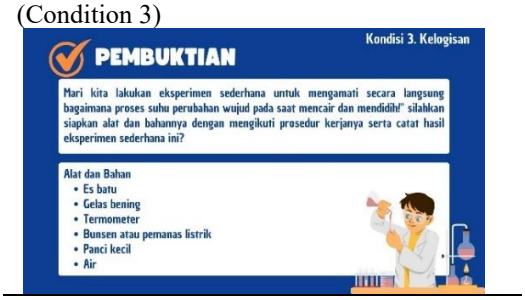
Media development in Genially begins after the account is successfully created. Users then choose "Create blank" to start a new project. Users can start designing the overall appearance of the learning media. Furthermore, interactive elements such as icons and navigation buttons are added through the menu "Resources" and interactivity is set using the "Add interactivity" feature, such as "Go to page". Each page is organized according to Posner's conceptual change structure, which includes cognitive conflict, explanation of new concepts, reinforcement through scientific evidence, and application in everyday life. After completing the initial design of the learning media, researchers evaluated the feasibility of the product through a validation process that included assessments of both the media and materials. The following is an example of Genially learning media, which is organized according to Posner's theoretical structure.

Table 4. Media Display

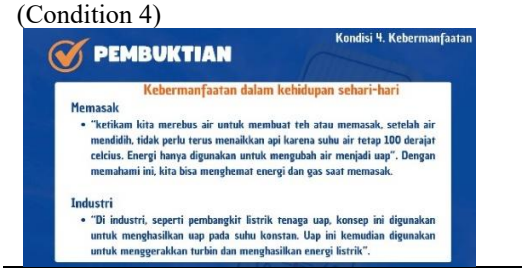
Media Display
Cover 
Discussion Topic 
(Condition 1)    
(Condition 2)



(Condition 3)



(Condition 4)



Closing

Product Validation

The validation activity involved 2 lecturers of Physics Education at Jambi University. This validation was carried out 2 times. Collecting data on the validator's assessment of the product developed using a questionnaire with a Likert scale. The results of the validation of media experts and material experts at stage I are shown in Tables 5 and 6, respectively, as follows:

Table 5. Results of Phase I Media Expert Validation

No	Appraiser	Percentage	Category
1	Validator 1	62,50 %	Good
2	Validator 2	78,57 %	Good
Average		70,54 %	Good

Table 6. Results of Phase I Material Expert Validation

No	Appraiser	Percentage	Category
1	Validator 1	48,21 %	Good enough
2	Validator 2	69,64 %	Good
Average		58,93 %	Good enough

Based on Table 5, the first validation process of the learning media developed has been deemed suitable for research, but requires minor revisions. Based on Table 6, the first validation

process of the learning media material developed is deemed sufficient for research purposes, although it requires numerous revisions.

Furthermore, researchers revised the product based on comments and suggestions from validators at the first validation stage, as well as various inputs received from both media experts and material experts. From the media expert's side, it was suggested that the media display be made more organized and neat, the placement of visual elements be clarified, the use of fonts and colors be made consistent between pages, and navigation be added to make it easier for users to access content. Meanwhile, feedback from material experts was provided to make the instructions more straightforward to understand. The material was explained in more detail and structured, with explanations of concepts clarified through examples. Emphasis was placed on the differences in concepts that often lead to misconceptions. Additionally, it was suggested to use communicative and straightforward language to make the content easier for students to understand.

After making revisions based on the suggestions of the validators, the researchers conducted phase II validation activities. The results of the validation of media experts and material experts in stage II are shown in Tables 7 and 8, respectively, as follows:

Table 7. Results of Phase II Media Expert Validation

No	Appraiser	Percentage	Category
1	Validator 1	94,64 %	Very Good
2	Validator 2	89,29 %	Very Good
Average		91,96%	Very Good

Table 8. Results of Phase II Material Expert Validation

No	Appraiser	Percentage	Category
1	Validator 1	92,86 %	Very Good
2	Validator 2	87,50 %	Very Good
Average		90,18%	Very Good

Based on the results of Phase II validation, as listed in Tables 7 and 8, the learning media developed have been rated as very good (feasible) and are ready to be tested without requiring further revisions.

Product Trial

Product trials were conducted to evaluate the effectiveness of Genially learning media, developed based on Posner's Conceptual Change Theory, in addressing misconceptions about heat. This study involved a population of 110 students of class XI IPA, with a trial sample of 33 students. The trial process involved administering an initial test (pre-test) and a final test (post-test) to assess students' understanding of concepts before and after using the learning media. The results of the two tests were analyzed to determine the percentage increase in concept understanding and the percentage decrease in misconceptions experienced by students.

Product Effectiveness Test Results

The effectiveness test using the Wilcoxon Signed Rank Test aims to measure the effectiveness of using learning media.

Table 9. Effectiveness Test Results

Test Statistics[a]

	Post-test - Pre-test
Z	-2.566[b]
Asymp. Sig. (2-tailed)	0,010
a. Wilcoxon Signed Ranks Test	
b. Based on positive ranks.	

Based on the data in the table, the Z-statistical value of -2.566, with a significance level of 0.01 ($p < 0.05$), indicates that the decrease in misconception scores from pre-test to post-test is

statistically significant. This indicates that the learning intervention provided succeeded in reducing students' misconceptions significantly.

Comparison of the Percentage of Pre-test and Post-test Misconceptions

The results of the comparison between the pre-test and post-test percentages of misconceptions are used to assess the extent of the decrease in student misconceptions after using Posner's Conceptual Change Theory-based Genially learning media. Based on the table, there is an increase in the percentage of concept understanding on all questions tested, as indicated by the increasing number of students who correctly understand the concept in the post-test compared to the pre-test. This shows that the learning media developed is effective in reducing students' misconceptions about heat material.

Table 10. Percentage of Pre-test and Post-test Misconceptions

Description of Misconceptions	Percentage of Misconceptions		% Mis	Description
	Pre-test	Post-test		
M1	69.70	24.24	45.45	Misconceptions Reduced
M4	30.30	33.33	-3.03	Misconceptions Increase
M5	6.06	6.06	0.00	-
M7	3.03	0.00	3.03	Misconceptions Reduced
M8	9.09	0.00	9.09	Misconceptions Reduced
Average	23.64	12.73	10.91	Misconceptions Reduced

The data showed variation in the change in students' misconception level after the learning intervention. In M1, there was a significant decrease from 69.70% in the pre-test to 24.24% in the post-test, reflecting the effectiveness of learning in reducing misconceptions. This finding aligns with the principle of constructivism, which emphasizes the importance of learning that facilitates the construction of a correct understanding. In contrast, in M4, the misconception rate increased from 30.30% to 33.33%, possibly due to the complexity of the material, which triggered a high cognitive load. In M5, the misconception rate remained stable at 6.06%, indicating that students already had the correct understanding beforehand. Meanwhile, a significant decrease occurred in M7 and M8, by 3.03% and 9.09 respectively. Overall, the average misconception rate decreased from 23.64% to 12.73%, representing a 10.91% decrease, which indicates the effectiveness of the implemented intervention.

The results of this study indicate that Genially-based learning media, combined with Posner's Conceptual Change Theory approach, are effective in reducing student misconceptions about heat material. The effectiveness test revealed an increase in conceptual understanding, although some questions showed a corresponding increase in misconceptions. This finding is in line with the results of research by Yuliana et al. (2023), which shows the high level of student misconceptions on the concept of heat, and supports the results of research (Hasanah et al., 2024; Miranda et al., 2024), which reveals that interactive media, such as Genially, can increase engagement and understanding of concepts in greater depth than conventional methods.

The level of misconception reduction varied between submaterials. In problem M1 related to temperature changes during state change, there was a significant decrease in misconceptions. However, an increase in misconceptions was detected in question M4 regarding heat flow and the effect of temperature, indicating difficulty in distinguishing between the concepts of temperature and heat, presumably due to a high cognitive load. In question M5, the results showed the stability of students' correct understanding from the beginning. In contrast, questions M7 and M8 (the effect of color on heat absorption) revealed a significant decrease in misconceptions, indicating the effectiveness of interactive media in supporting metacognitive reflection and improving understanding.

The factors causing misconceptions in heat material can be attributed to students' limited understanding of the relationship between temperature and shape change, the difference in the concepts of temperature and heat, and the principle of heat absorption based on color. Therefore, a

more concrete approach is needed, such as the use of simulations, virtual experiments, and interactive illustrations to facilitate conceptual change effectively.

Overall, although there are still challenges in reducing misconceptions in some sub concepts , Genially learning media, based on Posner's Conceptual Change Theory, has been proven to improve student understanding and reduce misconceptions significantly. Optimization of this media requires input from material and media experts, as well as the development of interactive features that better cater to students' cognitive needs.

CONCLUSION

The conclusion of this study reveals that the use of Genially-based learning media, grounded in Posner's theory of conceptual change, is effective in reducing students' misconceptions about heat. This interactive media effectively reduces students' misconceptions, particularly regarding the concepts of temperature change and heat transfer, as well as the impact of color on heat absorption. This result is significant because it demonstrates that interactive media-based learning technology can provide an effective solution to address misconceptions that frequently arise in complex physics concepts. This research also makes a significant contribution to enriching the educational literature, particularly in the context of technology applications in physics learning. The excellence of this research lies in its application of conceptual change theory, which has proven effective in the context of physics education at the secondary school level, an area that has been less explored in the international literature. For further research, it is recommended to test the effectiveness of Genially based media on other physics materials that are also prone to misconceptions, and involve a wider and more diverse sample, so that the research results can be generalized.

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