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Development of an SNI-Based Earthquake-Resistant Miniature House Model as a Structural Educational Medium

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Abstract

Indonesia is a country with high earthquake activity and earthquake-resistant buildings are needed. Residential building capabilities are required to remain safe during earthquakes is no longer merely a technical discourse, but a real need that touches people's daily lives. This study uses the R&D (Research and Development) research type with the object of research being a simple house miniature media based on SNI 2847:2019. The validity of the SNI-based earthquake-resistant house miniature model as a structural education medium is in the valid category. The validation results by material experts show an average value of 0.82 with a valid category, while the validation results by media experts show an average value of 0.93 which is also in the valid category. Thus, the developed learning media has met the eligibility criteria for use in the Basic Practice of Stone and Concrete course. The practicality level of the SNI-based earthquake-resistant house miniature model as a structural education medium is in the very practical category. This is indicated by the results of the student response questionnaire which obtained an average value of 97%, which indicates that the learning media is easy to use, useful, and able to support the practical learning process.

Keywords : *Miniature, House, Earthquake, Construction*

Abstract

Indonesia is a country with high seismic activity, therefore, earthquake-resistant buildings are essential. Therefore, the ability of simple residential buildings to maintain their safety during earthquakes is no longer merely a technical issue, but a real need that impacts people's daily lives. Research This use type R&D research (Research and Development) with object study is a miniature media House simple based on SNI 2847:2019. The validity of the SNI-based earthquake-resistant miniature house model as a structural educational tool is categorized as valid. Validation results by material experts showed an average value of 0.82, categorized as valid, while validation results by media experts showed an average value of 0.93, also categorized as valid. Therefore, the developed learning media meets the eligibility criteria for use in the Basic Stone and Concrete Practice course. The practicality of the SNI-compliant earthquake-resistant miniature house model as a structural education tool is highly practical. This is demonstrated by the results of the student questionnaire, which obtained an average score of 97%. This indicates that the learning tool is easy to use, useful, and able to support the practical learning process.

Keywords: *Miniature, House, Earthquake, Construction*

INTRODUCTION

Indonesia is a country with high seismic activity. Indonesia's geological location at the junction of several tectonic plates that are moving relative to one another makes Indonesia one of the most seismically active regions in the world [1]. Experiences of major earthquakes in various regions, including West Sumatra, have demonstrated serious impacts on occupant safety, building functionality, and economic losses. Therefore, the ability of simple residential buildings to perform safely during earthquakes is no longer merely a technical discourse but a real necessity affecting daily life. At the planning level, the primary reference is SNI 2847:2019, which regulates site classification, spectral response parameters, design response spectra, and the application of equivalent lateral or dynamic forces as the basis for earthquake load calculations [2].

To date, the construction industry has contributed to disaster management, particularly during emergency response efforts and in the post-disaster rehabilitation and reconstruction phases. However, the industry's involvement must be expanded from its current reactive role following an event to a proactive approach that includes pre-disaster activities [3]. This is in line with the shift in the disaster management paradigm, which now places greater emphasis on preparedness, hazard mitigation, and vulnerability reduction rather than solely on emergency response and aid delivery [4].

In this regard, Spence and Kelman state that disaster mitigation must be a key consideration at every stage of infrastructure development including planning, design, construction, operation, maintenance, and oversight [5]. Therefore, according to Benson and Twigg, construction experts with expertise in disaster management should be involved from the very beginning of the project. This early involvement will raise awareness among all stakeholders and will influence disaster risk reduction measures in subsequent stages [6].

In structural engineering, earthquake-resistant buildings are designed to absorb and distribute seismic energy efficiently to maintain stability and occupant safety. The use of materials such as reinforced concrete and steel enables structures to behave flexibly, allowing them to adapt to seismic vibrations without experiencing severe damage ṁ [5]. Designs generally combine flexible moment-resisting frames with rigid shear walls to achieve a balance between stiffness and flexibility. Innovations such as base isolation are also used to minimize seismic forces transmitted to the structure, thus enhancing building safety. In addition to design, the successful implementation of earthquake-resistant concepts depends heavily on appropriate construction practices and field supervision in accordance with established standards [7].

According to Arsyad, instructional media play a crucial role in conveying information in a concrete and engaging manner, increasing student interest and engagement, and clarifying the relationship between theory and practice. Therefore, the effective use of instructional media is expected to enhance students' conceptual understanding and support the achievement of learning objectives [8].

Previous research with entitled "Development of Three-Dimensional Miniature Media Integrated with Local Materials on Natural and Artificial Environment Topics in Grade III of SDN 92 Karetan,"found that the feasibility or validity of the learning media, as evaluated by experts, reached 85.7% and was categorized as highly valid. The practicality of the developed media also showed a positive impact on both students and teachers in the learning process [9].

Furthermore, the other reported that the validation results achieved an average score of 95.83%, categorized as “Very Valid” [10] . Nugroho also stated that the feasibility level of learning media based on validation by material experts, media experts, and instructional experts was categorized as highly feasible. In addition, both limited and extensive trials yielded highly feasible results [11].

One of approach effective For overcome problem the is through miniature model making House stand earthquake based on SNI 2847:2019. Miniature functioning as representation physique scale small help student understand interaction element structure to burden earthquake visually and applicable. With referring to in SNI 2847:2019 concerning Planning Procedures Resilience Earthquake for Structure Building Building and Non- Building, this media bridge theory with practice field as well as strengthen understanding principle base design building stand earthquake (SNI 2847, 2019).

More carry-on use of miniature models House stand earthquake in the learning process give opportunity for student for learn in a way direct parts important from structure buildings, such as system foundation, connection between element structure, stiffener wall, trusses, and roof in a way more real and interactive. Miniature models stand earthquake Also support implementation method learning active (active learning), where student Not only accept theory, but also participate in activity observation, analysis, and practice directly. In this process, the lecturer plays a role as guiding facilitator student understand draft through miniature media as well as evaluate level understanding based on method student operate and observe current model function tested. According to Sanjaya learning active put student as subject constructive learning his knowledge through experience directly, while lecturer play a role as the mentor who created environment interactive learning And reflective [12]. With Thus , the use of miniature media No only strengthen understanding theory resilience structure, but Also develop skills relevant practice with world Work.

METHOD

This study employs a Research and Development (R&D) approach, commonly referred to as development research. Development research aims to produce a specific product as the outcome. This type of research contributes to educational advancement through the creation of innovative learning products [12] . The development design used in this study is the DDDE model, which is particularly suitable for instructional media development. The DDDE model consists of four stages: Decide, Design, Development, and Evaluation.

This research was conducted at the Stone and Concrete Workshop, Faculty of Engineering, Padang State University, located on Prof. Dr. Hamka Street, Air Tawar, Padang, West Sumatra. The research was carried out during the even semester, covering all stages from initial data collection to final analysis.

The object of this study is a simple miniature house model based on SNI 2847:2019. The subjects include material experts, represented by lecturers in Building Engineering Education who teach construction practice courses, media experts, and students of the 2025 cohort in Building Engineering Education who are enrolled in the Stone and Concrete Practice course as participants in the practicality test.

The research procedure follows the R&D method using the DDDE model (Decide, Design, Development, Evaluation), followed by a practicality test. The research instruments are used to assess the validity and practicality of the developed SNI-based miniature house model. These instruments consist of material validation questionnaires, media validation questionnaires, and practicality questionnaires.

Data collection was carried out using research instruments, followed by data analysis to clarify the level of achievement in terms of criteria, validity, and responses toward the developed miniature model. The data collected includes validity test results and practicality test results. Test validity is level match of the data obtained condition Actually on object research . Testing process validity involving evaluation direct from expert judgment. For measure validity instrument said , used approach Aiken's validity or Aiken's V. Calculation validity instrument done with apply Aiken's formula as tool analysis .

$$V = \frac{\sum s}{[n(c-1)]}$$

Validity level instrument questionnaire when the data collection process is determined by results testing validity. Assessment to validity the done with referring to on coefficient categorized correlation based on Aiken's V index.

The practicality data analysis technique is based on questionnaire responses from lecturers and students, which are then calculated into percentages using the following formula:

$$P = \frac{x}{y} x100\%$$

NOTES:
P = Practical value of the learning media
X = Score obtained from practicality assessment
Y = Maximum possible score from the practicality assessment
Based on the resulting percentages, the practicality level is categorized according to the following criteria:

Table 1. Product Practicality Categories

Interval	Category
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Moderately Practical
21 – 40	Less Practical
0 – 20	Not Practical

Source : [14]

RESULTS AND DISCUSSION

The results of developing an SNI-based earthquake-resistant miniature house model as a structural education medium for students in the Building Engineering Education program were implemented in the Basic Practice of Stone and Concrete course. This study follows the DDDE (Decide, Design, Development, Evaluation) model, which is described as follows:

1. *Decide*
   This stage is the initial step in the DDDE development model, aiming to identify learning needs and existing problems. At this stage, the researcher collected preliminary

data through basic observations, interviews with lecturers teaching the Stone and Concrete Practice course, and students from the 2024 cohort, as well as questionnaires distributed via Google Forms. The collected data includes information regarding the limitations of existing learning media. Additionally, the researcher analyzed updated miniature model designs, particularly in the Stone and Concrete Practice course, to determine the scope of media development. The results of this stage were used to formulate development objectives and determine appropriate learning media solutions aligned with course needs.

2. *Design*
   Based on the analysis results, the design stage focused on developing a simple miniature house model based on SNI 2847:2019. The activities in this stage include: (1) preparing initial sketches and design concepts, (2) planning materials and components, (3) developing schemes in accordance with SNI 2847:2019, and (4) preparing research instruments such as material validation sheets, student practicality questionnaires, and observation sheets.

   The sketching and design process represents the conceptual planning stage before the media is developed into a physical product. The miniature model was designed systematically to align with learning objectives, material characteristics, and student needs in the Basic Practice of Stone and Concrete course

   a. Initial Sketch and Design Development
      The initial design focuses on structural components, including substructures (foundations) and superstructures (sloofs , beams, columns, and roof trusses). The selected materials are aligned with course learning outcomes and applicable standards. The content includes types of shallow foundations, structural components, SNI standards for earthquake-resistant housing, calculation examples, and design drawings. This selection aims to provide students with comprehensive conceptual and practical understanding.

Figure 1. Floor Plan

Figure 2. Left Elevation

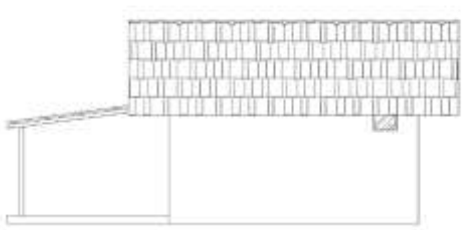

Figure 3. Right Elevation

Figure 4. Front Elevation

Figure 5. Rear Elevation

   b. Planning of Materials and Components to be Used
      Based on the model that has been designed, the researcher determined the specifications of the materials to be used, including sand, cement, and mini-sized gravel, reinforcement (sloof , beams, and columns) using NYA 2.5 cables for main reinforcement and NYA 1.5 cables for stirrup reinforcement, the number of main reinforcements, spacing between stirrups, shape and angle of stirrup hooks, and the dimensions of sloof ,

beam, and column elements. The roof truss also uses wood materials designed in miniature scale. The dimensions of these structural elements are adjusted to the provisions of SNI 2847:2019 so that the learning media is not only visual but also represents the correct implementation of earthquake-resistant house standards. The determination of material specifications aims to maintain material accuracy and increase the relevance of the media to field practice conditions.

c. Arrangement of the Scheme in Accordance with SNI 2847:2019
The resulting learning media is in the form of a simple miniature house that represents the structure of an earthquake-resistant house. This miniature is arranged based on the technical provisions in SNI 2847:2019 so that the reinforcement configuration displayed has been adjusted to the applicable planning and detailed requirements. Based on the implementation results, this miniature media can provide a more concrete visualization compared to theoretical explanations alone. Each structural component is designed to be clearly visible and easy to observe so that students can understand the function and position of each reinforcement according to the concept of earthquake-resistant house structures. In addition, the media is designed by considering ease of use in the learning process, both for lecturer demonstrations and student practical activities. The simple yet informative design ensures that the learning focus remains on understanding the basic concepts of structural behavior and reinforcement detailing principles in accordance with SNI 2847:2019, so that this media is considered effective as a support for learning in the Basic Practice of Stone and Concrete course.

d. Development of research instruments
As part of the design stage, the researcher also developed assessment instruments to evaluate the feasibility of the learning media. These instruments included material expert validation sheets, media expert validation sheets, and student practicality questionnaires. The instruments were designed to measure aspects such as suitability, completeness, accuracy, and the alignment of the media with the learning material, as well as media appearance, its use in the learning process, and user engagement. The results of these assessments were then used as a basis for improving the media in the subsequent stages.

3. *Development*
The implementation stage was carried out to test the practicality level of the media on a limited group of students who took the Stone and Concrete Practice course in the Building Engineering Education Study Program, Padang State University. The trial activities include: (a) the use of media in practical activities according to the designed guidelines, and (b) the collection of student response data regarding ease of use, time efficiency, attractiveness, and usefulness of the media in learning.

a. Development of the Earthquake-Resistant Miniature House Mode
Based on the results of the model design at the design stage, the researcher began to develop the learning media in the form of a physical miniature earthquake-resistant house model. The process of making the media was carried out by following the shape, arrangement, and proportion of the structure that had been designed. Each structural component, both substructures consisting of stone foundations and superstructures consisting of sloof, beams, columns, and roof trusses, was made according to the predetermined specifications so that the simple miniature house model can represent both structural and non-structural aspects of earthquake-resistant house educational media based on SNI 2847:2019.

Figure 6. Foundation Construction Process

Figure 7. Assembly and Tying of Sloof , Column, and Beam Reinforcement Using Thread

Figure 8. Installation of Room Partitions (Walls)

Figure 9. Roof Truss Assembly and Roof Installation

b. Application of SNI-Based Technical Specifications
At the development stage, the technical specifications of the media were consistently applied based on the provisions of SNI 2847:2019. This includes the dimensions of the miniature according to the determined scale, spacing between stirrups, shape and angle of stirrup hooks, and the relationship between sloof , column, and beam reinforcement. The application of these technical specifications aims to ensure that the learning media functions not only as a visual aid but also as an example of correct reinforced concrete standards in accordance with field practice.

c. Material Validation by Experts

The introductory material of the developed earthquake-resistant miniature house model was subsequently validated by three material experts with expertise in Building Engineering Education. The validators consist of lecturer validator 1 (NZ), lecturer validator 2 (YFP), and lecturer validator 3 (MY). This material validation aims to assess its conformity with SNI 2847:2019, the completeness of the material, the accuracy of concepts, and the alignment with learning objectives.

The results of material validation by experts indicate that the first assessed aspect was the conformity of the material content with the provisions of SNI 2847:2019. The evaluation results from the three material experts showed an Aiken's V value of 0.92, categorized as valid. This indicates that the material on simple earthquake-resistant house structures presented in the learning media is in accordance with the applicable standards for earthquake-resistant housing design based on SNI 2847:2019.

The second aspect assessed was accuracy and currency, which included the explanation of simple house foundation structures, reinforcement of sloof , columns, beams, and stirrups, roof truss structures, examples of reinforcement calculations, and supporting design drawings. Based on the material expert validation results, Aiken's V value of 0.89 was obtained, which falls into the valid category. This result shows that the material presented is complete and adequate to support the learning process in the Basic Practice of Stone and Concrete course.

The next aspect assessed was usefulness, meaning that the media can be used concretely and is appropriate as an educational medium in the learning process. In this aspect, an Aiken's V value of 0.89 was obtained with a valid category, indicating that the concepts presented are accurate and do not lead to misunderstandings among students.

Based on the overall results of the material validation by experts, the average Aiken's V value obtained was 0.90. This value meets the feasibility criteria, indicating that the material used in the development of the SNI-based earthquake-resistant miniature house model is categorized as valid and suitable for use in the implementation stage. The detailed results of the assessment and calculations are presented in Appendix 30.

1) Material Revision

In addition to feasibility assessments, the material experts also offered several comments and suggestions as a basis for improving the developed learning media of sloof and column reinforcement replicas. These comments and suggestions were intended to refine the material to make it clearer, more systematic, and easier for students to understand. A summary of the comments, suggestions, and the follow-up improvements made by the researcher is presented in the table below.

Table 2. Comments and Suggestions

NO	Na me Validator	Comments and Suggestions	Improvements or Revisions
1	Lecturer validator 1 (NZ)	Revise the grammar	The writing has been revised to comply with appropriate writing standards
		Expand the material on foundations	Foundation material has been added
		Ensure that each element presented/written describes clearly its details	Images for each element have been included in the materia l
2	Lecturer validator 2 (YFP)	The media is appropriate for learning and the material is aligned with the media	-
3	Lecturer validator validator 3 (MY)	Study how to calculate size/scale proportions	-

Based on the table above, the first validator provided comments and suggestions related to revising the grammar of the material, expanding the content on foundations, and ensuring that each element presented or written clearly describes its details. The second validator suggested that the media is appropriate for learning and that the material is aligned with the media.

d. Media Expert Validation

After the materials were validated and revised in accordance with the subject matter expert's recommendations, the earthquake-resistant house model was subsequently validated by one media expert with expertise in the field of Building Engineering Education. The media validators consist of validator 1 (FKP), validator 2 (A, S, R, A), and validator 3 (W, N, J). The purpose of this media validation was to assess the suitability of the learning media in terms of design, presentation, and ease of use in supporting the learning process for the Basic Stone and Concrete Practice course.

The media validation assessment was conducted using a learning media validation instrument developed based on several evaluation aspects, including design and appearance, usability, and innovation. The results of the media validation by the expert present the average scores from the validator as well as the Aiken's V values for each assessment aspect.

The first aspect evaluated in media validation is the design and appearance of the media, which includes the appeal of the design, the neatness of the presentation, visual clarity, and the appropriateness of the media's size and shape. The evaluation results from media experts indicate an Aiken's V score of 0.93, classified as “valid.” This indicates that the appearance of the earthquake-resistant house model meets good visual criteria and supports the learning process.

The second aspect evaluated was the utility of the media in learning, specifically its suitability for use in practical learning activities, its effectiveness in explaining concepts, and its role in helping students understand the material on the reinforcement of footings and columns. For this aspect, an Aiken's V value of 1.00 was obtained, falling into the “valid” category, which indicates that the learning media is highly suitable for use in the practical learning process for the course “Basic Stone and Concrete Practice.”

The next aspect is innovation, which assesses the extent to which the media can encourage active student participation, the ease of use of the media, and the clarity of the information presented in the media. The results of the media expert validation for this aspect yielded an Aiken's V score of 0.96, classified as valid. This indicates that the learning media is capable of actively engaging students and is easy to use in learning activities.

Based on the overall results of the media validation conducted by experts, an average Aiken's V value of 0.96 was obtained. This value meets the feasibility criteria, so it can be concluded that the earthquake-resistant house model is valid and suitable for use in the implementation phase.

2) Media Revision

Based on the results of the media validation conducted by the media expert, in addition to obtaining feasibility assessments, several comments and suggestions were also provided as a basis for improving the developed learning media of sloof and column reinforcement replicas in the Basic Practice of Stone and Concrete course. These comments and suggestions were intended to refine the learning media to make it more informative, easier to use, and capable of supporting independent learning by students. A summary of the comments, suggestions, and the follow-up improvements made by the researcher is presented in the table below.

Table 3. Comments and Suggestions from Media Experts

NO	Validator Name	Comments and Suggestions	Improvements or Revision
1	Lecture validator 1 (FKP)	Repair parts that are detached or loose	The media has been repaired

Based on the table above, the validator provided comments and suggestions related to repairing parts that were detached or loose. The results of the improvements made based on the validator's suggestions are presented in the following figures:

Table 4. Revisions of Detached Parts

Before Revision	After Revision
	

Based on the revisions carried out in accordance with the comments and suggestions from the media expert, the SNI-based earthquake-resistant miniature house model has been improved in terms of clarity of information, ease of use, and overall quality of the media's appearance. The results of these improvements are presented in the form of image documentation as evidence of the refinement of the learning media before it is used in the implementation stage.

e. Practicality of the Earthquake-Resistant Miniature House Model
The practicality test is a process used to determine the level of practicality of the SNI based earthquake resistant miniature house model developed in this study. The practicality testing was conducted using a research instrument in the form of a student response questionnaire regarding the use of the miniature model. The respondents in this practicality test were 17 students who were enrolled in the Basic Practice of Stone and Concrete course.
The practicality assessment was carried out by distributing questionnaires to students after they observed and used the miniature model during the learning process. The results of the practicality test of the earthquake-resistant miniature house model, based on student responses, are then presented in tabular form to determine the practicality category of the developed media.

Table 1. Student Practicality Results

No.	Practicality Aspects	S core Obtained	Maximum Score	Per percentage	Category
1.	Media Appearance	330	340	9 7 %	Very Practical
2.	Material al	325	340	9 6 %	Very Practical
3.	Pro c e s s	330	340	9 7 %	Very Practical
4	Media Usefulness	330	340	9 7 %	Very Practical
5	Practical Use	332	340	9 8 %	Very Practical
	Result	1464	1,700	9 7 %	Very Practical

Based on the data presented in Table 12, the results of the practicality assessment by students show a percentage of 97%. Therefore, it can be concluded that the earthquake-resistant miniature house model falls into the “very practical” category for use in the Basic Practice of Stone and Concrete course.

4. *Evaluation*
The evaluation stage was conducted to assess the level of validity and practicality of the SNI 2847:2019-based simple house learning media that had been developed. This evaluation process was carried out using research instruments, including material expert validation sheets, media expert validation sheets, and student practicality questionnaires.

Validation by material experts aims to evaluate the conformity of the media content with theoretical concepts and technical provisions outlined in SNI 2847:2019. The assessment focuses on aspects such as completeness and accuracy of the material, the integration between theory and practice, and the ability of the media to help students understand the form and function of each structural component presented in the miniature model.

Meanwhile, validation by media experts focused on assessing the feasibility of the design based on didactic, technical, and aesthetic aspects. These include layout organization, proportion, clarity of appearance, material quality, ease of use, and safety during its use in practical learning activities.

This study employed the Research and Development (R&D) method, which aims to produce a feasible learning medium in the form of an earthquake-resistant miniature house model for use in the Basic Practice of Stone and Concrete course. The media development was carried out regularly through the stages of the DDDE model, ensuring that the resulting product focuses not only on the physical aspects of the media but also on the alignment with learning materials and students' instructional needs.

The first stage, Decision, was conducted to identify the initial learning conditions and the need for media development in the Basic Practice of Stone and Concrete course. Based on the needs analysis, it was found that the learning process was not yet supported by instructional media capable of presenting both substructures and superstructures concretely in accordance with the provisions of SNI 2847:2019. The previously used media were still two-dimensional, making it difficult for students to fully understand the forms and elements of earthquake-resistant house structures. These findings indicate the need for a concrete and applicable learning medium. Therefore, the development of an earthquake-resistant miniature house model serves as a relevant solution to support practical learning, enabling students to understand structural concepts more clearly and systematically.

The second stage, Design, involved planning the SNI 2847:2019-based simple house miniature model. The activities at this stage include: (1) preparing initial sketches and model designs, (2) planning the materials and components to be used, (3) developing structural schemes in accordance with the provisions of SNI 2847:2019, and (4) preparing research instruments, including material expert validation sheets, student practicality questionnaires, and observation sheets for practical activities. The media design was aligned with the learning objectives and competency indicators to be achieved.

The third stage of development is the implementation of the designed media. The developed miniature model of an earthquake-resistant house was subsequently tested for validity by subject matter experts and media experts. Based on calculations using Aiken's V validity formula, the content validity test conducted by subject matter experts yielded an overall average score of 0.93, which falls into the "valid" category. The assessment results for each aspect of material validation showed varying values: the content suitability aspect received an average score of 0.93, the accuracy and currency aspect 0.94, and the utility aspect 0.92.

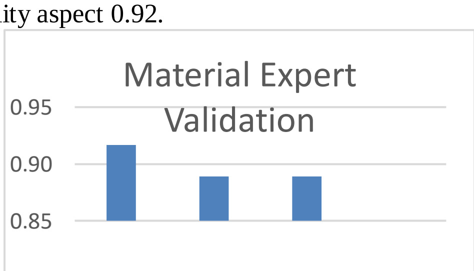

Figure 10. Material Expert Validation Graph

Based on the results of the content validity test, the earthquake-resistant house model used as a teaching aid received an average score of 0.96, which falls within the "valid" category. All evaluation aspects—including design and appearance, usability, innovation, and alignment with learning objectives—consistently fall within the "valid" category. Consequently, this teaching aid is deemed suitable for use as introductory material in the learning process.

The media validity test conducted by media experts yielded an overall average score of 0.96, which falls within the "valid" category. Different scores were obtained for each aspect of the media validation assessment, including 0.93 for design and appearance, 1.00 for usability, and 0.96 for innovation.

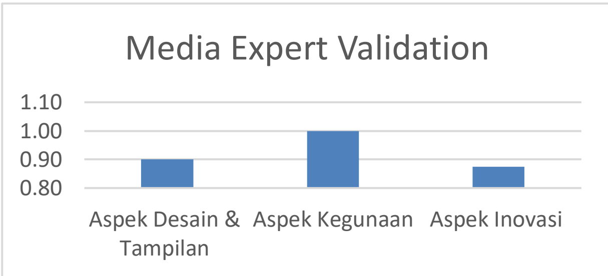

Figure 11. Media Expert Validation Graph

The results of the media validity test indicate that the earthquake-resistant house model has a high level of validity, with an average score of 0.96, placing it in the "valid" category. All evaluation aspects—including design and appearance, usability, and innovation—fell within the "valid" category, indicating that the developed media meets the criteria for use as a learning tool.

A practicality test was conducted to determine the ease of use of the media in the learning process. Based on the results of the practicality test, a practicality score of 97% was obtained, falling into the "very practical" category. This practicality score indicates that the miniature model is easy to use, helps students understand the material, and supports laboratory activities. The results of this practicality test are visually presented in Figure 12, which shows that student responses to the use of the media fall into the "very practical" category. Thus, the developed earthquake-resistant house miniature model is not only valid but also practical for use in learning.

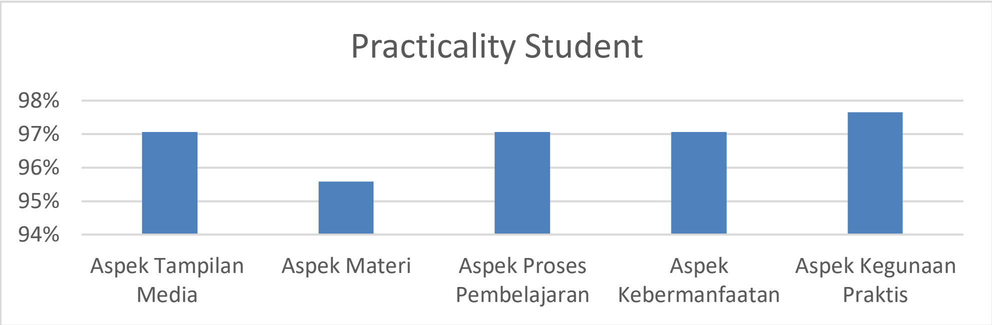

Figure 12. Student Practicality Graph

Based on the results of the students' practicality test, the learning media achieved an average practicality score of 97% and was classified as "highly practical." Evaluations of each aspect yielded positive results, with the media's visual presentation, content, process, usefulness, and practical applicability all falling into the "highly practical" category. These results indicate that the earthquake-resistant house model is easy to use, beneficial, and effectively supports the students' learning process.

The final stage, Evaluation, was conducted to assess the level of validity and practicality of the SNI 2847:2019-based simple house learning media that had been developed. This evaluation process was carried out using research instruments, including material expert validation sheets, media expert validation sheets, and student practicality questionnaires. Validation by material experts aims to evaluate the conformity of the media content with theoretical concepts and technical provisions outlined in SNI 2847:2019. The assessment focuses on aspects such as completeness and accuracy of the material, integration between theory and practice, and the ability of the media to help students understand the form and function of each structural component presented in the miniature model. Meanwhile, validation by media experts focused on assessing the feasibility of the design based on didactic, technical, and aesthetic aspects, including layout organization, proportion, clarity of appearance, material quality, ease of use, and safety during practical learning activities.

Furthermore, the results of the student practicality test indicate that the miniature house model is easy to use and provides a positive contribution to the practical learning process. The media is considered capable of helping students understand the material more quickly and clearly, as well as increasing student engagement in learning activities. This high level of practicality indicates that the media is not only academically feasible but also effective in supporting practical learning in the Basic Practice of Stone and Concrete course.

Research results that are similar and relevant to this research in general, these studies conclude that learning media in the form of miniatures or those developed using R&D approaches are feasible for use because they meet the criteria of validity and practicality. The validity of the media is demonstrated through high evaluation scores from material and media experts, while the level of practicality is indicated by positive user responses during the learning process [13], [14], [15], [16], [17] .

The similarity of these research findings indicates that the Research and Development (R&D) procedure, whether using the DDDE or 4D model, consistently produces learning media that meets feasibility standards in terms of content, appearance, and ease of use. In addition, the use of three-dimensional replica media has been proven effective in helping students understand both abstract and technical materials.

Thus, the results of this study reinforce previous findings that the development of learning media based on physical replicas, including SNI-based earthquake-resistant miniature house models, is successful in achieving its development objectives namely, producing learning media that are valid, practical, and relevant for use in practical learning activities.

CONCLUSION

Based on the results of this study on the development of an SNI-based earthquake-resistant miniature house model as a structural educational medium for students of Building Engineering Education, it can be concluded that the validity of the developed media falls into the valid category. The validation results by material experts showed an average score of 0.82, categorized as valid, while the validation results by media experts showed an average score of 0.93, also categorized as valid. Therefore, the developed learning media meets the feasibility criteria for use in the Basic Practice of Stone and Concrete course.

Furthermore, the practicality level of the SNI-based earthquake-resistant miniature house model as a structural educational medium is categorized as very practical. This is indicated by the results of the student response questionnaire, which obtained an average score of 98%. These findings show that the learning media is easy to use, beneficial, and capable of effectively supporting the practical learning process.

Limitations in study This Is manufacturing simulation physique and the materials used in the miniature buildings, the subject And Location media validation and No existence test effectiveness in increase results Study.

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