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Development of an ethnoscience-based REA learning model in natural science lessons changes in the form of objects: Analysis of validity and reliability

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Abstract: This study seeks to assess the credibility and trustworthiness of an ethnoscience-based REA (Read, Explore, Apply) learning model framed for teaching the transitions in states of matter in science education. To assess the model's validity and reliability, the study involved three subject matter experts who provided evaluations focused on content and construct validity. Two questionnaires assessed content and construct validity and reliability; expert responses were averaged for validity and percentages used for reliability. Results showed that out of the 12 content-related items, 11 were in the very valid category range (score interval: 3.25 < VS ≤ 4.00), while one item was in the valid category (2.50 < VS ≤ 3.25). For content validity, all 12 items met the threshold of 0.75 reliability score, thus achieving marked consistency. Regarding construct validity, 14 of 18 items scored as very valid while the remaining four were deemed simply valid. In summary, the investigation found that the ethnoscience based REA learning model is highly valid and reliable for teaching science specifically, for teaching phase changes. This study points to a shift toward learning models that reflect students' daily experiences. This study points to a shift toward learning models that reflect students' daily experiences.

Keywords: *Changes in the form of objects, Communication abilities, Elementary School student, Ethnoscience, Natural science, REA, Science literacy.*

1. Introduction

Educating students in natural sciences at an early stage sparks an interest in scientific learning that can last a lifetime [1, 2]. A pivotal topic that relates directly to the world around us is the idea of the changes in the form of objects [3, 4]. Even though the scientific ideas presented herein could be described in a more basic manner, they nevertheless likely would require an adequate level of science literacy [5] and communication skills [6]. Such skills allow learners to connect the scientific phenomena to their lived experiences and society [5]. Still, there are a lot of problems with the way science is taught, particularly in relation to building students' literacy [7] and communication skills of and about science [8]. Having a science literacy does not only mean that one can define concepts; one needs to explain them well [9]. In the same way, science communication concerns students' ability to reasonably relay the outcomes of a number of tasks which are often referred to as experiments and observations [10].

Students may face challenges in linking science to real-life contexts without the simultaneous training in literacy and communication which would impact their critical thinking and strategic planning [11]. Deficiency in scientific literacy, and the ability to articulate one's thoughts and decisions with supporting scientific rationale can have far-reaching harmful impacts [12]. Moreover, the absence of strong science communication capabilities can further exacerbate the misconception problem, lack of interest in pursuing science-related professions, and hinders students' adaptability to global issues [13].

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For these reasons, the development of an integrative model which can adequately promote science literacy, communication skills, and overall, communication capabilities in students on an innovative educational framework is warranted.

Previous research has highlighted the importance of fostering reading habits in students, emphasizing that consistent and repeated reading activities can enhance their literacy skills [14]. Exploration is a crucial component in developing both scientific literacy and communication skills in students [15, 16]. Application activities, which connect scientific theories and concepts to real-world situations, also play a significant role in this process [17]. Through these activities, students can apply scientific knowledge to solve complex problems, while simultaneously enhancing their critical and creative thinking skills, as well as improving their communication abilities [18-20]. The integration of local culture into learning, known as ethnoscience, has proven to be highly effective in boosting students' scientific literacy [21-23]. By using ethnoscience strategies, teachers can help students more easily achieve science process skills [24]. Ethnoscience offers a promising approach to addressing the issue of low scientific literacy among students, as it involves designing learning experiences that connect cultural contexts with scientific education [25]. While previous studies indicate the importance of reading, exploration, application, and ethnoscience in developing literacy and communication skills, the development of new learning models continues to show a significant shortage of innovation.

As the issues have been formulated, it is possible to note some gaps in research and innovation in education for fostering the development of a teaching model focused on integrating scientific literacy and communication skills into elementary education. Consequently, it necessitates the design of a pedagogical model that embeds reading (R), exploration (E), and application (A) of knowledge in practice within local culture. A gap is identified for the creation of an innovative learning model. Nevertheless, in order for the REA learning model based on ethnoscienceto be implemented in different places, schools and educational systems, it's necessary to verify the model's educational standing and trustworthiness first. Validity guarantees accuracy in measuring the intended outcomes, while reliability captures the model's constancy across multiple applications and settings. Therefore, this study aims to verify the validity and reliability of the development of an ethnoscience-based REA learning model in natural science lessons changes in the form of objects.

2. Materials and Methods

2.1. Types of Research

This study aims to evaluate an educational tool or model's accuracy and consistency. A Quantitative Approach is applied in terms of conducting validity and reliability analysis which seeks to verify the degree of precision and dependability an instrument or model achieves. This study does not test a hypothesis but instead analyzes the effectiveness of the goals set for the instrument in terms of reliability and application.

2.2. Instruments

This study developed the model's components, and evaluation of content validity, construct validity, reliability, and internal consistency were measured using a questionnaire. Three evaluators who were lecturers in science education and elementary education provided the assessments. For the purposes of this study, the measurement questions included in the outline were assessed using a using a Likert scale of 4 (very valid), 3 (valid), 2 (less valid), 1 (invalid).

2.3. Material

2.3.1. REA

The three components of the REA model include read, explore, and application. The logic behind structuring REA into these phases is explained within Figure 1.

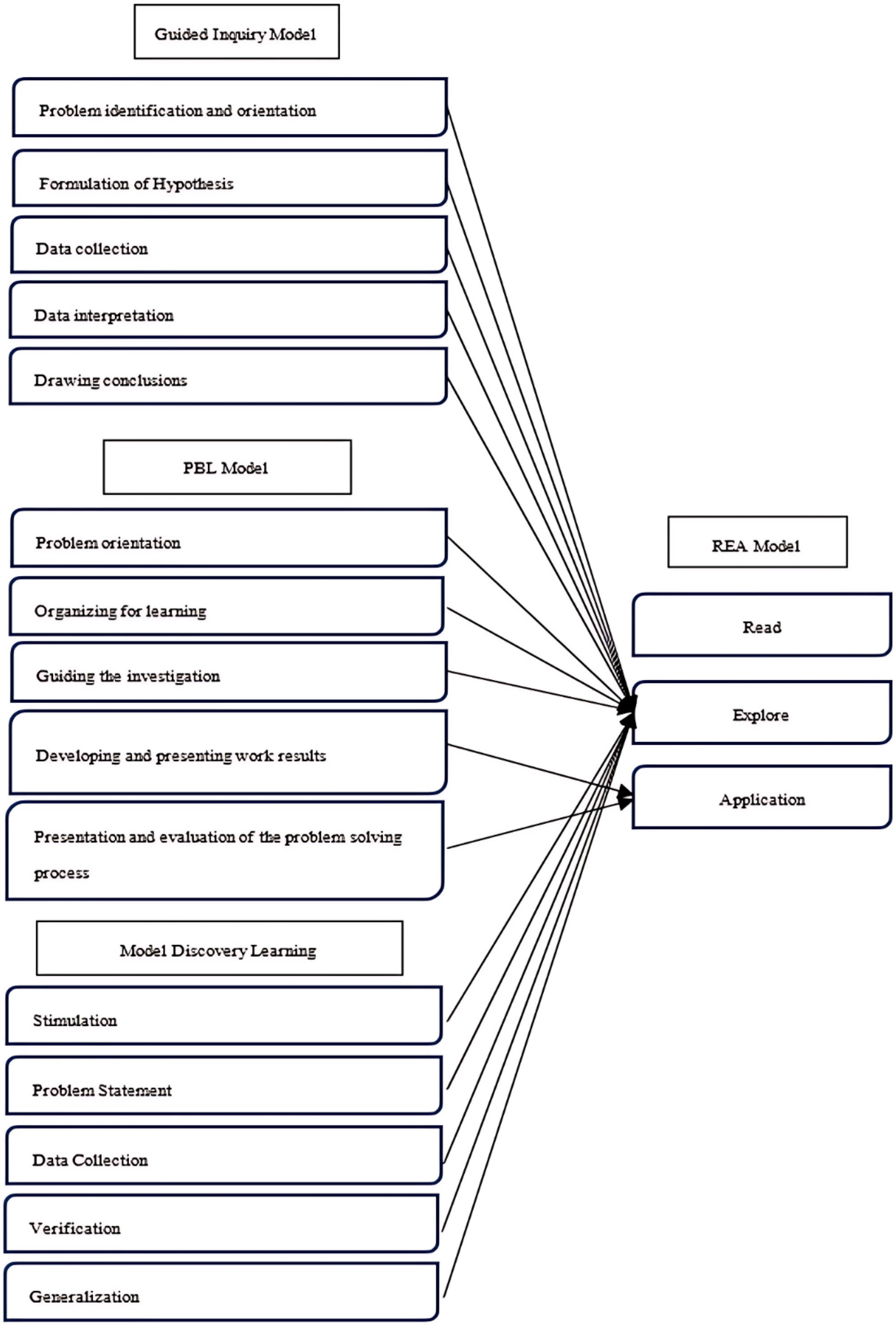

Figure 1.
The origin of the REA model syntax.

Referring to Figure 1, the first phase, Read, serves as an initial step to address challenges in fostering students' scientific literacy and communication abilities. The second phase, Explore, draws inspiration from the core principles of guided inquiry and discovery learning. In this stage, students engage with the topic through various exploratory activities such as watching educational videos, making observations, or working individually and collaboratively to build foundational understanding. The third phase, Application, is influenced by elements of PBL approach, particularly the stages involving the development and presentation of solutions as well as reflection on the problem-solving process. This phase is designed to help students apply their acquired knowledge in real-life scenarios or situations that mirror everyday challenges.

2.4. Ethnoscience

This approach highlights the connection between scientific learning and cultural context, using local wisdom as a foundation for grasping and applying scientific ideas [26]. Integrating ethnoscience into elementary science education can be observed through local traditions, such as the creation of batik textiles, the preparation of traditional jumbrek dishes, and the making of ice cream using time-honored methods in Lamongan Regency. These culturally significant activities align with the Grade 4 science curriculum in Phase B, particularly within the topic of examining how heat influences temperature and the changes in the form of objects.

2.5. Changes in the Form of Objects

In this study, the development carried out specifically for science lessons on changes in the form of objects. A change in the form of objects occurs when a substance shifts from one physical form to another, such as from solid to liquid or liquid to gas. These changes are closely connected to heat energy, which plays a vital role in the process. Heat, as a type of energy, influences the temperature of a substance. When a material absorbs heat, the added energy may increase its temperature or trigger a phase change. For example, heating water can cause it to transition from a liquid state to water vapor [27]. Heat is the form of energy that is exchanged between iki or more substances or objects owing to their different temperatures [28]. When a substance absorbs or loses heat, its temperature will change at first. However, once it reaches a certain point, known as the saturation point, the added or released heat no longer changes the temperature but instead triggers a phase change in the material [29]. This type of heat involved in changing the phase of a substance is known as latent heat. The two main categories of latent heat are fusion, connected to phase changes like melting and freezing, and vaporization, which relates to processes such as evaporation and condensation. As defined by the laws of thermodynamics, latent heat is generally more than sensible heat which is the energy required to raise the temperature of a substance since latent heat requires breaking or forming bonds which occurs during phase change. Matter usually exists in three states: solid, liquid and gas (Figure 2). Solids have a fixed shape and volume while liquids have a fixed volume but take the shape of their container. Gases change their volume and shape according to the environmental conditions. Melting, freezing, evaporation, condensation, sublimation and crystallizing are the primary phase transitions experienced in day to day life [28].

Figure 2.
Particles of solid (a), liquid (b), and gas (c).

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2.6. Data Analysis

The validity analysis of the REA model and ethnoscience-based learning tools was conducted using quantitative descriptive methods. The validation items on the assessment sheet, evaluated by the validator, were averaged for each item. Based on the average scores for each item, the validation results were categorized according to the table provided below Ratumanan and Laurens [30] on Khasana, et al. [31].

Table 1.
Criteria for Validating Learning Models.

Score Interval	Assessment criteria	Information
$3.25 < VS \leq 4.00$	Very valid	Usable
$2.50 < VS \leq 3.25$	Valid	Usable with minor edits
$1.75 < VS \leq 2.50$	Less valid	Usable but needs significant revisions
$1.00 \leq VS \leq 1.75$	Invalid	Not yet suitable; further consultation required

Note: Description: (VS = validation score).

The researcher follows up on the validator's evaluations, incorporating the provided suggestions and feedback. The reliability of the REA model validation tool and learning materials is calculated based on inter-observer agreement, determined through a percentage statistical analysis of agreement (R) and an instrument to be reliable if its reliability is ≥ 0.75 or 75% menurut Borich [32] on Rokhim, et al. [33].

$$R = 1 - \frac{A-B}{A+B} X100\%$$

Information:
R = instrument reliability.
A = the frequency of the behavior observed by the observer, who recorded it as occurring frequently.
B = the frequency of behaviors observed by those who assigned low frequencies.

3. Literature Review

Scientific literacy and communication skills are key components of education aimed at enhancing 21st-century competencies. Scientific literacy serves as an important indicator in measuring the human development index, which is significantly shaped by the quality of education [34]. The concept of scientific literacy has been in use since the 1940s. In its most basic sense, literacy refers to the ability to read and write [35]. Science refers to knowledge, but it also involves a systematic approach to exploring the natural world. Therefore, science is not just the accumulation of facts, concepts, or principles, but also a process of discovery. According to Angganing, et al. [36] communication skills encompass the exchange of information through various means, verbal and non-verbal, from the sender to the receiver. Another definition of communication skills is as the ability to precisely explain information in a way that others can understand [37, 38]. An effective learning model is necessary to develop both scientific literacy and communication skills.

A learning model helps in rationally organizing the educational activities to achieve specific goals and learning outcomes It aids teachers and designers in planning and implementing the teaching-learning process as it provides a framework for guiding learners through the activities. Therefore, the purpose of a learning model is to ensure that teaching and learning activities are organized systematically and effectively support the achievement of the intended objectives [39]. This study aims to develop an Ethnoscience-Based REA Learning Model for teaching Natural Science concepts related to changes in the form of objects.

The term "ethnoscience" is derived from the Greek word *ethnos*, meaning "nation," and *scientia*, meaning "knowledge." Ethnoscience learning is an educational approach that incorporates local

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knowledge, culture, and ethnic viewpoints into the teaching and learning of science. This method highlights the connection between scientific concepts and their cultural contexts, using local knowledge as a foundation for understanding and applying scientific principles [26]. The local knowledge students have can serve as a foundation for exploring and applying scientific concepts in ways that are relevant to their lives [40]. The REA model, which stands for Read, Explore, and Apply, is a conceptual framework designed to guide learning. Each phase of the read, explore, apply model is grounded in both theoretical and empirical research to create a well-founded learning approach. Changes in the form of objects refer to phenomena where a substance transforms from one state to another, such as from solid to liquid, liquid to gas, or the reverse. These transformations occur due to changes in the arrangement and movement of particles within the material. For instance, when a solid turns into a liquid, the particles begin to move more freely, causing the substance to soften [27]. This study seeks to create an Ethnoscience-Based REA Learning Model for teaching Natural Science concepts related to changes in the form of objects. To ensure its effectiveness, it is essential to assess the validity and reliability of the ethnoscience-based REA learning model.

4. Research Results

The results of this study will present the validity and reliability of this, as well as the validity and reliability of the construct of the learning model development.

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Table 2.
Content Validity Assessment of the REA Based on Ethnoscience.

Rated aspect	Validity Results		Reliability	
	Average score	Criteria	R (%)	Average score
The need for model development				
1. The REA learning model based on ethnoscience aims to improve scientific literacy and communication skills, in accordance with the needs of 21st century skills competencies.	4.0	VV	100%	Reliable
2. ethnoscience- based REA learning model bridges the gap between expectations for 21st century competency needs and the current reality of education in Indonesia, namely that scientific literacy and communication skills are still low.	4.0	VV	100%	Reliable
3. The REA learning model based on ethnoscience fulfills the need for a learning process that prioritizes scientific investigation activities.	4.0	VV	100%	Reliable
4. ethnoscience- based REA learning model takes into account recommendations for improvement from research on scientific literacy skills.	3.3	VV	85.7%	Reliable
5. The REA learning model based on ethnoscience uses a transdisciplinary approach to meet state of the art scientific knowledge , according to the needs of model development, and the existence of mutual consistency between model components.	3.7	VV	85.7%	Reliable
Model design meets the novelty of knowledge (state of the art of knowledge)				
1. The novelty of the REA learning model based on ethnoscience was built by considering the advantages and disadvantages of implementation in the field based on recommendations from researchers.	3.3	VV	85.7%	Reliable
2. Development of the objectives of the REA learning model based on ethnoscience using primary sources from reputable journals	3.7	VV	85.7%	Reliable
3. The development of the REA learning model based on ethnoscience uses theoretical foundations from standard and modern educational psychology figures.	3.7	VV	85.7%	Reliable
4. The development of the REA learning model based on ethnoscience uses an empirical basis obtained from studies and references from various studies that are relevant to the learning model being developed, and are often found in the latest journals related to scientific literacy and communication skills.	3.7	VV	85.7%	Reliable
Description of the REA Learning Model based on Ethnoscience				
1. The REA learning model based on ethnoscience was developed with certain characteristics and has the main objective of facilitating scientific literacy and communication skills.	3.7	VV	85.7%	Reliable
2. The syntax of the REA learning model based on ethnoscience can be categorized as a new syntax in science learning, namely facilitating the competencies of 21st century students.	4.0	VV	100%	Reliable
3. Development of assessment and evaluation of the REA learning model based on ethnoscience using the latest reference sources, namely the scientific literacy skills assessment developed by PISA.	3.3	V	85.7%	Reliable

Source: Description: (VS= Very Valid); (V= Valid); (R= Reliability).

Table 2 shows that the content validation score of REA ethnoscience learning model is in accordance with developing learning models to support graduate competencies in the 21st century, and was deemed to be highly valid. Looking from the perspective of novelty of knowledge (State of the Art of Knowledge), taking into account all theoretical and empirical reasoning, as well as recommendations from relevant research, the model also earned very valid scores. Validation of the model, based on the description of objectives of the learning model, implementation, management of the learning environment, and assessment, received very valid ratings in the range of ($3.25 < VS \leq 4.00$) and valid ratings of ($2.50 < VS \leq 3.25$). The reliability estimates for all aspects of content validation were between

85.7% and 100%, therefore subsantially high validated value. Thus, the validation results of the ethnoscience–based REA learning model can be said to be valid and reliable.

Table 3.
Construct Validation Assessment of the REA Based on Ethnoscience.

Rated aspect	**Validity Results**		**Reliability**	
	Average Score	**Criteria**	**R (%)**	**Criteria**
Rationale for REA Learning Model based on Ethnoscience				
1. The alignment between the objectives of developing the REA Learning Model based on Ethnoscience, aimed at enhancing students' scientific literacy and communication skills, and the requirements for 21st-century competencies.	4.0	VV	100%	Reliable
2. The alignment between the objectives of developing the REA Learning Model based on Ethnoscience and the research recommendations aimed at enhancing learning to improve scientific literacy and communication skills.	4.0	VV	100%	Reliable
3. The meanings and symbols within the components of the REA Learning Model book based on Ethnoscience are consistent and do not conflict with each other.	4.0	VV	100%	Reliable
Theoretical and Empirical Support				
1. theoretical basis and empirical support for phase 1: Read	3.7	VV	85.7%	Reliable
2. theoretical basis and empirical support for phase 2: Explore	3.7	VV	85.7%	Reliable
3. theoretical basis and empirical support for phase 3: Application	3.7	VV	85.7%	Reliable
Model Syntax				
1. The stages in the syntax of the REA Learning Model based on Ethnoscience present a logical progression of learning activities and outline the steps to achieve the learning objectives, which focus on enhancing scientific literacy and communication skills.	4.0	VV	100%	Reliable
1. The stages embedded within the ethnoscience-based REA Learning Model's syntax are interrelated, supporting and strengthening one another.	3.7	VV	85.7%	Reliable
2. The social system that states the roles and relationships between teachers and students is stated and described in the model book.	3.7	VV	85.7%	Reliable
3. The learning environment strongly supports the achievement of the main objective of developing the REA Learning Model based on Ethnoscience to improve scientific literacy and communication skills as stated and described in the model book.	4.0	VV	100%	Reliable
4. The reaction principle which states how the teacher's role is in paying attention to and treating students during the learning process is stated and described in the model book.	3.3	VV	85.7%	Reliable
5. The instructional and accompanying impacts of the REA Learning Model based on Ethnoscience are stated clearly and logically in the model book.	3.7	VV	85.7%	Reliable
Planning and Implementation of the Model				
1. Consistency in determining Learning Achievements and Learning Objectives with the curriculum	3.3	V	85.7%	Reliable
2. literacy ability test items with assessment scientific literacy developed by PISA	3.3	V	85.7%	Reliable
3. Consistency in organizing resources (equipment) and logistics (teaching modules, LKPD, assessment sheets) supports the learning process with the REA Learning Model based on Ethnoscience	3.3	V	85.7%	Reliable
4. Learning activities in all phases reflect a flow of activities that are oriented towards developing students' scientific literacy and	3.3	V	85.7%	Reliable

communication skills.				
5. Consistency of assessment and evaluation with the aim of developing the REA Learning Model Learning Model based on Ethnoscience	3.7	VV	85.7%	Reliable
6. The consistency of the assessment and evaluation of scientific literacy skills is consistent with the learning objectives that are scenario-based in the syntax of the REA Learning Model Learning Model based on Ethnoscience.	3.7	VV	85.7%	Reliable

Source: Information: VV= Very Valid; V= Valid; R= Reliability.

As shown in Table 3, the construct validity that "very valid" category with score interval ($3.25 < VS \leq 4.00$) and valid ($2.50 < VS \leq 3.25$). For the planning and implementation aspects, the construct validity ranged from valid to very valid. The reliability coefficient across all components of construct validity was between 85.7% and 100%, indicating a high level of reliability. These findings suggest that the construct validation instrument used to evaluate the developed ethnoscience-based REA learning model produced results that are both valid and reliable.

5. Discussion

The REA learning model, which includes ethnoscience as a way to improve scientific literacy and communication skills among elementary school learners, was validated and juried by three experts who concluded it to be both valid and reliable. These findings corroborate similar studies in the literature. The validation results prove that the instrument accurately measures the constructs it intends to capture [41]. Validity and reliability are are the content and constructs that strengthen that the instrument captures the essence of ethnoscience in relation to the REA model and elementary science education.

Two criteria underpin the quality of learning model are validity and reliability [42]. Incidentally, as far as content validity is concerned, what determines its level is the degree to which the elements in the model incorporate all constituents, goals, and skills to be covered [43-45]. A learning model is said to have high content validity if all strategies, methods, and activities included in it accurately and comprehensively represent the content domain that should be taught [46]. On the other hand, content reliability refers to the consistency of evaluation results and how the evaluation is conducted, that is, whether several specialists provide identical estimates regarding scope and appropriateness of the model's content; if yes, then content reliability is high [47]. Expert appraisers validated that the items were appropriate to the REA model operationalized in students' scientific literacy and communication skills. Construct validity refers to the degree to which the instrument measures the intended theoretical framework, and it is very important when a model is developed based on a certain educational theory. Construct validity refers to the extent to which a learning model is able to capture an underlying theoretical construct or concept such as creativity, collaboration, or problem solving. A model is considered construct valid if all of its components are aligned with the rationale of the construct theory. Construct reliability pertains to the interrelated consistency of the constituents that form the construct in the model [46]. Hence, attempting to validate and verify the reliability of Content and Construct is an integral part of ensuring that the learning model is suspect, unreliable, and untrustworthy in theory but dependable and consistent in practice.

Instrument validity ensures that the information the model provides is dependable, which highly influences how trustful model outcomes will be with regard to the dataset after evaluation and results are produced compared to what is new upon wider application [48]. Furthermore, the three expert evaluations confirmed the tool's reliability. This uniformity demonstrates that the device is able to reliably measure the impact of the REA model on different scenarios. In development work, reliability is crucial as it guarantees that measurement tools will yield consistent and reproducible results especially when testing is conducted in phases like pilot and full-scale testing. Instruments that do not provide sufficient reliability are likely to produce contradictory and fallacious results that impede sound judgments concerning model and strategy tuning or implementation.

As noted above, the ethnoscience-based REA learning model displays significant integration of theoretical and empirical substantiation. Validity and reliability already offered in the framework is a strong reason to hypothesize that it will serve as an innovative science education tool for grade school learners.

6. Conclusion

Ethnoscience-based REA learning model in natural science lessons changes in the form of objects has been proven to be valid and reliable in improving students' science literacy and communication. Therefore, this model can be used in teaching changes in the form of objects to elementary school students. However, this study is only limited to assessing the validity and reliability of the model. This study opens up opportunities for further research exploring the effectiveness of ethnoscience-based REA models at different educational levels, other subjects, or in other cultural contexts.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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