Students are naive in analyzing physics concepts: An ethnophysical study of the Tanimbar Islands community, Indonesia

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Abstract
Through various policies, the Indonesian government has encouraged community culture to be included in the school curriculum, which is integrated into relevant subjects. One is physics learning, which is packaged with the term ethnophysics. The study of culture, local wisdom, and local potential in Indonesia has grown in recent years. However, more research needs to be done on physics learning so it impacts students' academic achievement. One of them is that students still need to be made aware of conceptual building, so they cannot explain a physics concept scientifically. This study aims to explore the nature and structure of students' naïve knowledge of physics and, more specifically, their understanding of physics parameters at work. This research is a qualitative study for students related to the concept of Keku. The results show that naivstudents are naive when constructing concepts related to Keku. Therefore, by direct teaching, teachers straighten out physics concepts related to Keku culture so that students can understand completely. As for the future, it is important to examine further students' prior knowledge related to emotional literacy, physics communication skills, and learning activities in development to overcome naive conceptions and misconceptions.

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1. Introduction

Around 80% of students enter university physics courses in their first semester with belief systems and intuitions often inconsistent with Newton's frame of reference (Corten-Gualtieri et al., 2016). Although research on naïve conceptions has primarily come from the domain of physics (mainly mechanics), a significant amount of work has now also been compiled that explores naïve understandings of more abstract physics concepts (Reiner et al., 2000). Physics educators currently face two significant challenges: supporting acquiring a strong foundation of conceptual knowledge and reducing the persisting gender gap. Physics is perceived as a complex subject, and many assume that only capable students can take up this area of interest (Hofer et al., 2018). Students still have difficulties understanding basic physics concepts, which are not easily overcome. People acquire rich knowledge through various experiences in daily life. It is more focused on basic concepts to improve the situation, where ideas are first developed at the conceptual level (Souisa et al., 2024).

Laos has yet to follow this trend for concept-based learning. Physics teaching in Laos is very formal, and teachers mainly discuss mathematical formulas and train students to solve problems (Luangrath & Vilaythong, 2010). The results of physics investigations show that the physics performance of students in Laos obtained low scores when tested with the Force Concept Inventory (FCI). The students still relied on their daily life experiences when they answered the question (Luangrath et al., 2011). Another physics study from Nigeria showed that the causes of low enrollment in physics majors include poor Science and Mathematics background at the secondary level, incomplete physics laboratories, inadequate teacher motivation, poor remuneration, inappropriate teaching strategies used by teachers, and insufficient number of qualified physics teachers (Bawan, 2024). For example, in Portugal, science concepts have been introduced at the primary level, but many students need help understanding scientific concepts due to conventional teaching practices. This is evident from the concept of weight and mass, which students still do not understand. Students still do not understand the concept well and need to be better. Therefore, they

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developed a computer simulation so that students can understand abstract physics learning well (Sarabando et al., 2014; Dourado et al., 2017). The same situation is also shown in the physics performance of students in Zimbabwe due to inappropriate teaching methods (Manunure et al., 2020). Research in physics education has published findings on the existence and persistence of thousands of students' naïve ideas covering almost all physics topics (Bigozzi et al., 2018). Naive ideas tend to be described in one physics topic without discussing similar ideas in other topics. This may be partly due to how the physics course is structured. Due to the breadth of material covered by the field of physics and considered important by physicists and physics teachers alike, many students take multiple physics classes, with content separated among those classes. For example, at the college level, mechanics is typically taught in a different course than electromagnetism (Hull et al., 2021).

Humans have many naive ideas or misconceptions about how nature works (Nehring, 2020). Student misconceptions can be persistent, disrupt learning, and resist change. The results of a Thai study in physics learning showed that misconceptions remained high despite learning. These results confirm the characterization of misconceptions as persistent difficulties. The implications suggest the importance of combining multiple strategies for conceptual understanding, matching strategies to context, and the limitations of evaluating conceptual understanding (Phanphech et al., 2019). Newton's laws of motion are key ideas in mechanics and form the conceptual foundation of almost all other physics topics (Gates, 2014; Wilson, 2020). However, research in physics education reveals many naive theories or misconceptions of students even after instruction of Newton's laws. According to naive theories, beliefs or knowledge form the basis for developing students' interactions with nature. Students' naive theories are usually only valid in a specific context, yet they tend to use them in a broader context. As a result, students' naive theories often need to be revised to match scientific knowledge. This is because naive theories are built from long-term efforts and are consistent with experience; theories tend to be challenging to change and will interfere with the science being studied. Therefore, remediating students' naive theories must be done, and serious attention must be given to physics teaching. It should be noted that naive theories have been given several terms in the literature, including preconceptions, alternative conceptions, naive beliefs, or misconceptions (Docktor & Mestre, 2014). We use the term naive theory in this paper, but some experts prefer other terms. The results of the Indonesian study showed that there were significant differences between the three groups of students. The reduction of naive theory in students with high misconceptions occurred in classes that used open-ended problems supplemented by discussion (Batlolona, 2024). However, in some classes using open problems with scaffolding, students prefer to solve real-life problems. Thus, open problems in problem-based learning are the key to successful learning, while scaffolding discussion strengthens the implementation of open problems (Suwasono et al., 2023).

Since the late 1970s, research on education and learning shifted from an emphasis on behaviorism to a cognitive perspective by realizing that it is difficult to put knowledge into students' minds directly. Many cognitive psychologists and constructivists state that people construct new knowledge and understanding based on what they already know and believe. However, some of these ideas are inconsistent with scientific conceptions and are referred to as alternative framework misconceptions or child science, depending on the researcher's orientation. There have been attempts in physics education research to identify students' ideas about scientific phenomena before and after formal instruction. Research shows that students enter the physics classroom with various prior ideas built up in their daily lives. These prior ideas, considered misconceptions or alternative frameworks, can affect the acquisition of scientific knowledge because they influence what students pay attention to and how they interpret and develop their understanding of physics concepts. Therefore, it is important to identify students' misconceptions in physics to improve physics teaching. In Taiwan, physics teaching covers optics, mechanics, electricity, magnetism, sound, and heat. In this study, others investigated how students' misconceptions about these various topics can be detected using a questionnaire. The aim is that the findings can be used to help physics educators and teachers design teaching strategies and curricula (Chang et al., 2007). Students often experience difficulties in solving physics problems. These difficulties are mainly due to a need for a more conceptual understanding of the topic. The conceptual learning process reflects the nature of the causal reasoning process (Hung & Jonassen, 2006).

Naïve knowledge of sound and heat matter appears to be organized relatively coherently and conceptually changes from one naïve theory to the next (Lautrey & Mazens, 2004). Understanding learners' naïve conceptions and misconceptions is a must for successful teaching. Misconceptions refer to ideas that students have that differ from ideas accepted by scientists. Contrary to naive conceptions, misconceptions are formed after instruction or self-initiated learning and are often based on false information and incorrect assumptions. Misconceptions are built through more complex and abstract processes than naive conceptions and are highly resistant to change (Zhang et al., 2019). Naive people are credulous; they form their beliefs based on insufficient critical reflection (Langsam, 2017). Previous studies concluded that education, socioeconomic, and cultural factors influence the acquisition of naïve theories (Vlok & de Witt, 2012). The naïve mind seems full of misconceptions, where exaggerated simple ideas about the world are not explicitly taught. There are misconceptions about biology, astronomy, chemistry, and physics, to name just a few domains, and those domains exist among many others across a wide range of individuals, including infants, preschoolers, high school students, college students, and adults (Kloos et al., 2010).

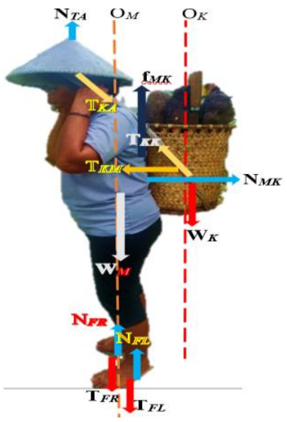
When students learn a scientific theory that contradicts their previous naive theory, it will become newer and more correct, even though knowledge only sometimes replaces older and incorrect knowledge. Both may coexist in the learner's long-term memory (Stricker et al., 2021). Conceptual change has long been viewed as a process in which a naïve initial theory is discarded, replaced, modified, or restructured (Potvin, 2013). However, until now, no physics research has highlighted students' naïveté related to Keku culture in the Tanimbar Islands, an ancestral culture still preserved today. This study aims to explore the nature and structure of students' naïve knowledge of physics and, more specifically, their understanding of physical parameters at work.

2. Method

In this qualitative research,zandts' answers with diary analyzed rect questions in the form of interviews. This research was conducted to analyze students' knowledge of Keku culture and reconstruct it into scientific knowledge in physics. The reconstruction is focused on farmers' activism when they return from the fields and have to put the garden products in Bakul (as shown in Figure 1). The research subjects were 7th-semester students of the physics education study program at one of the universities in Maluku. Data collection was done through in-depth interviews, observation, and documentation. In this case, qualitative research is sensitive to the social context in which specific research is conducted. Semi-structured interviews were conducted to obtain data from 20 sixth-grade students (4 males and 16 females). Students' participation in the study was voluntary. Participants were selected based on their overall performance in the science course. Each of the eleven face-to-face interviews lasted for about one and a half hours. During the interviews, students were encouraged to use paper and pencil as needed. The questions that formed the basis of the interview protocol were developed based on the literature review, specifically on issues related to the equilibrium of rigid bodies. Students will be introduced to some pictures of Keku from the Tanimbar Islands taken by the research. The pictures taken are original and do not use other people's pictures. The researcher deliberately made the environment more relaxed so that students felt comfortable to describe relevant scenarios. The information included the participants' backgrounds, attitudes, beliefs about physics, and experiences with nature. The interviewer started by asking some general questions. All interviews were recorded transcribed and thoroughly analyzed. To protect the identity of the students, they were given pseudonyms. The results of the previous study revealed that students (a) had problems organizing prior knowledge, (b) could not separate differences in concepts related to cells and tissues, (c) had difficulty remembering and recalling some of their knowledge, and d) explained concepts better when teachers used analogies and visual materials in their lessons. The study also determined that students had eleven high misconceptions (Cavas & Kesercioğlu, 2010). Furthermore, data analysis was conducted qualitatively with data collection, reduction, display, and verification. The data analysis process was carried out from the beginning to the end of the research. The data obtained were then verified and reconstructed into a science. Data interpretation was done through discussions with competent experts in ethnophysics.

3. Results and Discussion

The people of the Tanimbar Islands have a variety of cultures, including *Foruk*, *Badendang* Dance, *Duan-Lolat*, *Tumbur* Statue, Stone Boat, Stone Burning, and Tanimbar Ikat Woven Fabric. No less unique is the *Keku* Culture, as shown in **Error! Reference source not found.**.



Code		Description
N_{TA}	:	Head Normal Force Due to Rope Tension
N_{MK}	:	Body Normal Force Due to Basket Pressure
N_{FR}	:	Ground Normal Force Due to Total Force Pressure Through Right Foot
N_{FL}	:	Ground Normal Force Due to Total Force Pressure Through Left Foot
T_{KK}	:	Rope Tension Acting on Basket Due to Basket Weight
T_{KA}	:	Rope tension acting on the Head due to basket weight
T_{KM}	:	The Pressing Force of the Basket on the Body
T_{FR}	:	The Pressing Force on the Ground from the Right Foot Support Due to the Total Force
T_{FL}	:	The Pressing Force on the Ground from the Left Foot Support Due to the Total Force
W_K	:	Weight Force acting on the Basket Through the Center of Mass of the Basket
W_M	:	Weight Force acting on the body through the body's center of mass
f_{MK}	:	Friction Force of Body and Basket
O_M	:	Vertical stability point line through the center of mass of the body
O_K	:	Vertical Stability Point Line Through the Center of Mass of the Basket

Forces acting on the system (person and Basket)

Figure 1. Activities of Farmers When Carrying Farm Products to the House that are Transferred using *Bakul*

Question asked by the lecturer to the students: *Several forces are acting on this system* (They can only be mentioned but cannot be explained in detail). The explanation by the lecturer is:

3.1. Gravitational Force on Basket due to Weight of Basket and Contents (W_K)

The force of gravity acts on the Basket on the person's back. This force has a magnitude of WK=m· g where m is the mass of the Basket, and its contents and g is the acceleration of gravity (about 9.8 m/s^2 at the Earth's surface). This force pulls the Basket downward, so the person carrying the Basket must resist the weight of the Basket with another force, the normal force NK.

3.2. Normal Force as Reaction of Back Surface to Basket Pressure (N_K)

The normal force is the force exerted by the body surface of the person carrying the Basket, which offsets the force of gravity. This force acts perpendicular to the body surface in contact with the Basket.

3.3. Tension force or rope-pulling force (K_K)

The Rope on the person's Head provides tension to help distribute the Basket's weight. This force works along the length of the Rope and points upwards, helping to lighten the load received by the person's body. The tension depends on the length and strength of the Rope and the size of the Basket being carried.

3.4. Friction Force Between Back and Basket (f_{MK})

The frictional force between the Basket and the person's back is also important. This force prevents the Basket from slipping or falling. The magnitude of this frictional force depends on the coefficient of friction between the surface of the Basket and the back and how intense the pressure between the two is.

3.5. Muscle Force and Body Position (T_{FR}/T_{FL})

The person's body will use the back and leg muscles to hold and lift the Basket. These muscles work to overcome the force of gravity and the forces acting on the body, such as the pressure from the basket's weight. The resultant force will accumulate on the ability of the legs and the pressure of the feet on the ground.

3.6. Tensile and Compressive Force on Neck and Head (T_{KA}/N_{TA})

The head strap also exerts a force on the neck and Head, which aims to keep the Basket stable. This force can cause strain on the neck and head muscles.

3.7. Students must be able to explain some of the reviews (Students need help). The detailed explanation is explained as follows:

3.7.1. Case Studies Based on the Concept of Equilibrium

In the study of equilibrium in physics, we examine the condition where the forces and torques acting on an object balance each other so that the object does not accelerate, either translational (moving in a straight line) or rotational. In the context of a person carrying a basket with a rope on the Head, we can examine the translational and rotational equilibrium in the body. To clarify the study related to the case of rigidity, the mapping of the forces that work can be divided into three sub-systems, namely (Figure 2):

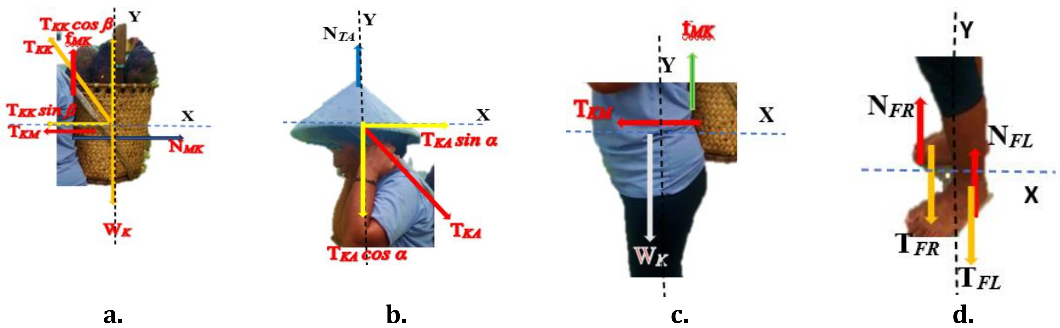


Figure 2. The forces acting on the body

3.7.2. Translational Equilibrium:

Translational equilibrium occurs when the sum of the forces acting on the object (in this case, the human body) equals zero. That is, the forces acting on the body compensate each other so that there is no linear acceleration on the body. For this analysis, we will look at the forces acting on the body of the person carrying the Basket and check if the condition $\sum F = 0$ is satisfied, where ΣF is the total number of forces acting on the body.

The forces acting on the body:

Figure 2.A shows that the gravitational force on the Basket is W_K (the Basket's weight). This force pulls the Basket down by the amount $W_K = m_k \cdot g$, where $m_{(k)}$ is the Basket's mass and g is gravity's acceleration. Frictional Force f_{MK} (between Basket and back): The friction force prevents the Basket from slipping and exerts a force in the horizontal or vertical direction (depending on position).

Normal Force N_{MK} on the Back: This force balances the weight of the Basket acting on the back. This normal force acts on the body and helps hold the Basket. Rope Tensile Force T_{KK}, $T_{KK} \cos ß$, T_{KK}

sin β: The Rope on the Head exerts an upward pulling force to alleviate the load received by the body. To achieve translational equilibrium, the sum of the forces acting on the Basket must satisfy the equations $\sum Fx=0$ and $\sum Fy=0$

If this is imposed on image a, then $\sum F_K x=0$ and $F_K y=0$.

$\sum F_K x=N_{MK}-T_{KK}\sin\beta=0$ and $\sum F_K y=T_{KK}\cos\beta+f_{MK}-W_{(K)}=0$

The sum of the forces acting in the horizontal (x-axis) and vertical (y-axis) directions must equal zero for the Basket and its contents to remain at rest or move at a constant speed. Vertical direction (y) The gravitational force on the Basket must be balanced by the normal force from the back and the pulling force of the Rope at the Head. The frictional force between the back and the Basket must be balanced by the forces acting on the body. In Figure 2. B, the sum of the forces acting in the horizontal direction (x-axis) and the vertical direction (y-axis) is equal to zero in order to maintain a stable head position in balance, the pulling force on the Head will be responded to by the Head in the form of an upward normal force so that the distribution of the Rope pulling force towards the vertical can be balanced as in the following description: $\sum F_A x=T_{KA}\cos\alpha=0$ and $\sum F_A y=N_{TA}-T_{KA}\sin\alpha=0$. If the condition where all the forces acting on the body and basket system, as shown in Figures 2. A,B,C,D both in the horizontal direction (x-axis) and the force acting in the vertical direction (y-axis), have a resultant equal to zero then the system can be said to be in a state of translational equilibrium.

3.7.3. Rotational Equilibrium

In addition to translational equilibrium, we must also consider rotational equilibrium, which occurs when the sum of the torques (moments of force) acting on the body equals zero. If the torques are not balanced, the body will rotate. The torque on the body carrying the Basket can occur at several points, such as the neck (due to the pulling rope T_{KA}) and the body's center of mass (due to the weight of the Basket W_K). Torque (τ) is defined as the product of a force F and a distance d from the point of the axis of rotation, which is perpendicular to the direction of the force $\tau=F\cdot d$. A rotational equilibrium condition is reached if the sum of the torques acting on the body equals zero, i.e., $\sum\tau=0$.

Torque on Neck and Head (Rope Pull T_{KA})

The strap on the head exerts a pulling force T_{KA} and is slightly backward. This force causes a torque on the neck that keeps the body's position stable. The amount of torque on the neck is calculated as:

$\tau_L= T_{(KA)} \times d_L$

$\tau_L= T_{KA}\sin\alpha .\ d_L$

T_{KA} is the pulling force of the Rope acting on the Head, and d_L is the distance from the point of force (on the Head) to the rotation (the axis of the body through the spine).

Torque on Back and Body Center of Mass (Basket Load W_K)

The Basket on the back exerts a downward gravitational force on the WK, which also causes a torque on the body, particularly on the body's center of mass or pelvis. This torque can be calculated by :

$\tau_K= W_{(K)}\times d_P$

$\tau_K= W_{(K)}.d_P$ since the force $W_{(K)}$ is perpendicular to d_L, $W_{(K)}=m_K\cdot g$ is the force of gravity on the Basket. d_P is the distance from the center of mass of the Basket to the axis of rotation of the body (usually at the pelvis or center point of the body). To achieve rotational equilibrium, the sum of the torques acting on the body must equal zero ($\sum\tau=0$). This means that the torque caused by the pulling force of the Rope on the Head must be balanced by the torque caused by the weight of the Basket on the back.

3.7.4. Overall Balance

Total equilibrium of the body carrying the Basket is achieved if the following two conditions are satisfied, i.e. translational equilibrium (∑Fx=0 and ∑Fy=0). The forces acting on the body must compensate each other in horizontal and vertical directions and rotational equilibrium (∑τ=0). The torques acting on the body must counterbalance each other to prevent unwanted rotation. In the case of *keku*, if the person carrying a basket with a rope on the Head is in a stable position, the body is in translational and rotational equilibrium. The forces (basket weight W_K, Rope pulling force T_{KK}, T_{KA}, friction force f_{MK}, and normal force $N_{(K)}$, N_A) must balance each other in the vertical and horizontal directions. In contrast, the torques generated by these forces must balance each other to keep the body from rotating. The body must maintain the correct posture and even load distribution to maintain equilibrium.

3.7.5. *Keku* in the Dynamics Perspective of Newton's Laws

Newton's laws still apply in the rigid case of a person carrying a basket with a head strap, and they can be used to analyze the forces acting on the body and the basket. Here is a classification of the application of Newton's three laws to this case:

Newton's First Law (Law of Inertia)

Statement of law:

Every object will remain at rest or move in a straight line unless an external force acts on it or ∑F=0

In this case:

If the person is at rest (i.e., just standing without moving), his body and the Basket will remain at rest until an external force causes a change in his state of motion. This means that if there is no force that changes the system's state, the person's body and the Basket will remain at rest. It means that it fulfills ∑F=0, and if the person is moving with the Basket on his back, the body and basket system will remain moving at a constant speed if no external force changes its speed (e.g., friction force or thrust force). Therefore, this first law shows that in the absence of an external force acting (e.g., if the person is at rest or moving at a constant speed), the body and basket system will maintain its state of motion.

Newton's Second Law (Law of Acceleration)

Legal statement:

The acceleration of an object (person and Basket) is directly proportional to the total force acting on it and inversely proportional to its mass. It is expressed in the equation:

∑F=m a·

∑F is the total force acting on the object, m is the object's mass, a is the object's acceleration. In the rigid case of a person carrying a basket, we can analyze the forces acting and how the acceleration of the person's body and the Basket depends on the external forces. If the person is moving with acceleration: If any force is applied to the person (e.g., thrust force applied to start walking), then the total force acting will accelerate the body and Basket. $\sum F=(m_{(O)}+m_K)\cdot a_{(K)}$; a_K and a_O are the same because the person and the Basket are considered to be one system or are in a tight condition; the accelerations a_O and a_K are determined by the total force acting on the body and the Basket, and their respective masses. If the person is not moving or moving at a constant speed, Then the total force on the system will be zero, and there will be no acceleration, which means aO or aK=0. In this case, the forces acting on the body and the Basket must be balanced, e.g., the tensile force of the Rope (T_{KK} and the frictional force (f_{MK}) must offset each other, and the gravitational force (W_K) on the Basket balanced by the normal force ($N_{K)}$ on the back.

Newton's Third Law (Law of Action and Reaction)

The third statement of law:

Every action has an equal and opposite reaction. (F_{Action} = - $F_{Reaction}$). In the *keku* case, in the context of carrying a basket with a rope around the Head, Newton's third law can be seen in the interaction of forces between the person's body, the Basket, and the Rope. In the force between the Rope and the Head, the Rope pulls with a tension force T_{KA} on the person's Head, and in reaction, the person's Head exerts an equal and opposite force -T_{KA} on the Rope (action-reaction force). This force causes tension in the Rope and helps relieve the Basket's weight on the body.

Forces on the Back (T_{KM}) and the Basket: when the Basket is placed on the back, the force of gravity W_K pulls the Basket downwards. In response, the back exerts a normal force N_{MK} that holds the Basket in place and prevents the Basket from falling. Frictional Force f_{MK} on Basket and Back: If the basket tries to move or slip off the back, frictional force will arise between the back and the basket. This frictional force has an action force on the Basket -f_{MK}; in reaction, the Basket exerts an equal and opposite frictional force on the person's back.

Physics misconceptions among students have long been a problem for teachers. Language barriers, cultural influences, and past knowledge are just some causes of these errors (Kotsis, 2023). Research has shown that students often retain their misconceptions even after receiving conventional learning, making it more difficult to understand complex scientific topics (Chen et al., 2020). These misconceptions can seriously hinder effective learning as they may be deep-rooted and complex to overcome (Qian & Lehman, 2017). To design focused treatments that meet the unique requirements of students in physics education, it is important to understand the underlying causes of these misconceptions (Kazantzidou & Kotsis, 2023). To eliminate common misconceptions and promote a better understanding of physics concepts, educators can adjust their teaching tactics by recognizing these misconceptions and their sources (Lodge et al., 2018). Misconceptions must be addressed in education as they can hinder students' understanding of basic concepts and impede learning. Misconceptions can significantly impact student learning outcomes in physics (Stylos & Kotsis, 2023). When students need clarification about a particular concept, it can hinder their understanding of related topics and lead to accurate problem-solving approaches. These misconceptions can persist through formal education and beyond if not effectively addressed (Sadler et al., 2013; Batlolona & Jamaludin, 2024). Recent developments suggest that misconceptions in physics education can be efficiently addressed and corrected using practical experiments and the AI-powered conversational aid ChatGPT (Kotsis, 2024).

Many developmental psychologists have recently pointed out that young children have their own 'naïve theories .'Some theorists argue that children's naïve theories consist of naïve physics, naïve psychology, and naïve biology. Children's naïve theories are coherent and causal and have functions such as explanation and prediction. Children have their naïve theories. Teachers can acquire these naïve theories through various pedagogical methods and strategies to understand and scaffold children's learning. Through eliciting naïve theories and through understanding, teachers can also challenge these theories. In considering the continuum of children's experiences, teachers can promote children's development with explanations and predictions, providing evidence, addressing counter-evidence, and even leading instructions. Teacher instruction and teacher-child interactions increase, rather than decrease, in our new model of kindergarten curriculum based on children's naive theories (Yan, 2005).

Contrary to what exists, these naive ideas often do not materialize as irrational or absurd and can even be helpful in everyday life (Vosniadou, 2019). However, some naive ideas prove to be a "pain in the neck" for physics educators, as they often do not correspond to physical science content. Research results show that naive ideas are likely to persist, even after completing a doctorate

(Allaire-Duquette et al., 2021). Therefore, one of the important goals of physics education is to encourage the process of conceptual change. However, conceptual change is often challenging to achieve, and students often revert to naive ideas despite carefully planned teaching (Potvin et al., 2015; Kummer et al., 2016). Most sub-Saharan African countries aim to achieve middle-income economies, so they need a qualified and scientifically trained workforce with 21st-century skills. The workforce that can sustain such complex tasks are those who can understand key science concepts, think critically and reason at a higher level, and understand modern views on the nature of science (Bilican et al., 2015). It is reported that students develop an appropriate understanding of the nature of science and higher scientific reasoning abilities when they engage in complex cognitive tasks such as evidence-based argumentation and promoting curiosity learning strategies employing higher learning and assessment abilities (Opitz et al., 2017), and using evidence-based tools (de Aldama & Pozo, 2020). This suggests that when students engage in complex tasks, they develop higher-order thinking skills and the view that scientific knowledge should be tentatively constructed rather than trying to remember and recall what is written in the textbook as it appears. It was revealed that students perceive scientific knowledge as static, fixed, universal, specific, and unchangeable. It is suggested that it is necessary to consider inquiry-based teaching combined with a contextualized approach to the nature of science in the school science curriculum and classroom teaching to promote students' scientific view of science and higher scientific reasoning ability (Abate et al., 2021). Educational processes generate a wealth of data that can generate actionable insights to innovate how students learn (Rincon-Flores et al., 2022).

Constructivists argue that learning new knowledge is based on old knowledge, and new and old knowledge interact. Children's naive concepts formed in daily experience are the basis of scientific learning, while some of these concepts contradict fundamental science theories and hinder children's learning. Literature summarizes research on children's misconceptions in the field of children's naive physics, analyzes the debate about the natural structure of naive concepts, and lists several important factors, including cognitive conflict, metacognition and motives, epistemological beliefs, which affect the process of concept change (Butler et al., 2015). Concepts are ways of categorizing and classifying things around us based on similar attributes. Concept formation depends on many processes and is a direct product of an individual's culture. Concepts can form without students being aware of the process. As new knowledge is acquired, current conceptions are modified so that students try to understand what they know. Efforts to make sense of the new knowledge can develop inaccurate or incomplete conceptions for students. This is because students personally construct knowledge and actively interpret the social classroom environment (Butler et al., 2015). Naive conceptions and misconceptions embedded in students' prior knowledge prevent students from assimilating new and scientifically robust knowledge and potentially inform students to make unhealthy lifestyle-related decisions. Moreover, certain misconceptions directly contribute to students' acceptance of body image and lifestyle-related social biases and stereotypes. In the future, it is important to examine students' prior knowledge of health literacy and developmental learning activities to address naïve conceptions and misconceptions (Zhang, 2019). A high level of misconceptions in students' explanations indicates their fragmented understanding of these abstract concepts. This may stem from students' lack of knowledge. In addition, differences between students' misconceptions may stem from their level of training (Keshavarz et al., 2017).

4. Conclusion

From the research findings, most of the physics learning seen by students is temporary and does not involve them in developing conceptual understanding. Students often need to realize that they are using different concepts in different contexts, and often, their original concepts are still retained long after the science concepts learned for the exam have been forgotten. Naive conceptions and misconceptions embedded in students' prior knowledge prevent students from assimilating new and scientifically robust knowledge and inform students to make decisions regarding physics concepts. Moreover, certain misconceptions directly contribute positively to the lifestyle of students. In the future, it is important to examine further students' prior knowledge related to emotional literacy, physics communication skills, and learning activities in development to address naive conceptions and misconceptions.

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References

Abate, T., Michael, K., & Angell, C. (2021). Upper primary students' views vis-à-vis scientific reasoning progress levels in physics. *Eurasia Journal of Mathematics, Science and Technology Education*,*17* (5), 2-15. https://doi.org/10.29333/ejmste/10834

Allaire-Duquette, G., Brault Foisy, L. M., Potvin, P., Riopel, M., Larose, M., & Masson, S. (2021). An fMRI study of scientists with a Ph.D. in physics confronted with naive ideas in science. *Npj Science of Learning*,*6* (1), 38-41. https://doi.org/10.1038/s41539-021-00091-x

Batlolona, J. R. (2024). Misconceptions of physics students on the concept of equilibrium of rigid bodies: a case study of keku culture. *Journal of Mathematics and Natural Sciences Education*, *25*(1), 87–102.

Batlolona, J. R., & Jamaludin, J. (2024). Students' misconceptions on the concept of sound: A case study about Marinyo, Tanimbar Islands. *Journal of Education and Learning (EduLearn)*,*18* (3), 681-689. https://doi.org/10.11591/edulearn.v18i3.21135

Bawan. (2024). Refocusing the teaching of physics for the technological development of Nigeria. *British Journal of Education, Learning and Development Psychology*,*7* (3), 14-20. https://doi.org/10.52589/bjeldp-raj4ekc5

Bigozzi, L., Tarchi, C., Fiorentini, C., Falsini, P., & Stefanelli, F. (2018). The influence of teaching approach on students' conceptual learning in physics. *Frontiers in Psychology*,*9* , 1-14. https://doi.org/10.3389/fpsyg.2018.02474

Bilican, K., Cakiroglu, J., & Oztekin, C. (2015). How contextualized learning settings enhance meaningful nature of science understanding. *science Education International*, *27*(4), 463–487.

Butler, J., Mooney Simmie, G., & O'Grady, A. (2015). An investigation into the prevalence of ecological misconceptions in upper secondary students and implications for pre-service teacher education. *European Journal of Teacher Education*,*38* (3), 300-319. https://doi.org/10.1080/02619768.2014.943394

Cavas, B., & Kesercioğlu, T. (2010). A qualitative study on students' understanding and misconceptions regarding the living cell. *June 2009*.

Chang, H. P., Chen, J. Y., Guo, C. J., Chen, C. C., Chang, C. Y., Lin, S. H., Su, W. J., Lain, K. Der, Hsu, S. Y., Lin, J. L., Chen, C. C., Cheng, Y. T., Wang, L. S., & Tseng, Y. T. (2007). Investigating primary and secondary students' learning of physics concepts in Taiwan. *International Journal of Science Education*,*29* (4), 465-482. https://doi.org/10.1080/09500690601073210

Chen, C., Sonnert, G., Sadler, P. M., Sasselov, D., & Fredericks, C. (2020). The impact of student misconceptions on student persistence in a MOOC. *Journal of Research in Science Teaching*,*57* (6), 879-910. https://doi.org/10.1002/tea.21616

Corten-Gualtieri, P., Ritter, C., Plumat, J., Keunings, R., Lebrun, M., & Raucent, B. (2016). Having students create short video clips to help transition from naïve conceptions about mechanics to true Newtonian physics. *European Journal of Engineering Education*,*41* (4), 438-454. https://doi.org/10.1080/03043797.2015.1095157

de Aldama, C., & Pozo, J. I. (2020). Do You Want to Learn Physics? Please Play Angry Birds (But With Epistemic Goals). *Journal of Educational Computing Research*,*58* (1), 3-28. https://doi.org/10.1177/0735633118823160

Docktor, J. L., & Mestre, J. P. (2014). Synthesis of discipline-based education research in physics. *Physical Review Special Topics - Physics Education Research*,*10* , 1-58. https://doi.org/10.1103/PhysRevSTPER.10.020119

Dourado, L., Leite, L., & Morgado, S. (2017). In-Service science teacher education in Portugal: An analysis of the short courses available. *Turkish Online Journal of Educational Technology*,*2017* (November Special Issue INTE), 1065-1076.

Gates, J. (2014). Experimentally Building a Qualitative Understanding of Newton's Second Law. *The Physics Teacher*,*52* (9), 542-545. https://doi.org/10.1119/1.4902198

Hofer, S. I., Schumacher, R., Rubin, H., & Stern, E. (2018). Enhancing physics learning with cognitively activating instruction: A quasi-experimental classroom intervention study. *Journal of Educational Psychology*,*110* (8), 1175-1191. https://doi.org/10.1037/edu0000266

Hull, M. M., Jansky, A., & Hopf, M. (2021). Probability-related naïve ideas across physics topics. *Studies in Science Education*,*57* (1), 45-83. https://doi.org/10.1080/03057267.2020.1757244

Hung, W., & Jonassen, D. H. (2006). Conceptual understanding of causal reasoning in physics. *International Journal of Science Education*,*28* (13), 1601-1621. https://doi.org/10.1080/09500690600560902

Kazantzidou, D., & Kotsis, K. T. (2023). Misconceptions for concepts in sciences in Charles Perrault's fairy tales. *Aquademia*,*7* (2), 1-5. https://doi.org/10.29333/aquademia/13697

Keshavarz, E., Alizadeh, A., & Alizadeh, R. (2017). High school students' ideas about concepts related to chemistry and physics: an exploration of common misconceptions in science. *IOSR Journal of Research & Methods in Education*,*7* (5), 71-74. https://doi.org/10.9790/7388-0705027174

Kloos, H., Fisher, A., & Van Orden, G. C. (2010). Situated naïve physics: task constraints decide what children know about density. *Journal of Experimental Psychology: General*,*139* (4), 625-637. https://doi.org/10.1037/a0020977

Kotsis, K. T. (2023). Alternative ideas about concepts of physics, a timelessly valuable tool for physics education. *Eurasian Journal of Science and Environmental Education*,*3* (2), 83-97. https://doi.org/10.30935/ejsee/13776

Kotsis, K. T. (2024). Correcting Students' misconceptions in physics using experiments designed by chatgpt. *European Journal of Contemporary Education and E-Learning*,*2* (2), 83-100. https://doi.org/10.59324/ejceel.2024.2(2).07

Kummer, T. A., Whipple, C. J., & Jensen, J. L. (2016). Prevalence and persistence of misconceptions in tree thinking. *Journal of Microbiology & Biology Education*,*17* (3), 389-398. https://doi.org/10.1128/jmbe.v17i3.1156

Langsam, H. (2017). The intuitive case for naïve realism. *Philosophical Explorations*,*20*(1), 106–122. https://doi.org/10.1080/13869795.2016.1222627

Lautrey, J., & Mazens, K. (2004). Is children's naive knowledge consistent? A comparison of the concepts of sound and heat. *Leaning and Instruction*,*14* (4), 399-423. https://doi.org/10.1016/j.learninstruc.2004.06.011

Lodge, J. M., Kennedy, G., Lockyer, L., Arguel, A., & Pachman, M. (2018). Understanding difficulties and resulting confusion in learning: an integrative review. *Frontiers in Education*,*3* , 1-10. https://doi.org/10.3389/feduc.2018.00049

Luangrath, P., Pettersson, S., & Benckert, S. (2011). On the use of two versions of the force concept inventory to test conceptual understanding of mechanics in Lao PDR. *Eurasia Journal of Mathematics, Science and Technology Education*,*7* (2), 103-114. https://doi.org/10.12973/ejmste/75184

Luangrath, P., & Vilaythong, T. (2010). An analysis of the students' perceptions of physics in science foundation studies at the national university of Laos. *Canadian and International Education Journal*,*39* (1), 32-40. https://doi.org/10.5206/cie-eci.v39i1.9145

Manunure, K., Delserieys, A., & Castéra, J. (2020). The effects of combining simulations and laboratory experiments on Zimbabwean students' conceptual understanding of electric circuits. *Research in Science and Technological Education*,*38* (3), 289-307. https://doi.org/10.1080/02635143.2019.1629407

Nehring, A. (2020). Naïve and informed views on the nature of scientific inquiry in large-scale assessments: Two sides of the same coin or different currencies? *Journal of Research in Science Teaching*,*57* (4), 510-535. https://doi.org/10.1002/tea.21598

Opitz, A., Heene, M., & Fischer, F. (2017). Measuring scientific reasoning-a review of test instruments. *Educational Research and Evaluation*,*23* (3-4), 78-101. https://doi.org/10.1080/13803611.2017.1338586

Phanphech, P., Tanitteerapan, T., & Murphy, E. (2019). Explaining and enacting for conceptual understanding in secondary school physics. *Issues in Educational Research*, *29*(1), 180–204.

Potvin, P. (2013). Proposition for improving the classical models of conceptual change based on neuroeducational evidence: conceptual prevalence. *Neuroeducation*,*2* (1), 16-43. https://doi.org/10.24046/neuroed.20130201.16

Potvin, P., Sauriol, É., & Riopel, M. (2015). Experimental evidence of the superiority of the prevalence model of conceptual change over the classical model and repetition. *Journal of Research in Science Teaching*,*52* (8), 1082-1108. https://doi.org/10.1002/tea.21235

Qian, Y., & Lehman, J. (2017). Students' misconceptions and other difficulties in introductory programming: A literature review. *ACM Transactions on Computing Education*,*18* (1), 1-24. https://doi.org/10.1145/3077618

Reiner, M., Slotta, J. D., Chi, M. T. H., & Resnick, L. B. (2000). Naive physics reasoning: A commitment to substance-based conceptions. *Cognition and Instruction*,*18* (1), 1-34. https://doi.org/10.1207/S1532690XCI1801_01

Rincon-Flores, E. G., Lopez-Camacho, E., Mena, J., & Olmos, O. (2022). Teaching through Learning Analytics: Predicting Student Learning Profiles in a Physics Course at a Higher Education Institution. *International Journal of Interactive Multimedia and Artificial Intelligence*,*7* (7), 82-89. https://doi.org/10.9781/ijimai.2022.01.005

Sadler, P. M., Sonnert, G., Coyle, H. P., Cook-Smith, N., & Miller, J. L. (2013). The influence of teachers' knowledge on student learning in middle school physical science classrooms. *American Educational Research Journal*,*50* (5), 1020-1049. https://doi.org/10.3102/0002831213477680

Sarabando, C., Cravino, J. P., & Soares, A. A. (2014). Contribution of a Computer Simulation to Students' Learning of the Physics Concepts of Weight and Mass. *Procedia Technology*,*13*, 112– 121. https://doi.org/10.1016/j.protcy.2014.02.015

Souisa, C. A., Batlolona, J. R., & Malawau, S. (2024). Student misconceptions about heat transfer mechanisms: an island ethnophysics study. *KnE Life Sciences*,*2024* , 162-179. https://doi.org/10.18502/kss.v9i31.17567

Stricker, J., Vogel, S. E., Schöneburg-Lehnert, S., Krohn, T., Dögnitz, S., Jud, N., Spirk, M., Windhaber, M. C., Schneider, M., & Grabner, R. H. (2021). Interference between naïve and scientific theories occurs in mathematics and is related to mathematical achievement. *Cognition*,*214* , 1-6. https://doi.org/10.1016/j.cognition.2021.104789

Stylos, G., & Kotsis, K. T. (2023). Undergraduate physics students' understanding of thermal phenomena in everyday life. *Contemporary Mathematics and Science Education*,*4* (2), ep23023. https://doi.org/10.30935/conmaths/13406

Suwasono, P., Sutopo, S., Handayanto, S. K., Mufti, N., Sunaryono, S., & Taufiq, A. (2023). Alleviating students' naive theory on newton's laws of motion through problem optimization and scaffolding discussion. *Education Research International,2023* , 1-19. https://doi.org/10.1155/2023/2283455

Vlok, M., & de Witt, M. W. (2012). Naive theory of biology: The pre-school child's explanation of death. *Early Child Development and Care*,*182* (12), 1645-1659. https://doi.org/10.1080/03004430.2011.636811

Vosniadou, S. (2019). The Development of Students' Understanding of Science. *Frontiers in Education*,*4* (April), 1-6. https://doi.org/10.3389/feduc.2019.00032

Wilson, M. (2020). Mechanics: force, mass, acceleration energy, work, power. *Anaesthesia and Intensive Care Medicine*,*21* (5), 256-260. https://doi.org/10.1016/j.mpaic.2020.02.007

Yan, C. (2005). Developing a kindergarten curriculum based on children's 'naive theory.' *International Journal of Early Years Education*,*13* (2), 145-156. https://doi.org/10.1080/09669760500171162

Zhang, T. (2019). Elementary school students' naïve conceptions and misconceptions about energy in physical education context. *Sport, Education and Society*,*24* (1), 1-16. https://doi.org/10.1053/j.gastro.2019.03.013.Mechanical

Zhang, T., Chen, A., & Ennis, C. (2019). Elementary school students' naïve conceptions and misconceptions about energy in physical education context. *Sport, Education and Society*,*24* (1), 25-37. https://doi.org/10.1080/13573322.2017.1292234