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# Designing Mathematics Teaching through Deep Learning Pedagogy: Toward Meaningful, Mindful, and Joyful Learning

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## Abstract

Mathematics education in the 21st century requires an approach that focuses not only on procedural mastery but also on deep conceptual understanding, critical thinking skills, and the ability to transfer knowledge across various life contexts. This article discusses the design of mathematics learning based on a *deep learning* approach not in the context of artificial intelligence, but as a pedagogical approach integrating three core principles: meaningful, mindful, and joyful. Meaningful learning is built through contextual activities and open-ended problems that connect mathematical concepts to real-world situations. Reflective and process-aware learning is facilitated through discussion, metacognitive reflection, and evaluation. Meanwhile, a joyful learning environment is created through active participation, open exploration, and recognition of diverse student thinking styles. The theoretical framework includes constructivism, transfer theory, metacognition, and process-based assessment. The implementation of this approach requires a transformation of the teacher's role into a facilitator, a flexible and meaning-oriented curriculum, and a supportive, collaborative learning environment. It is concluded that the deep learning approach, through the principles of meaningful, mindful, and joyful learning, can enhance student engagement, deepen understanding, and foster a positive attitude toward mathematics.

**Keywords:** constructivism, deep learning, joyful learning, mathematics learning, meaningful learning, mindful learning

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## 1. Introduction

The rapid development of technology in the last two decades has shifted the educational paradigm from a traditional approach to more adaptive and collaborative learning. This transformation encourages the role of teachers to no longer only be a conveyor of information, but as a facilitator of learning that creates an active, reflective, and innovative classroom atmosphere. Teachers are required to be able to design learning that is relevant to the needs of 21st century students who are not only required to master the content, but also think critically, creatively, communicatively, and collaboratively. One approach that emerges in this context is student-centered learning by paying attention to the psychological, social, and emotional aspects of students. Therefore, teachers need to have competence in designing teaching tools that are contextual and in accordance with the characteristics of students in their classes. Learning can no longer be uniform, but needs to be tailored to students' learning styles, interests, and backgrounds. These abilities do not arise automatically, but rather need to be built through training, professional reflection, and a learning community. In line with Piaget's (1972) constructivist approach, knowledge is actively built by learners through interaction with the environment and meaningful learning experiences. Therefore, a good learning design will be the key to creating an effective and memorable learning process (Yuliana & Rahayu, 2021).

In an effort to create meaningful *learning*, teachers must be able to relate teaching materials to the context of students' real lives. This is in accordance with the theory of meaningful learning by David Ausubel who states that learning will be more effective if new information can be linked to the knowledge that students already have before (Ausubel, 1968). Contextual learning not only makes students understand the material more deeply, but also encourages them to develop a complete understanding of the problems around them. In practice, teachers need to create learning activities that encourage exploration, experimentation, and real problem-solving. This approach will increase student engagement and make them feel that what they are learning is relevant to their lives. The use of digital media, learning videos, and interactive simulations can also support the creation of meaningful learning experiences. This is where the teacher's ability to choose or design teaching tools that are in accordance with the characteristics of students and the learning context is important. This competence is not only technical, but also pedagogical, which reflects the professionalism of the teacher as a learning designer. Teachers who are able to carry out this function optimally will be able to realize more meaningful education and empower students (Prasetyo & Sari, 2022).

In addition to being meaningful, learning also needs to be conscious and reflective, or known as *mindful learning*. This concept was introduced by Ellen Langer who emphasized the importance of full awareness in the learning process so that students are able to pay attention to nuances, contexts, and choices in learning situations (Langer, 1989). In this approach, students are invited to actively reflect on their understanding, question information, and evaluate their thought processes. Teachers as facilitators must create an atmosphere that encourages students to think critically and be open to new possibilities. One technique that can be used is reflection-based learning, a daily study journal, or small group discussions that give students space to express their thinking process. Thus, learning is no longer only oriented to the end result, but also to the process that students go through. Mindful learning will produce students who are more aware of their learning goals, more independent, and more resistant to learning challenges. In the context of the Merdeka curriculum, the mindful learning approach is very relevant to form a reflective and civilized Pancasila student profile. The application of mindful learning also has a positive impact on students' mental health because they feel more valued and involved in the learning process (Handayani, 2023).

In addition to being meaningful and aware, *the joyful learning* aspect is also very important in creating a healthy and productive learning atmosphere. Fun learning is not without challenges, but rather a balance between emotional engagement, curiosity, and cognitive achievement. According to the Flow theory from Mihaly Csikszentmihalyi (1990), the optimal conditions for learning occur when students feel challenged but still feel able to face the challenge. Teachers need to design activities that are engaging, interactive, and varied, for example through educational games, simulations, creative projects, and the use of technology. Fun learning also increases students' intrinsic motivation, which is essential for long-term learning. When students feel happy and emotionally connected to learning, their knowledge retention and involvement in the learning process will increase. Teachers need to create an environment that is supportive, pressure-free, and respects the diversity of students' ways of thinking. Thus, learning will be a positive experience, not a burden. This is especially important in the post-pandemic era, when students' mental and social-emotional health needs to be given more attention. Teachers who are able to create *joyful learning* consistently will help form a generation of lifelong learners (Lubis & Kurniawati, 2024).

In this whole framework, the teacher's ability to design meaningful, conscious, and fun learning is very central. This role cannot be replaced by technology, but needs to be supported by digital literacy, pedagogical understanding, and sustainable professional reflection. In the context of Indonesia's growing education, teachers play a strategic role in shaping an adaptive and inclusive learning system. Therefore, teacher training should not only emphasize on administration or workload fulfillment, but should be focused on increasing their capacity as designers of the learning process. Recent research shows that the success of the implementation of the independent curriculum is highly dependent on the readiness of teachers in designing and implementing differential learning (Sutanto & Wijaya, 2025). This shows that the professionalism of teachers is not only measured by content knowledge, but also by pedagogical skills and creativity in designing learning. With this competency strengthening, it is hoped that classroom learning will become more relevant, lively, and have a long-term impact on the development of students' character and competencies in the future.

The rapid development of technology and social changes today have significantly changed the pattern of education. Teachers no longer play the role of only informants, but also as designers, facilitators, and innovators of learning who are able to develop students' competencies as a whole (Aliustaoglu & Tuna, 2022). In this context, the ability of teachers to design learning tools independently is crucial, because teachers best understand the character of their students so that teachers can choose/design devices to be used in learning according to student characteristics which will ultimately give students the opportunity to get meaningful learning, with *mindfulness*, and fun learning (*joyful*).

Designing device Independent learning allows teachers to tailor learning materials and methods to the needs, characteristics, and context of students. This is in line with the *pedagogical content knowledge* (PCK), which emphasizes the importance of integration between material knowledge, pedagogy, and learning contexts (Wood, 2021). Studies show that teachers' involvement in lesson planning improves their understanding of teaching materials and effective teaching strategies (Mok & Park, 2022). In addition, the involvement of teachers in designing learning tools makes teachers to always reflect which can encourage the improvement of a teacher's professionalism. When designing a learning tool, of course, teachers must think about what plan will be developed and how the procedure will be developed.

According to Behling et al. (2023) through *the planteach-reflect* cycle, teachers can evaluate and improve their teaching practices on an ongoing basis. Of course, this will be good for students and teachers because it can make the learning provided relevant and effective. When designing learning, it requires teachers to continue to develop their technological abilities because the development of digital technology requires teachers to integrate technology in the learning process. The development of *technological pedagogical content knowledge* (TPACK) is important so that teachers can design learning that is relevant to the digital era (Su, 2023). Research shows that teachers who develop a TPACK approach in learning will be able to create learning that is more interactive and in accordance with the needs of students. The integration of technologies such as artificial intelligence (AI) can also be a tool in designing learning devices. Studies show that the use of AI can assist teachers in designing more personalized and efficient learning (Karpouzis et al., 2024). However, it is important for teachers to remain critical and reflective in using technology, to ensure that the AI is truly appropriate and supports learning objectives. Thus, the *ability* of 21st century teachers to design learning tools independently/independently is important in improving the quality of education. This not only supports the development of teacher professionalism, but also ensures that the learning provided is in accordance with the needs and challenges of the times. But the challenges in designing learning are also not easy. For example, teachers often lack time, resources, and support in the learning process (Phillipson, 2024). The large administrative burden of a teacher causes the teacher's priorities to change, which should be prioritized for the success of the learning process by designing quality learning. One of the learning tools that teachers need to develop is mathematics learning tools, because the abstract nature of mathematics always makes it difficult for students to understand it.

Mathematics learning is an important foundation in shaping students' logical, analytical, and critical thinking skills. The demands of 21st century learning should use an approach that is able to explore these abilities in more depth. However, the reality in the field shows that the mathematics learning process in schools is still stuck in a conventional pattern that is oriented towards memorizing formulas and problem-solving procedures. This learning model risks causing students to understand mathematics superficially, uncontextually, and lose the true meaning of the concepts learned. As a result, many students have difficulty solving non-routine problems, relating between concepts, and applying mathematics in their daily lives.

One of the approaches that is relevant to these demands is the deep learning approach. This approach does not simply emphasize the achievement of academic outcomes, but rather the process of forming a whole, reflective, and meaningful conceptual understanding. *Deep learning* encourages students to integrate new knowledge with previous knowledge, explore ideas critically, and develop the ability to think abstractly and creatively (Biggs & Tang, 2011). Trigwell and Prosser (2020) explained that the deep learning approach is closely related to the quality of learning outcomes, because students who apply this approach tend to understand the structure of the meaning of learning materials as a whole. They are not only memorizing information, but also actively constructing meaning, relating new ideas, and applying concepts in relevant contexts. In the context of mathematics learning, this is very important considering the characteristics of the subject which are hierarchical and interrelated between concepts.

Several studies have shown the positive impact of applying deep learning approaches in mathematics learning. Research by Zhang and Zheng (2020) shows that the deep learning approach contributes significantly to academic achievement in mathematics, especially in terms of concept mastery, thinking flexibility, and reflective problem-solving ability. In addition to having an impact on cognitive aspects, the deep learning approach also has an impact on affective aspects such as student motivation and self-efficacy. Rodríguez et al. (2018) in their research stated that the deep learning approach can increase students' self-confidence in completing academic tasks, especially when students feel that the learning process is meaningful and relevant to their lives. This is reinforced by the findings of Nhat & Le (2023). which emphasizes that the practice of reflection, elaboration strategies, and information organization that are characteristic of deep learning have a positive influence on intrinsic motivation and student learning outcomes.

The learning conditions in Indonesia, especially in mathematics subjects at the junior high school level, still show a gap between curriculum expectations and practice in the field. The Independent Curriculum as the latest education policy mandates learning that emphasizes strengthening competencies, critical thinking, problem-solving, and contextual learning. However, many teachers do not yet have the appropriate pedagogical understanding or model to realize this meaningful learning. Therefore, designing mathematics learning with a deep learning approach is very important to answer this challenge. It is in this context that it is important to design a mathematical learning model that integrates *deep learning* principles systematically and applicatively. The model should be able to encourage students to think critically, build deep conceptual understanding, and develop metacognitive skills. McGregor (2020) argues that *the deep learning approach* encourages students to build new knowledge through reflection and connection with previous understanding, rather than simply memorizing information. Furthermore, Biggs and Tang (2011) introduced the concept *of constructive alignment* which is an important foundation in deep learning. In this concept, learning objectives, learning activities, and assessments must align with each other to encourage students to achieve deep understanding. If learning activities are only in the form of lectures and routine exercises, then what happens is that students only adjust to these demands without really understanding the substance of the material being studied.

The close link between *deep learning* approaches and 21st-century competencies such as critical thinking, creativity, and collaboration shows that these approaches are not only academically relevant, but also practical. In the ever-changing global context, students are required to have lifelong learning, and this can only be formed through a learning process that fosters deep understanding, not just the results of a momentary exam. The *deep learning* approach in education emphasizes meaningful, mindful, and fun learning, which can increase student engagement and understanding (Sari & Lestari, 2024).

By paying attention to various empirical findings and current educational needs, it is clear that the development of mathematics learning based on *a deep learning* approach is not just an option, but an urgent need. Learning designed with the principles of *deep learning* will help students build meaningful understanding, increase motivation and confidence, and better prepare them for future challenges.

However, although the concept of *deep learning* has been widely discussed in the context of 21st century learning, its application specifically in the context of mathematics learning at the primary to secondary education level is still relatively limited, especially in terms of structured, contextual, and evidence-based learning designs. Most of the existing research is still general or theoretical, not yet leading to an operational learning model that can be applied directly by teachers in the classroom.

In addition, there is still a lack of literature that comprehensively integrates *deep learning* principles such as meaningful, collaborative, reflective, and transformative learning into systematic mathematics learning designs. This gap is the basis and urgency of this paper, namely to design mathematics learning based on *a deep learning* approach that is not only conceptually strong, but also applicable and relevant to the real needs of students and the demands of today's curriculum.

21st-century mathematics education is no longer enough to simply emphasize mastery of mechanical procedures and skills. A learning approach is needed that encourages students to think critically, is able to transfer concepts to various contexts, and understands the meaning behind mathematical processes. In this context, the *Deep Learning* not in the sense of artificial intelligence technology, but as a pedagogical approach offering a strategic framework that emphasizes conceptual understanding, integration of ideas, and long-term meaningful learning (Biggs & Tang, 2015).

*Surface learning* It is characterized by the student's attempt to memorize and fulfill the demands of the task without understanding the essence of the concept. Instead *Deep Learning* encourage students to build connections between ideas, reflect on their understanding, and be able to apply concepts to new situations (Boaler, 2015). In math learning, this approach demands designing learning experiences that are challenging, relevant, and actively engage students.

The following is a theoretical framework for why it is necessary to design learning using a deep learning approach.

The deep *learning* approach is deeply rooted in the theory of constructivism which holds that knowledge is actively constructed by students through experience and reflection (Lepp & Barklund, 2018). In this context, the teacher plays the role of a facilitator who guides students to explore concepts, make generalizations, and build a deep understanding of mathematical ideas.

Learning design that aligns with constructivist approaches and supports *deep learning* must start from the formulation of contextual problems that are relevant and stimulate students' curiosity. Teachers can present real problems or authentic situations that are close to students' daily lives, such as the question "How do I calculate the volume of water needed to fill a school pool?" Problems like this not only encourage students to think critically, but also give meaning to the learning they are undergoing. Once the problem is designed, the next step is to facilitate exploration and discovery. In this stage, students are invited to find their own solutions, develop hypotheses, try various strategies, and use available learning tools and resources. Teachers provide a space for discussion and accompany students' thinking processes so that they can build understanding independently.

In addition, learning must also encourage collaboration between students. The use of methods such as group discussions, debates, presentations, or collaborative projects can develop communication, cooperation, and reflective thinking skills. In this process, teachers play the role of facilitators who guide students, not as an information center. After the learning activity has taken place, it is important to integrate reflection as part of strengthening understanding. Students are invited to reflect on what they learn, how their process is in achieving that understanding, and how that knowledge can be used in other contexts. Finally, learning should make room for students' cognitive growth. Teachers need to adapt challenges to students' abilities based on *the zone of proximal development* (ZPD), provide temporary assistance (scaffolding), and gradually reduce them as students' independence increases. This approach supports deep, meaningful, and ongoing learning.

*Deep learning* also emphasizes knowledge transfer, which is the ability of students to apply what they learn to a new context (Hattie & Donoghue, 2016). In addition, the role of metacognition is very important: students need to learn how they learn, recognize their misunderstandings, and correct them through reflection.

The SOLO (Structure of Observed Learning Outcomes) taxonomy is used to evaluate the depth of student understanding, from unistructural to extended abstract (Donnison & Penn-Edwards, 2019). The deep learning approach aims to take students to the upper levels in this taxonomy.

## 2. Method

This research uses a qualitative approach with the type of library research. This approach is used to delve deeply into the concepts, principles, and implementation of *deep learning* approaches in mathematics learning based on relevant theoretical and empirical sources.

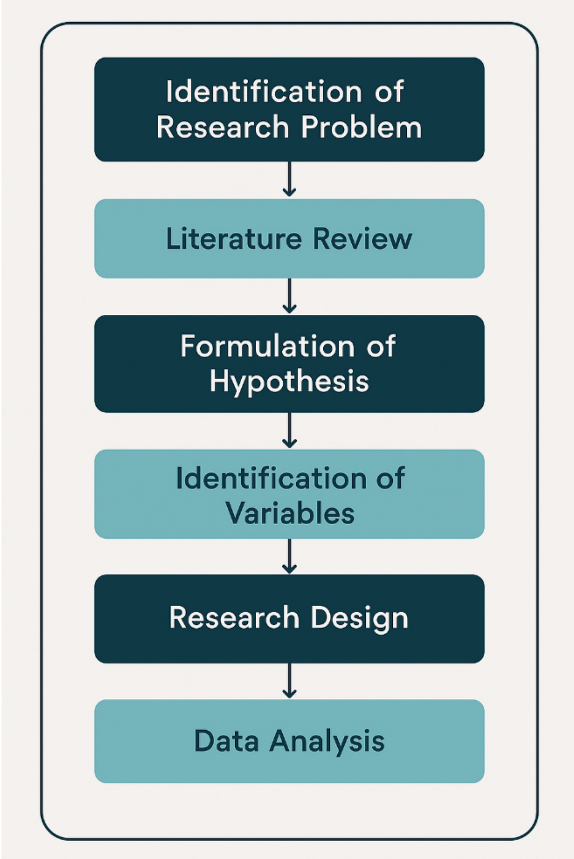


**Figure 1. Research Flow**

Literature review is carried out systematically by collecting, analyzing, and synthesizing various scientific literature to design a mathematical learning framework based on *a deep learning* approach. This research aims to provide conceptual contributions in the form of learning models or designs that can be tested in further research empirically (Moleong, 2019).

The data sources in this study were obtained from various secondary libraries that are relevant to the focus of the study, especially in the fields of mathematics education, *deep learning*, and learning theory. Data was collected through literature studies of textbooks and the main references used in the world of education. In addition, articles from reputable national and international journals published in the last ten years (2015–2024) are also used as the main reference to ensure the novelty and relevance of information. Not only that, conference proceedings, dissertations, and research report results that are closely related to the topic discussed are also used as considerations. All library sources were selected selectively based on the criteria of relevance to the topic, novelty of content, and credibility of the publisher or academic institution that published it, in order to ensure the accuracy and reliability of the data used in this study.

The data collection technique in this study was carried out through the documentation method. This process begins with searching for scientific sources through various reputable databases such as Google

Scholar, ERIC, Scopus, and DOAJ. In the search, keywords relevant to the research focus were used, including *deep learning in mathematics education*, *conceptual understanding*, *constructivist learning*, *metacognition*, *transfer of learning*, and *SOLO taxonomy*. Once relevant sources are found, researchers record and organize the literature findings into several main topic categories, such as learning strategies, assessments, the role of teachers, and theoretical frameworks. This approach is carried out systematically to ensure that the data collected is not only relevant, but also supports the conceptual and analytical foundations in the research.

## 3. Results and Discussion

### a. Designing Learning with a Deep Learning Approach

*Deep learning* in the context of education does not refer to *deep learning* in artificial intelligence technology, but to deep learning (*deep approach to learning*), which is a learning approach that encourages students to understand thoroughly, relate knowledge to experience, and develop critical and reflective thinking skills.

According to Biggs & Tang (2011), *the deep learning* approach occurs when students actively try to understand the meaning of the subject matter, rather than just memorizing facts. The main goal is to form a solid conceptual understanding, allowing students to apply knowledge in different contexts and solve problems creatively.

One of the main characteristics of learning with *a deep learning* approach is that the learning process is student-centered, where students play an active role as subjects who build knowledge through experience and interaction. This learning is also meaningful, because students are invited to relate the material to their real lives and personal experiences, so that the information learned is not separate from the daily context. In addition, *deep learning* encourages reflection, both on the learning process and outcomes. Students are given space to think critically, evaluate their own understanding, and devise more effective learning strategies.

Another feature is the use of contextual and authentic learning. The assignments and activities given are designed to challenge students in integrating concepts into real situations, rather than just doing regular exercises. This approach is also problem-solving and collaborative, where students are invited to engage in exploration, discussion, and group work to build deeper understanding. Thus, learning focuses not only on the final outcome, but also on the thought process and skills that develop during learning.

### b. Steps to Designing Learning with a Deep Learning Approach

The initial steps in Planning learning Meaningful be by identifying the core and essential competencies that you want to develop. The main focus is directed on high-level thinking skills (*Higher order thinking skills*), such as analysis, evaluation, and synthesis.

The selection of materials must also prioritize in-depth understanding of concepts, not just memorization, in order to encourage *meaningful learning*. After the competencies are determined, the next step is to design a triggering question or learning challenge in the form of open-ended questions that are exploratory in nature. Questions like "Why can one math strategy be more effective than another?" can spark discussion and foster students' curiosity, in line with the principles of *mindful learning*.

To encourage active student engagement, it is important to develop activities that demand the application of knowledge in a real-world context. Activities such as projects, case studies, experiments, or simulations will provide space for students to learn deeply and reflectively. Meaningful discussions, *peer teaching*, and *learning journal writing* are also important parts of this process to strengthen engagement and understanding. In addition, the use of authentic assessments is highly recommended, for example in the form of portfolios, performance rubrics, and qualitative feedback. Assessment focuses not only on the final outcome, but also on the student's thought process and development. Finally, all of these efforts need to be supported by a collaborative learning environment that supports *joyful learning*, which is a safe environment to ask questions, give opinions, and learn from mistakes (Adhantoro et al., 2025). Collaborative activities and cross-disciplinary projects can strengthen a sense of community and form a positive learning culture in the classroom.

### c. Deep Learning-Based Mathematics Learning Strategies

### 1. Designing Activity Sheet and Meaningful Tasks

Questions and activities ask not only "how did it work", but "why is that", "what is the relationship between concepts", and "what if conditions change?" Teachers encourage strategic exploration, not just one solution (Boaler, 2015). Three Principles emphasized in the approach *Deep Learning* that is *mindful learning, meaningful learningand joyful learning*. These three main principles are intertwined to create an experience Learn Yeffective and meaningful.

### 2. Mindful Learning

The main focus of this learning is awareness and mindfulness in learning. Meanwhile, the goal is for students to be active, critical, and open in thinking. This principle emphasizes the awareness that each individual has a different background, potential, and way of learning. Teachers are expected to recognize the uniqueness of each student, so that they can adjust teaching methods that encourage active engagement and critical thinking. Thus, students are encouraged to think with full awareness and creativity during the learning process. There are three criteria that show that students are actively involved, focusing on new things, including; (1) Students do not learn automatically or passively, but are aware of what is being learned; (2) There is openness to new perspectives; and (3) Students dare to ask, explore, and seek the meaning of the subject matter. For example, when solving a math problem, students not only follow the steps taught by the teacher, but also think: "Is there another easier way? Why is this method used?"

### 3. Meaningful Learning

The main focus of this learning is deep understanding and connection with previous experiences. The goal is for students to really understand and be able to apply the knowledge that has been acquired into their daily lives. Meaningful learning occurs when students can relate new knowledge to existing experiences or knowledge. This makes the material learned more relevant and significant for students, allowing students to better understand and internalize information. The characteristics of this meaningful learning are as follows; (1) students do not just memorize, but understand concepts; (2) the material studied is related to real life; and (3) learning emphasizes the interconnectedness between concepts. For example, when learning about the area of a flat building, the teacher associates the lesson with the calculation of the area of the yard. Students become more understanding because they can imagine and apply it in real life.

**4. Joyful Learning**

The main focus of this learning is a fun learning atmosphere. The goal is for students to be happy, motivated, and not bored of learning. A fun learning experience is important for increasing student motivation and engagement. Approaches to learning that incorporate fun elements, such as games or interactive activities, can make students more enthusiastic and motivated in learning. Because currently students are developing rapidly in technological advancement, teachers should design interactive media so that students feel interested and happy in the learning process.

The characteristics of fun learning are as follows; (1) the classroom environment is fun and non-stressful; (2) teachers use a variety of creative methods, such as games, stories, experiments, or group activities; and (3) students feel valued and free to express ideas.

The first example, the teacher invites students to play interactive quizzes or create interesting small projects. Students become active, laughing, and enthusiastic about learning because the learning atmosphere feels like playing. The next example provides time for reflection and discussion, as Deep learning requires time for students to reflect on their understanding. Group discussions, study journals, and formative assessments are used to help students become aware of their thought processes (Tan, 2017). Another example is Associating Concepts with Real Life. Mathematics is studied not as a collection of abstract symbols, but as a tool for understanding and solving problems in the real world. Contextualization deepens understanding because students see the relevance of the concepts being learned (Núñez & Leon, 2022). For example, in math learning, teachers may ask students to explore applications of linear equation systems in real life, such as in financial planning. Students are not only asked to solve problems, but also create simulations of problems and explain their solution strategies through group presentations.

The following are Student Activities designed in mathematics learning with Phytagoras theorem material. From these questions (figure 1), it is hoped that students will gain a relevant, meaningful, and fun experience.

**Question:**

**Figure 2. Sample Questions**

The traditional Batak Mandailing house from North Sumatra has a triangular roof. When viewed from the side, the roof forms two sloping sides of equal length and flat base. Builders want to know the height of the roof in order to make a precise triangular frame.

**Known:**

- Length of the sloped side of the roof: 6 meters
- Base length (width of the house): 8 meters

**Question:**

1. How high is the roof of the traditional house?
2. Sketch a mathematical model of the roof of the house.

**Settlement:**

**Step 1: Drawing a Mathematical Model Sketch**

The roof of the Batak Mandailing traditional house can be described as a triangular with:

- Slanted side = 6 meters (two sides equal length)
- Base (width of the house) = 8 meters

We'll use the concept of geometry to find the height of the roof. The height of the roof is a perpendicular line from the apex of the triangle to the base of the triangle, dividing the base into two equal parts of equal length.

Mathematical model sketch:

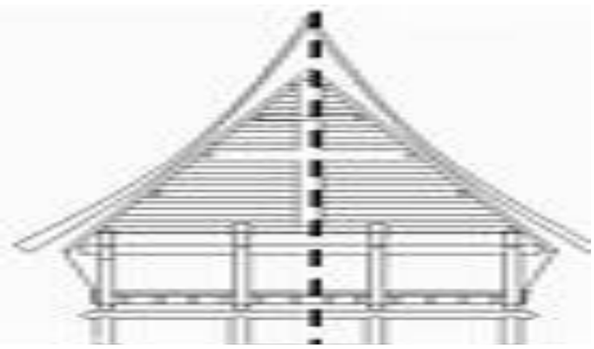

**Figure 3. Sketch of the mathematical model of the Batak Mandailing Traditional House**

Where:

- Slanted side = 6 meters
- Base = 8 meters (divided into two equal parts of equal length, i.e. 4 meters each)

**Step 2: Finding the Roof Height**

To find the height of the roof, we use the Pythagorean Theorem on one of the right triangles that are formed. This right-hand triangle has:

- Hypotenuse = slope of the roof = 6 meters
- One side of the base = half of the base = 4 meters
- Side height = roof height (to be searched)

Pythagorean theorem:

$c2=a2+b2$

where:

- $c$ = hypotenuse (sloping side of the roof) = 6 meters
- $a$ = side of the base = 4 meters
- $b$ = roof height (to be searched)

Value substitution:

62=42+b2

36=16+b2

$b2=36-16$

$b2=20$

$b=\sqrt{20}$

$b=2\sqrt{5}$ meters

**Step 3: Answer**

1. The height of the roof of the traditional house is $2\sqrt{5}$ meters.
2. A sketch of a mathematical model has been made above.

**Final Answer:**

$2\sqrt{5}$ meters.

### d. Authentic and Process-Based Assessments

Assessments are not only in the form of final tests, but also observations, projects, and portfolios that assess students' thinking processes, conceptual understanding, and critical thinking abilities (Zepke, 2018).

### Application of *Meaningful, Mindful, and Joyful Principles*

To create meaningful, conscious, and fun learning, teachers can combine these three principles in one learning activity. Here's an example of how to apply as shown in Figure 4:

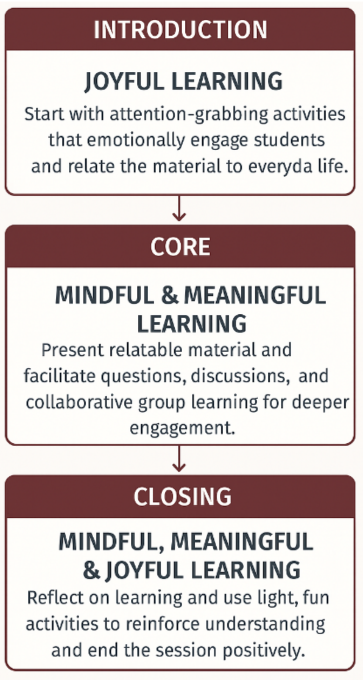


**Figure 4. Three Stages of Engaging and Effective Teaching**

In the early stages of learning or introduction, the approach used should focus on *joyful learning* to arouse students' interest and enthusiasm for learning from the beginning. Teachers can open the lesson with fun and attention-grabbing activities, such as light games, stories associated with local culture, or short video playbacks relevant to the material. This introductory activity serves as an emotional and cognitive bridge for students to feel close to the topic to be studied. For example, teachers can start a math lesson by showing an animated video that shows a graph in everyday life, such as comparing the price of goods or the distance traveled. This approach not only creates a fun learning atmosphere, but it also makes it easier for students to relate the material to the real context in their lives.

At the core learning stage, the approach used focuses on *meaningful* and *mindful learning*. Teachers present material that is directly related to students' daily lives so that learning becomes more meaningful and relevant. In this way, students not only understand concepts theoretically, but are also able to see their application in a real context. Furthermore, teachers provide a space for students to ask questions, explore various solutions, and discuss their own ideas and strategies. This approach encourages *mindfulness* and active involvement in the thought process. To reinforce this process, learning is carried out collaboratively through group discussions or joint projects, so that students can exchange ideas and build understanding collectively. For example, in learning about the area of a flat building, the teacher invites students to measure the school garden directly and calculate the area using various approaches. Students are then asked to explain the processes they use, so that they not only understand formulas, but also develop critical thinking and problem-solving skills.

In the final or closing stage of learning, teachers can combine all three approaches at once, namely *mindful*, *meaningful*, and *joyful learning*. The closing process begins by inviting students to reflect on what they have learned, both in terms of understanding the concept and the thought process they experienced. This reflection helps students realize their self-development and strengthen their *mindfulness*. Furthermore, teachers reconnect the subject matter with the real lives of students so that learning feels meaningful and meaningful. In closing, teachers can provide light and fun activities, such as interactive quizzes, creative challenges, or simple games that stay relevant to the material, to create a positive and enthusiastic atmosphere at the end of the session (*joyful*). This well-rounded approach not only strengthens students' understanding, but also builds a fun and memorable learning experience.

The implementation of the deep learning approach in mathematics learning in the field requires changes to; (1) The role of the teacher: from instructor to facilitator; (2) Curriculum design: from dense content to deepened focus on key concepts; and (3) Learning environment: supports open dialogue, mistakes as part of learning, and active student engagement. An example of its implementation in learning the concept of straight-line equations in grade 8, teachers not only ask students to memorize gradient and cut-off point formulas, but challenge students to explain how changes in values in equations affect the shape of the graph, and relate them to real-life situations such as road slope or cost growth.

## 4. Conclusion

The *deep learning* approach in mathematics learning places conceptual understanding, reflection, and knowledge transfer as the main goals. In this approach, learning is not about memorizing formulas, but about building meaning from mathematical ideas and using them flexibly in a variety of situations. Learning designed with these principles is able to form students who think critically, are confident, and able to learn independently throughout their lives.

The application of a deep learning approach has a number of important implications for various aspects in the world of education. For teachers, training is needed that supports their ability to design learning experiences that encourage deep conceptual understanding, rather than just providing procedural exercises. Teachers need to be equipped with learning strategies that emphasize student exploration, problem-solving, and reflection. On the other hand, the curriculum also needs to be adjusted to provide space for a more meaningful learning process. The curriculum should not only focus on the speed of material achievement, but also encourage exploration, discussion, and reflection as an integral part of learning. Meanwhile, in the realm of educational research, it is necessary to develop instruments that are able to measure the depth of student understanding in a valid and reliable manner. In addition, longitudinal studies are needed to explore the long-term impact of the application of *deep learning* on students' learning outcomes and cognitive development on an ongoing basis.

In order to approach *Deep Learning* In mathematics learning can be implemented effectively, there needs to be synergy between teachers, curriculum developers, and educational researchers. First, it is recommended that teachers obtain ongoing training that focuses on learning design that emphasizes concept understanding, reflection, and connections between ideas. Teachers also need to be given space to experiment with innovative learning methods that facilitate open discussion, collaboration, and real problem-solving. Second, educational institutions and policy makers should review the curriculum structure to be more flexible, adaptive, and oriented towards a meaningful learning process, not just the rapid achievement of material targets. Third, higher education institutions and research institutions need to develop diagnostic assessment instruments that can evaluate the depth of students' conceptual understanding holistically. In addition, further longitudinal research is needed to determine the long-term effects of this approach on students' 21st-century competencies, including critical thinking skills, creativity, and independent learning. Thus, the application of the *Deep Learning* Not only is it a pedagogical slogan, but it can be manifested in real life in daily learning practice.

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