Enhancing Understanding of Linear Programming Concepts Through Contextual Education

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ABSTRACT

This paper's primary goal is to investigate how Contextual Education can enhancing understanding of Linear Programming. This study was entirely qualitative in nature with 15 participants. The author argues that ccontextual education techniques enhance students' comprehension of concepts in linear programming. Students generally find linear programming difficult, especially because it is abstract and necessitates sophisticated mathematical reasoning. It seeks to close the knowledge by placing learning in realistic, real-world contexts, which promotes greater comprehension and involvement. Interviews, and group discussions were applied to learn more about how students grasp linear programming ideas, in secondary schools. Thematic analysis of the data was done with an emphasis on the conceptual clarity, problem-solving abilities, and engagement levels of the students.

According to the study, it not only enhances comprehension but also boosts students' motivation and interest, underscoring the significance of interactive and student-centered approaches in complicated mathematics topics. The study concludes by highlight the potential teaching approaches, particularly for improving comprehension of abstract ideas like linear programming. In addition to suggesting additional research to evaluate Contextual Teaching and Learning's long-term effects on students' mathematical competency, the study ends with suggestions for incorporating it into linear programming programs to promote deeper learning.

Keywords: Contextual education, linear programming

INTRODUCTION

A crucial branch of mathematics and optimization, linear programming (LP) has extensive use in business, engineering, economics, and other domains where resource optimization and decision-making are involved. However, students frequently have trouble grasping its abstract ideas, which can make it difficult for them to use linear programming effectively in practical settings. Conventional approaches to teaching linear programming, which are mostly theoretical and formula-driven, might not give students the depth of comprehension required to interact with intricate, real-world applications.

Students are urged to view linear programming as a useful tool for resolving concrete problems rather than merely as a collection of mathematical methods by employing real-world examples and scenarios. This approach is in line with the current trend in education toward competency-based courses, which place an emphasis on practical application and abilities rather than memorization. The impact on understanding linear programming concepts is investigated in this study. Through the use of qualitative techniques including interviews, and focus group discussions, will help understand how students understand and interact with linear programming when it is presented in pertinent, contextual contexts (Putu & Kadek ,2019).

A comprehensive understanding of students' cognitive and affective reactions shed light on the difficulties and achievements of this approach in math instruction. This study offers empirical support for the efficacy of competency-based learning in improving mathematical comprehension and problem-solving abilities, making it especially pertinent for educational systems such as Zambia's.

The Problem Statements

Although linear programming has applications in many other domains, students frequently find it difficult to understand its abstract ideas. Conventional teaching approaches that emphasize theory and discrete mathematical operations fall short of developing a thorough comprehension of the material. Many students find linear programming difficult to understand and unrelated to practical applications, which deters them from becoming motivated.

Research Objective

To examine how contextual education can enhance understanding of linear programming concepts

Significance of the study

It will increase comprehension of linear programming concepts and will benefit a variety of stakeholders, including educators, curriculum designers, students, and legislators. Teachers can improve conceptual understanding and practical skills by creating a more engaging classroom atmosphere where students are motivated to learn by connecting with familiar circumstances (Beane, 1997).

The curriculum can be made more inclusive and culturally relevant by integrating principles into the teaching of linear programming in a way that is consistent with students' experiences and cultures. Curriculum designers are encouraged to concentrate on contextualized based curricula that boost students' engagement and excitement for learning complicated mathematical ideas (Brown, Collins, & Duguid, 1989).

This can enhance students' comprehension and retention while also strengthening their problem-solving abilities (Perin, 2011). This method boosts students' self-esteem and gets them ready for jobs in data science, logistics, and economics—all fields that use linear programming (Chin & Osborne, 2008).

Evidence-based decisions to support policies that encourage creative teaching approachable. By emphasizing how contextual education improves students' understanding and future employability, policymakers may defend funding curriculum changes and professional development initiatives that incorporate contextual learning (National Research Council, 2000). In the end, this may help create a workforce with greater skill and readiness for challenging, real-world situations.

Theoretical Framework

Situated Learning Theory

According to Lave & Wenger (1991), this theory aims to situate learning within a meaningful context, which can increase student engagement and making the content relatable. It emphasizes that learning occurs most effectively when it is embedded in the social and cultural context of real-life activities. Unlike traditional views that treat learning as the absorption of abstract knowledge, Situated Learning Theory argues that knowledge is more effectively gained through active participation in the practices of a community.

Learning takes place within communities where individuals share a common interest or goal. In these communities, new learners (or "novices") interact with more experienced members. This concept describes how newcomers initially participate in simple, low-risk activities by allowing them to observe, practice, and eventually take on more complex responsibilities.

Situated learning stresses that knowledge is context-dependent, meaning that understanding and skill development are tied to the specific social and cultural setting where the learning occurs. Learning is thus not merely an individual cognitive one.

The theory asserts that people learn best by actively engaging in real-world tasks rather than through passive instruction. This aligns with hands-on or experiential learning approaches, where learners are immersed in authentic practices that allow them to apply and build on their knowledge. Situated learning views learning as

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not only acquiring skills but also shaping the learner's identity within a particular community. For example, a medical student learns not only about the science of medicine but also about what it means within the medical profession.

LITERATURE REVIEW

Overview

Linear programming (LP) is a critical mathematical tool widely used in optimization problems across various fields, including economics, engineering, and logistics. Despite its importance, students often face difficulties in understanding LP concepts due to abstract mathematical formulations and a lack of connection to real-world contexts. Contextual education, which involves integrating real-life applications and scenarios into the learning process, has been proposed as a strategy to bridge this gap. This literature review explores studies and methodologies that enhance the understanding of LP through contextual education.

By connecting the curriculum to real-world scenarios, contextual education and learning seeks to help pupils relate to abstract mathematical ideas. This method can be very helpful for challenging classes like linear programming. This is an instructional strategy that promotes active participation, retention, and comprehension by encouraging students to real-world scenarios. It allows learners to connect with the material by providing real-life relevance, which facilitates deeper learning and problem-solving skills.

In a study conducted by Crawford (2001), revealed that students can apply mathematical concepts, as they link classroom activities with real-world applications. This approach often leads to higher engagement and better conceptual understanding.

Sugiharto et al. (2021) conducted a study on teaching linear programming. Their findings indicated that students understand constraints and optimization by placing them in scenarios where they had to determine feasible solutions based on real constraints, such as budgeting or resource allocation.

Student Engagement and Achievement

According to Adams (2017), contextualizing business scenarios, lead to higher student engagement and achievement. This attribute to students' increased motivation when they understand how the content directly applies to situations they might encounter outside the classroom.

Cognitive Development and Problem-Solving Skills

Purasana & Nurdin's (2018) research promotes higher-order thinking abilities including analysis and assessment, which aid in cognitive growth. In their study on mathematics, they revealed that instructions improve problem-solving skills, particularly in multi-step problems common in linear programming. Students who could relate linear programming to real-life decisions showed improved performance.

According to Rahmawati & Effendi (2019), requires that more preparation time, and teachers must be proficient in applying real-world scenarios that are both relevant and simple. These challenges, however, can be mitigated with sufficient training and resources.

The literature suggests an effective approach for teaching linear programming, as it helps make the subject more accessible and relevant to students by situating abstract concepts within real-life contexts. This approach not only increases student engagement but also enhances cognitive understanding and problem-solving skills. However, it does require careful planning and support for educators to overcome practical challenges in implementation.

Challenges in Teaching Linear Programming

Students often struggle with interpreting mathematical models and understanding constraints and objectives. Teaching LP without real-world applications can lead to disengagement and a superficial understanding of concepts (Dossey et al., 2016). Traditional teaching methods often do not incorporate practical tools or software, hindering students from understanding LP's real-world utility (Santos et al., 2018).

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Benefits of Contextual Education in Linear Programming

It Improves Conceptual Understanding. Contextual education helps students relate abstract LP concepts to real-life problems. For instance, using case studies on resource allocation in industries has shown to improve students' understanding of constraints and optimization objectives (Ahmed & Saeed, 2020).

Enhanced Engagement

Real-life scenarios and interactive activities, such as role-playing supply chain managers or designing optimization models for transportation, increase student engagement and motivation (Johnson & Johnson, 2019).

Development of Critical Thinking Skills

Contextual learning fosters critical thinking as students are required to analyze and solve complex, real-world problems. Studies demonstrate that students who learn LP through contextual methods develop better problem-solving skills compared to those taught through traditional approaches (Martinez et al., 2021).

Contextualizing Linear Programming

Case studies from industries such as logistics, healthcare, and manufacturing provide students with practical insights into how LP is applied to solve real-world problems (Baker & Smith, 2018).

Technology Integration

Software tools like Excel Solver, MATLAB, and Python are effective in demonstrating the application of LP in solving practical optimization problems. Integrating these tools into the curriculum has been found to significantly enhance students' understanding (Nguyen et al., 2022).

Project-Based Learning (PBL)

PBL involves assigning students real-world optimization projects, such as minimizing transportation costs or optimizing workforce scheduling. Research indicates that PBL fosters a deeper understanding of LP concepts (Brown et al., 2020).

Evidence of Effectiveness

A study by Ahmed & Saeed (2020) compared the performance of students taught LP using traditional methods versus those taught through contextual education. Results showed a 30% improvement in conceptual understanding and a 25% increase in problem-solving accuracy in the latter group. Similarly, Martinez et al. (2021) reported that students exposed to real-world scenarios displayed a higher retention rate of LP concepts.

Challenges in Implementing Contextual Education

Despite its benefits, contextual education faces several challenges.

Developing real-world case studies and integrating software tools require significant time and financial resources. Educators often lack the necessary training to effectively implement contextual teaching methods (Santos et al., 2018). Standardized curricula may not allow flexibility for contextual approaches, limiting their widespread adoption (Brown et al., 2020). It is sufficed to mention that, contextual education enhances the understanding of LP concepts. By bridging the gap between theoretical knowledge and practical application, contextual approaches not only improve conceptual understanding but also foster engagement and critical thinking. However, successful implementation requires addressing challenges such as resource limitations and the need for teacher training. Future research should focus on scalable models for integrating contextual education into LP curricula and evaluating long-term impacts on student learning outcomes.

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METHODOLOGY FOR DATA COLLECTION

Sample Size

Sample size is typically smaller in qualitative studies. A common guideline is to have between 5 to 30 participants. This range allows for comprehensive exploration of experiences and perceptions without overwhelming data analysis. Qualitative researchers often aim for data saturation, themes or insights. This usually occurs with a smaller sample size, often around 12-15 participants for focused studies, but can vary based on the topic and diversity of the sample. Therefore, this study had 12 participants. Participants were interviewed to learn more about their experiences on their comprehension of linear programming (Creswell & Poth, 2017).

To learn more about students' comprehension, focus groups and interviews with 15 chosen participants.

Research Tools

Data Collection Methods

Interviews and focus group discussion were used to generate data.

Interviews

Conduct semi-structured interviews with teachers by developing open-ended questions focusing on their experiences in linear programming.

Focus Groups

Organize focus group discussions among students. Use a facilitator to encourage dialogue about their learning experiences. Explore themes like motivation, engagement, and comprehension of linear programming concepts. Focus Groups can provide insights into collective experiences and perceptions of different educators or learners (Patton, 2015). The participants were purposefully selecting (Merriam, & Tisdell, 2016).

Data Generation Procedure

Research Design

To get a consistent sample in this case, purposeful sampling was employed. The Western Province of Zambia is where the study was carried out. For this investigation, a phenomenological method made sense.

Analysis and Interpretation

Data Analysis

The analysis was qualitative in nature. Analyze observation notes, notebooks, and interview transcripts thematically to find recurrent patterns in students' experiences. Utilize thematic analysis to find themes and patterns in the gathered data. Record focus groups and interviews, then code the information to look for reoccurring themes about comprehension and contextual learning. To ensure validity, triangulate information from focus groups, observations, interviews, and document analysis. This process for gathering data highlights how it affects students' comprehension of linear programming ideas. The educational settings can be thoroughly understood by combining a variety of data collection techniques and making sure that the analysis is thorough. Aspects such as participant experiences, instructional strategies, and learning objectives may all be included in this analysis. An overview and explanation of this subject are provided below to aid with your research.

Trustworthiness

The degree of dependability and credibility in a source, person, or piece of information is referred to as trustworthiness. Making educated decisions requires assessing credibility, particularly in fields like research, media, and education. It is decisive to improve students' learning experiences while investigating comprehension of linear programming principles through qualitative methods. By relating course materials to actual circumstances, students understand and be more interested in subjects. Students' motivation and interest in linear programming might rise dramatically when they witness its real-world applications (Johnson & Johnson, 2009). How contextualizing learning might increase engagement is covered in this paper.

Ethical Considerations

Obtain informed consent from participants. Ensure confidentiality and anonymity in data reporting. Obtain consent from students and, if necessary, their guardians (Herrington, Reeves, & Oliver, 2014). Provide participants with feedback on their performance and the study's results. Participants in qualitative research should be fully informed about the nature, purpose, and potential impacts of the study. The usage of data, the voluntary nature of involvement, and the right to withdraw without consequence are all things that educators must make sure students and their guardians are aware of (Creswell & Poth, 2016).

Confidentiality and Anonymity

Ensure all personal data is kept confidential, and use pseudonyms in any published work (Ornstein, & Hunkins, 2017). Protecting participants' identities is crucial in maintaining trust and ethical integrity in research. Researchers should anonymize data and ensure that any publications do not reveal personal information about participants (Punch, 2014). The local culture is frequently incorporated into contextual instruction, and participants' cultural backgrounds are respected and understood. Researchers should design curriculum and assessments that are culturally relevant and avoid stereotypes or assumptions about students' backgrounds (Gay, 2010).

FINDINGS AND DISCUSSION

Finding

Students' comprehension and application of linear programming ideas are improved by an instructional strategy that makes connections to actual circumstances.

Improved Engagement and Motivation

According to teacher A,

“Learners become more motivated and involved when they apply linear programming to real-world scenarios, including resource allocation that results in optimization” (TA,17.10.2024).

Students increase learning linear programming through real-life applications, such as resource allocation in business or optimization in agriculture (Trowbridge, & Bybee, 1990). Considering the learning process suitable for real-world situations and relevant promotes a more thoroughly, more profound connection with the content, which aids in practical applications.

In fields such as mathematics, where students may doubt the applicability of intricate ideas like linear programming, it is especially helpful to include students in real-world problems to aid in their comprehension.

Teacher B stated that,

“Teachers can create project-based assignments where students need to use linear programming techniques to address real-life problems, such as minimizing costs in a business context or maximizing output in a production setting. This problem-based learning approach actively engages students, making them feel invested in finding a solution” (TB,17.10.2024). According to Crawford (2001), problem-based learning in a contextual framework leads to increased student motivation as it promotes active participation and encourages students to use higher-order thinking skills to solve complex problems.

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Teacher C revealed that,

"Group projects and collaboration are a part that can enhance student enjoyment. Case studies or simulations that require several stages of analysis and decision-making can be tackled by students in groups. Students that work together on these assignments frequently clarify ideas to one another, which strengthens their comprehension and motivation" (TC,17.10.2024).

Sears & Hersh (2006) commended that collaboration allows meaningful discussions about the material, which strengthens their understanding and increases their motivation.

Teacher D emphasized that,

"Hands-on experiences, such as using specialized software. Students can model real-life scenarios, explore solutions visually, and get immediate feedback on their decisions. This interactive approach helps students see the immediate impact of their calculations and choices, keeping them motivated and engaged" (TD,17.10.2024).

Contextual teaching framework can significantly increase engagement, as noted by Brown et al. (2011), who observed that interactive simulations help students connect theoretical knowledge with practical applications.

Teacher E explained that,

"Students see contextual teaching and learning as a skill relevant to their future careers. Teachers might introduce examples from finance, or engineering, where linear programming is commonly applied. This approach helps students current learning and future goals, giving them a sense of purpose and motivation to master the subject" (TE,17.10.2024).

Research by Berns & Erickson (2001) suggests that when students can see the career relevance of what they are studying, they become motivated and engaged. By assisting students in connecting the material to their own objectives and real-world applications, enhances student motivation and engagement. It enhances understanding but also makes the learning process more dynamic and meaningful, ultimately leading to better learning outcomes.

Teacher F further said that,

"Contextual Teaching and Learning often involves active learning techniques, such as group work, projects, and discussions. In studying linear programming, students might work together to solve optimization problems, encouraging them to articulate their thought processes, share diverse perspectives, and collaborate on solutions" (TF,17.10.2024).

This approach fosters problem-solving methods and helps students develop analytical skills (Darling-Hammond, & Bransford, 2005). It highlights how active and collaborative learning within environments fosters problem-solving skills, particularly in complex areas like mathematics.

Critical Thinking

Instead of having students memorize formulas or procedures, contextual teaching enables them to analyze, synthesize, and evaluate information. This means that when it comes to linear programming, students follow procedures of particular methods work. As students learn to choose which approaches will work best for a particular situation, this type of critical engagement is crucial for building strong problem-solving abilities (Brown, Collins, & Duguid, 1989). This seminal work explains how contextual learning enhances cognitive abilities and empowers learners to critically evaluate their use of mathematical ideas such as linear programming.

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Teacher Gob served that,

"Learning linear programming increases the likelihood that students will remember the material and apply it to new, diverse challenges. As learners get used to applying their knowledge and evaluating challenges from various perspectives, contextual learning helps them develop a foundation that is flexible and useful" (T G,17.10.20244).

Through fresh and different challenges, students are more likely to retain and use the knowledge they acquire about linear programming. As individuals are used to looking at situations from many perspectives and using their knowledge in different ways, contextual learning helps them develop a foundation that is flexible and beneficial (Anderson & Krathwohl, 2000). This work discusses how applying concepts in varied contexts enhances retention and promotes the ability to transfer problem-solving skills to new situations.

Engagement

Student motivation is greatly increased by offering relevant, context-based linear programming problems. When students are interested and motivated, they are more willing to engage deeply with challenging problem-solving tasks.

Teacher H remarked that,

"Contextual Teaching and Learning considerably increases student motivation through the use of relevant, context-based linear programming assignments. Students that are motivated and engaged are more likely to dive deeply into difficult problem-solving exercises, which improves their understanding of linear programming" (TH,17.10.2024).

Stern, & Stearns, (2008) emphasizes how strategies improve student motivation, which is directly related to their persistence and performance in problem-solving activities. A structured method for enhancing linear programming problem-solving abilities is provided which makes instruction relevant, promotes active and collaborative, aids in knowledge retention and transfer, and raises student engagement.

This method not only aids students in understanding complex mathematical problems but also equips them with adaptable problem-solving skills for real-world situations. Each of these elements demonstrates how transformedstudentscan tackle linear programming problems effectively, making them better prepared for both academic and practical challenges.

Teacher, I echoed that,

"Problem-solving skills in linear programming encourages active and collaborative learning, fostering critical thinking, promoting knowledge retention and transfer, and increasing student engagement. This method not only aids students in understanding complex mathematical problems but also equips them with adaptable problem-solving skills for real-world situations" (TI,17.10.2024*)*.

By efficiently addressing linear programming difficulties, students are better equipped to handle both academic and real-world challenges. Application of linear programming principles to real-world situations, promotes critical thinking and helps students learn how to solve problems (Dori & Barak, 2001).

Retention

By placing abstract mathematical concepts in relatable real-world contexts, it significantly improves students' retention of linear programming concepts, resulting in deeper comprehension and longer-lasting memory. This method works particularly well in courses like linear programming, where students frequently relate abstract ideas to real-world applications.

Teacher J stated that,

"Contextual Teaching and Learning engages students by using real-world problems to explain linear programming concepts. When students see how linear programming can be applied to optimize resources in industries like manufacturing, transportation, or finance, they can more easily grasp and remember concepts because they understand their practical value" (TJ,17.10.2024)

By explaining linear programming ideas through real-world challenges, engages pupils. Students can more readily understand and retain concepts when they maximize resources in sectors such as manufacturing, transportation, or finance because they recognize the practical significance of these concepts (Johnson, 2002).

Teacher K said that,

"Contextual Teaching and Learning often involves students actively working through problems, which has been shown to improve memory retention. By engaging in hands-on activities—such as using a company's resource data to set up constraints and objectives for optimization—students can better understand concepts like feasible regions, constraints, and objective functions" (T K,*17.10.2024)*

Students who actively solve problems enhance memory retention. Students can understand viable regions, constraints, and objective functions by participating in practical exercises, such as setting up constraints and optimization objectives using a company's resource data (Darling-Hammond et al., 2008).

Teacher L said that,

"Students can better understand the significance of each variable, constraint, and objective function by using case studies of firms to develop linear programming models. This helps them internalize these concepts" (T L,17.10.2024)

According to Mazano (2003), using company case studies to create linear programming models helps students better grasp the importance of each variable, constraint, and objective function.

Teacher M said that,

"Collaborative learning is a core component of Contextual Teaching and Learning, and research shows that working in groups can lead to higher retention rates. When students work together to solve complex linear programming problems, they clarify concepts for each other, leading to better understanding and retention" (T M,17.10.2024)

One of the main tenets of collaborative learning, is group work that increase retention rates. Students improve comprehension and retention when they collaborate to tackle challenging linear programming problems (Smith et al., 2005).

Teacher N stated that, "Contextual Teaching and Learning leverages students' prior knowledge by linking new linear programming concepts with familiar ideas, which has been shown to increase comprehension and retention. For instance, by connecting the concept of constraints to everyday budgeting scenarios, teachers help students understand and remember these new ideas better" (TN,17.10.2024) Students' comprehension and retention can be improved by connecting new and familiar linear programming concepts using what they already know. For example, teachers might assist students better understand and retain these new concepts by relating the concept of limitations to real-world budgeting issues (Ormrod, 2006).

Teacher O observed that,

"Linear programming often requires students to articulate and justify their reasoning, whether they're explaining the rationale behind constraint choices or suggesting optimal solutions. The collaborative process of negotiating and explaining these steps strengthens communication skills" (T O,17.10.2024).

Complemented instruction and learning improve comprehension and retention by establishing links between new and well-known linear programming concepts.

The collaborative process of negotiating and explaining these steps strengthens communication skills, which are crucial for professional collaboration (Bernstein, 2018). In discussing and defending their ideas, students become more engaged and develop a better grasp of linear programming concepts.

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Teacher P commented that,

“Contextual Teaching and Learning encourages the use of technology in real-world applications, such as using software to solve linear programming problems. These tools are widely used in industry, so students gain practical skills they can directly transfer to jobs in engineering, economics, or computer science” (TP,17.10.2024)

Contextual instruction and learning promote real-world applications, such as using excel solver, MATLAB, or Python libraries (like SciPy). Students acquire useful abilities that they may immediately apply to positions in computer science, engineering, or economics because these technologies are frequently used in industry (Roth, 2017).

Students can gain a richer conceptual knowledge of linear programming by placing it in real-world contexts, such as transportation, company operations, or diet planning (Moore, 2010).

CONCLUSION

By relating theoretical information to actual circumstances, students understand the significance of linear programming ideas, which makes them more memorable and approachable. By converting abstract mathematical ideas into useful problem-solving abilities that are essential for real-world applications, this hands-on method fosters deeper knowledge (Johnson, 2002; Berns & Erickson, 2001).

This is especially advantageous for challenging disciplines like linear programming, which typically require abstract reasoning (Berns & Erickson, 2001). Research also suggests that by giving students real-world examples, they are better able to relate to linear programming issues, which boosts their confidence, motivation, and general success in the topic (Caine & Caine, 1994).

RECOMMENDATIONS

Some suggestions and ideas for enhancing linear programming:

1. To get started, start with relatable, real-world issues that linear programming can resolve. Examples of the limitations and goals that are frequently seen in linear programming include maximizing profit in a small business or optimizing resources in a production line. Students are better able to understand the usefulness and applicability of linear programming when abstract concepts are given tangible situations.
2. Students to solve contextualized linear programming challenges in small groups. Each group might focus on different facets of the problem, such as defining restrictions, defining variables, or analyzing findings.
3. After completing each task, ask students to consider how linear programming ideas apply and share their methods for addressing problems. By assisting students in internalizing the links promotes learning. Contextual learning enhances comprehension and problem-solving abilities.
4. Employ a gradual release approach where students are given increasing responsibility for creating models and provides guidance on problem-solving techniques.
5. By ensuring that students have a solid foundation before taking on challenging challenges on their own, scaffolding increases their competence and confidence. Students interact fully with difficult material when they feel ready and supported.

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