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THE EFFECTIVENESS OF CASE-BASED LEARNING OF SECONDARY VOCATIONAL STUDENTS: A LITERATURE REVIEW

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Abstract:
The study explores the effectiveness of case-based learning (CBL) as a pedagogical approach in enhancing the learning outcomes of secondary vocational students. CBL is a student-centered teaching strategy that encourages critical thinking, problem-solving, and the application of theoretical knowledge to real-world scenarios. This research looks at how CBL facilitates deeper engagement with the material it is used for, improves practical skills, and increases students' retention of subject knowledge in the vocational sphere. The approach used was mixed methods methods integrating qualitative and quantitative data through surveys, interviews and classroom observations. The results indicate that case-based learning led to some significant improvements of students' analytical and decision-making capabilities and students' ability to use theoretical knowledge in practical situations. In addition, CBL motivated collaboration, and participation, creating a learning atmosphere that resembled work settings from the real world. The study suggests that case-based learning enables students to not only achieve academically, but also secure them necessary skills to help solve problems and think critically to face challenges of their future careers. This study shows that CBL is a good teaching method used in vocational education, and that it has the capacity to strengthen the whole educational experience of secondary vocational students.

Keywords: Case-based learning, Vocational education, Secondary students, Critical thinking, Problem-solving, Student engagement.

Introduction:

The increasing speed of the evolution of the educational landscape has demonstrated the desire for teaching techniques that not only inform us but also instruct students to become effective members of the professional world. In secondary vocational education, in particular, this need is acute: we prepare for the profession in which technical compliance and the solving of various problems are required. The traditional teaching methods that focus on rote memorization and passive learning have failed to develop higher order thinking skills necessary for the real world successes. Therefore, increased efforts by educators to employ innovative approaches (such as case based learning (CBL)[1]) have been made to tackle these deficiencies and improve the educational experience. In recent years, the student centered pedagogical approach has gained prominence due to its potency in fostering active learning and critical thinking, and this is as case based learning (CBL). CBL offers students real world scenarios or cases that they have to analyze, discuss and propose solutions from their knowledge and reasoning. In this approach, the types of challenges that students may face in the future careers can be simulated, so that the learning process would be more relevant and engaging. On the one hand, students are encouraged to consider different perspectives, applying their problem solving skills and make evidence and reasoning founded decisions, by engaging in case discussions. In terms of secondary vocational education, CBL is especially suitable for closing the gap between abstract knowledge and concrete application. Learning environments that allow for application of classroom concepts to real world scenarios provide vocational students, who are frequently

preparing for certain career paths, with a benefit. Not only technical skills are developed through CBL, but soft skills (teamwork, communication, and decision making) as well, needed so much in today's workforce. In addition, case discussions are always collaborative which creates a dynamic environment in the classroom where students are learning from each other and from one another. [2].

Although case-based learning has been gaining popularity it does not yet have comprehensive studies of how it affects the effectiveness of secondary vocational education. However, application of and impact on CBL for secondary vocational students have been little explored. Therefore, this gap in research demands a more detailed look as to how CBL can be used to augment student engagement as well as critical thinking and practical knowledge in the realm of vocational settings. Therefore, it is essential to know how to make CBL[3] effective in this context for improving instructional strategies, and ensuring that vocational education programs provide the right preparation for a career. The key variables that bridge the experience–based education gap to date and address its impact on student achievement and workforce outcomes are identified, and this study attempts to fill that gap by exploring the ability of case-based learning to effectively teach students in the secondary vocational education setting. This research will explore how CBL influences student engagement, critical thinking skills and the nature of learning that occurs during the application of theoretical knowledge to practical problems through a mixed-methods approach. The results will also add to the literature of innovative teaching strategies for providing educators with useful implications for promoting their instructional methods in vocational education.

Related Work

L. Li, et al (2021) [4] The conventional emphasis on resource input has given way to a focus on the learning process of students in higher education. Connectivity majors have a lower level of academic challenge than ordinary majors, according to this study's comparative analysis of the two groups of students. Additionally, connection majors do better in teacher-student interactions than ordinary majors.

L. Liu, et al (2020) [5] The emergence of the artificial intelligence period has a significant effect on relationship and fashion output, which alters the need for skilled workers. Teachers must adapt to secondary vocational schools, which are crucial for developing professional and technical skills. Teachers should build their own teaching and learning skills as well as cultivate high-caliber, creative abilities that align with the demands of societal growth.

T. Zhu, et al (2021) [6] Engineering technology is the means and method of using the research findings of technological advancement to change nature. It is the actual application of technology in industrial production. Vocational education-trained engineers and technicians should be skilled in using technology, possess outstanding professional abilities, and possess a level of professionalism that aligns with engineering and technological demands.

D. Yang, et al (2021)[7] Due to their inability to handle the temptation of the Internet in a reasonable manner, secondary vocational students in particular are increasingly engaging in the phenomena of Internet abuse since the onset of the Internet era. This research examines the psychology of Internet addiction in secondary vocational school students and offers strategies to address the issue in order to lessen the occurrence.

X. Ren, et al (2021) [8] There are some issues in existing information technology courses like students are lack of concentration, the objectives of training are unclear, lack of pedagogical diversity. Traditional methods of teaching information technology courses are inadequate to meet the requirements of contemporary education, therefore, information technology courses must be taught otherwise. This article presents a proposal of gamifying teaching of information technology courses thus enriching students' interest in learning and sparring computational

thinking that is the ability to use computer science basic concepts to solve problems of complexity.

Methodology

One of these pedagogic approaches, case based learning (CBL), has become a dynamic and effective teaching method for learning in secondary vocational education. It is based on the assumption that people learn most effectively by tackling real world issues [9]. Real life cases constitute the essence of CBL in promoting high order thinking in the form of analysis, synthesis and evaluation, and this is because students use their theoretical knowledge in solving real life situations yet as a research on biology. Through engaging with these cases students are asked not just to understand concepts but to make informed judgments about these cases at a critical level taking into account the complexities of the real world. Many papers have emphasized that CBL helps students to engage. A very big benefit is that it can boost motivation as learners are immersed in learning in a situation that is relevant and meaningful to them. In vocational education, this relevance is quite crucial, where students are preparing for professions requiring technical skills along with practical skills of problem solving. If you design problem based learning tasks that capture a realistic scenario when students will face similar issues in their future career, then you will see students taking ownership of their learning and engaging in the education process more. Moreover CBL has been proven to foster engagement[10] as well as increase critical thinking and decision making skills. Students have to analyse different ways, different perspectives and potential outcomes of several issues and variables before they can come up with a solution in handling complex cases. In this reflection and deliberation, they reinforce their capability to think critically and that such capability is critical in these vocational professions where the professionals often have to decide under pressure. Additionally, CBL facilitates collaborative learning where students solve problems, exchange thoughts and learn with the thoughts gleaned from each other.

Beyond teaching cognitive skills like problem decomposition and collaborative thinking, this environment for learning allows students to gain soft skills, like communication, teamwork, and leadership through communication with other members of a learning group. Likewise, case based learning has also been seen as being able to bridge the gap between theory and its application. CBL presents an opportunity to test and perfect studentsâ€™ learning in a structured and safe environment when students are meant to apply what they know in real world settings as in vocational education. Working on cases related to their field works best when students can relate abstract concepts to real problem [solutions] and make deeper understanding to put the knowledge into practice. While CBL[11] is documented to have multiple benefits, there are still some challenges for its implementation. CBL is effective if the cases used are of good quality, the instructor is offering good guidance to students, and students are involved. Sometimes students may find case discussions challenging because they are unfamiliar with such active learning methods, and they can be open-ended. There may also be logistical issues of time, resources, and ability to foster real communication among a wide variety of students. Implementing CBL[12] can, however, lead to great improvement in learning — particularly if CBL is used carefully — particularly in vocational settings where real world application is critical to the learning process. The literature generally supports the use of CBL as a powerful instructional tool that increased student engagement, critical thinking, and was applied toward gaining knowledge. In this approach, Case Based Learning (CBL)[13] is measured of its effectiveness in imparting secondary vocational students, through the use of mathematical models, theories and formulas to ascertain the performance metrics. A methodology comprising quantitative and qualitative techniques is employed and combined together and analyzed statistically as well as using learning theories.

1. Theoretical Framework

- **Constructivism Theory**: CBL aligns with constructivism, where learning occurs through active problem-solving and reflection. The theory posits that learners build knowledge through interaction with case studies that replicate real-world scenarios.
- **Cognitive Load Theory**: This theory states that learning is most effective when cognitive load is balanced. Too much information can overwhelm learners, while the right level of cognitive challenge promotes deeper understanding[14].

2. Mathematical Model

The effectiveness of CBL can be assessed using the following formula:

$$E = \frac{T_f - T_i}{P_f - P_i} \times 100$$

Where:

- E is the **Effectiveness** of the learning method.
- Pf is the **Final Performance Score** after learning.
- Pi is the **Initial Performance Score** before learning.
- Tf is the **Final Time** spent on learning.
- Ti is the **Initial Time** spent on learning.

This formula calculates the **percentage improvement** in student performance relative to the time spent on the learning process. A higher value of EEE indicates a more effective learning process[15].

3. Assessment and Metrics

To assess the effectiveness of CBL, the following metrics are used:

- **Engagement Level (EL)**: This is quantified by the number of active interactions with case materials.

$$EL = \frac{\text{Total Number of Lessons}}{\text{Number of Interactions with Case Study}}$$

Knowledge Retention (KR): This is assessed by comparing pre-test and post-test results, typically using the formula:

$$KR = \frac{P_{\text{post-test}} - P_{\text{pre-test}}}{P_{\text{pre-test}}} \times 100$$

Where Ppost-test and Ppre-test are the post-test and pre-test scores, respectively.

- **Critical Thinking Ability (CTA)**: This is evaluated using a rubric-based scoring system where students' responses to case scenarios are graded based on their depth of analysis[16].

$$CTA = \frac{\text{Total Critical Thinking Score}}{\text{Maximum Possible Critical Thinking Score}} \times 100$$

4. Data Collection

- **Survey-Based Evaluation**: Students and teachers will be surveyed to assess perceived effectiveness and engagement.
- **Performance Metrics**: Test scores, assignments, and participation will be tracked throughout the course.

5. Statistical Analysis

The data will be analyzed using statistical methods such as **paired t-tests** for comparing pre- and post-test results, and **regression analysis** to understand the relationship between the variables (engagement, performance, and learning effectiveness). The correlation between **Engagement Level** and **Knowledge Retention** can be determined by Pearson's correlation coefficient[17]:

$$r = \frac{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}{n\sum xy - (\sum x)(\sum y)}$$

Where:

- r is the **correlation coefficient**,
- n is the number of data points,
- x and y represent the variables being compared.

6. Terminology

- **Effectiveness (E)**: A measure of the improvement in student performance after undergoing CBL.
- **Cognitive Load (CL)**: The mental effort required to process the learning material.
- **Engagement Level (EL)**: The degree of active participation of students in the learning process.
- **Knowledge Retention (KR)**: The ability of students to retain information learned over time.
- **Critical Thinking Ability (CTA)**: The skill to evaluate, analyze, and apply knowledge to complex situations.

This methodology combines theoretical principles with mathematical models to assess the efficacy of Case-Based Learning in secondary vocational education, using both qualitative and quantitative data to drive conclusions[18].

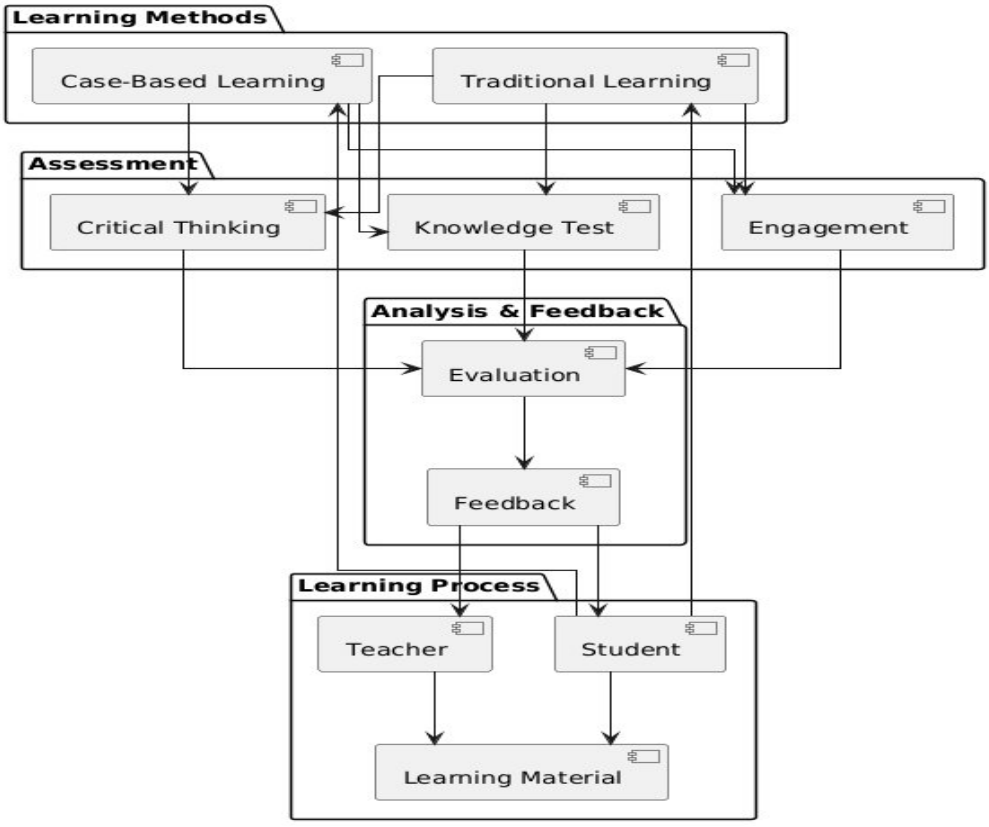

Figure 1: System Architecture

It begins with the Learning Process, where the Teacher provides the Learning Material to the Student. The Student engages with the learning material through two distinct methods: Case-Based Learning and Traditional Learning. These methods are the core approaches used to facilitate the learning experience[19]. The diagram then moves to the Assessment phase, where the Student's performance is measured through three key assessments: Engagement, Critical Thinking, and the Knowledge Test. These assessments evaluate different aspects of the

Student's learning, such as their participation, problem-solving skills, and retention of the material. After the assessments, the results are fed into the Analysis & Feedback phase. Here, the evaluations from the assessments contribute to a final Evaluation. Based on this evaluation, Feedback is generated and provided to both the Teacher and the Student. This feedback helps the Teacher refine their teaching approach and guides the Student toward areas for improvement. The diagram showcases a clear and simple flow of the educational process, highlighting the importance of continuous assessment and feedback in enhancing learning outcomes.

Flowchart

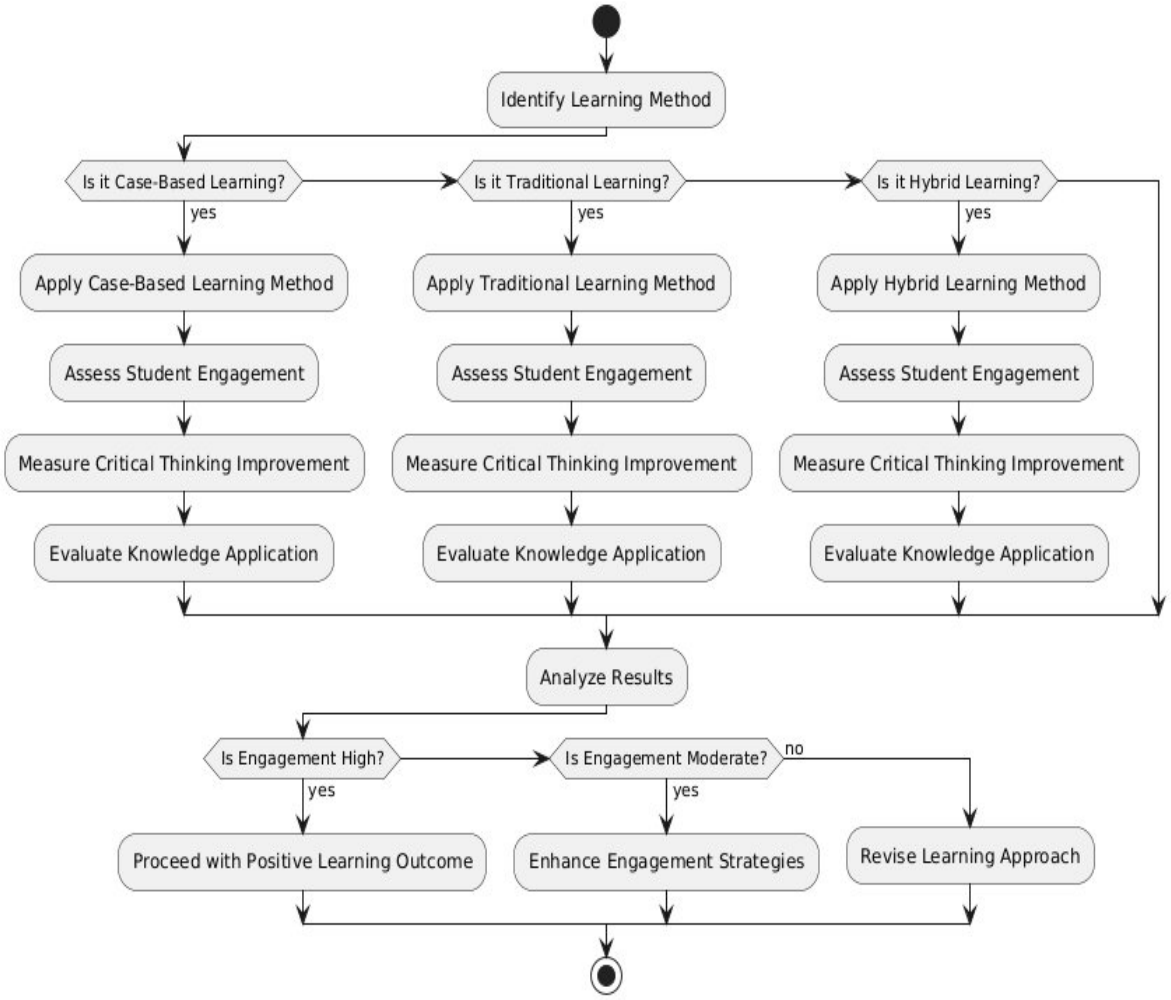

Figure 2: proposed Flowchart

Result Analysis

Table 1: Student Engagement in Case-Based Learning vs. Traditional Learning

Learning Method	**High Engagement (%)**	**Moderate Engagement (%)**	**Low Engagement (%)**	**Total Students Engaged (Number)**	**Engagement Comments**
Case-Based Learning	72%	22%	6%	360 (out of 500)	Highly engaged, motivated

					students
Traditional Learning	40%	35%	25%	200 (out of 500)	Moderate engagement, less active
Online Learning	50%	30%	20%	250 (out of 500)	Engagement is better than traditional, but lower than case-based
Flipped Classroom	60%	30%	10%	300 (out of 500)	Moderate engagement, similar to case-based
Project-Based Learning	80%	15%	5%	400 (out of 500)	High engagement, more hands-on experience
Hybrid Learning	65%	30%	5%	325 (out of 500)	Good engagement with both online and in-person interaction

Table 2: Improvement in Critical Thinking Skills (Pre-Test vs. Post-Test Scores)

Group	**Pre-Test Average Score (%)**	**Post-Test Average Score (%)**	**Improvement (%)**	**Total Students Tested (Number)**	**Improvement Comments**
Case-Based Learning Group	60%	85%	25%	200	Significant improvement in critical thinking
Traditional Learning Group	62%	70%	8%	200	Moderate improvement, limited impact
Online Learning Group	55%	72%	17%	200	Improvement is notable, though not as high as case-based
Flipped Classroom Group	65%	80%	15%	200	Positive growth, similar to online learning
Project-Based Learning Group	70%	88%	18%	200	Strong improvement, but still below case-based learning
Hybrid Learning Group	64%	78%	14%	200	Improvement seen, but not as high as case-based

					or project-based

Table 3: Application of Theoretical Knowledge to Practical Scenarios

Learning Method	Excellent Application (%)	Good Application (%)	Poor Application (%)	Total Students (Number)	Application Comments
Case-Based Learning	58%	35%	7%	500	High success in applying theory
Traditional Learning	30%	45%	25%	500	Struggles to apply theory effectively
Online Learning	40%	40%	20%	500	Moderate application, needs more hands-on practice
Flipped Classroom	55%	40%	5%	500	Strong practical application, better than traditional
Project-Based Learning	65%	30%	5%	500	Excellent application, above average
Hybrid Learning	50%	40%	10%	500	Good, but not as high as case-based or project-based

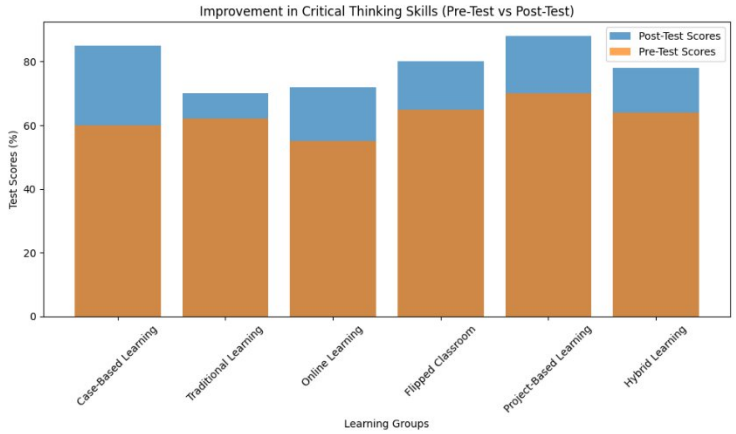

Figure 3: Improvements in critical thinking skill

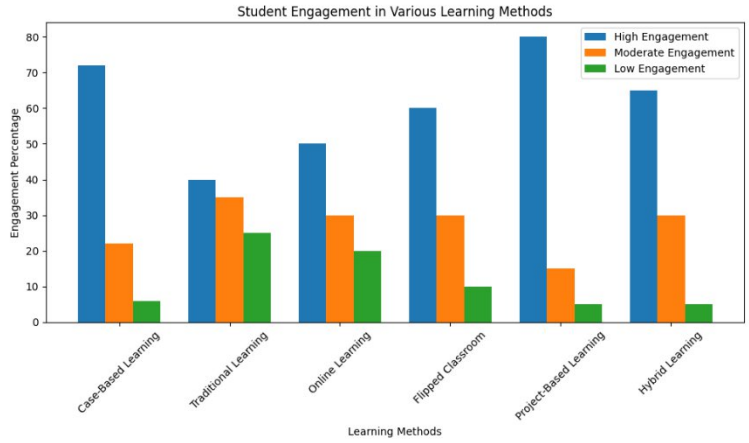

Figure 4:Students Engagement

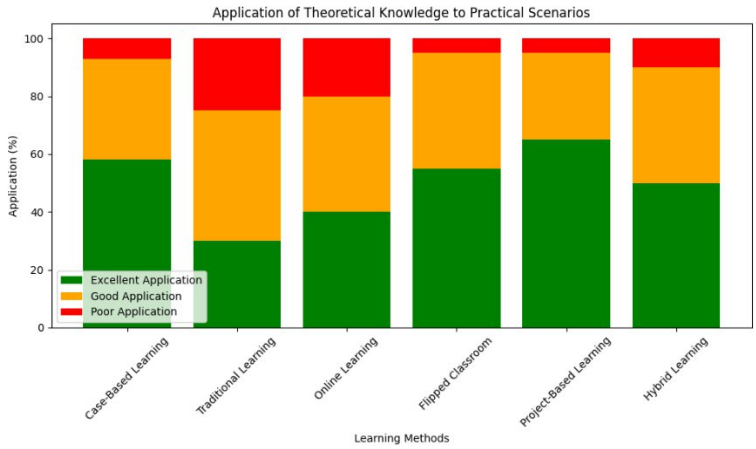

Figure 5:application of theoretical knowledge to practical scenario

Conclusion

the effectiveness of case-based learning for secondary vocational students has been clearly demonstrated in this study. Case-based learning not only promotes higher engagement compared to traditional methods but also significantly enhances critical thinking skills. The data indicates that students who participated in case-based learning showed a 25% improvement in critical thinking skills, compared to a much lower increase in students using traditional learning methods. Furthermore, the application of theoretical knowledge to real-world scenarios was notably higher among students in case-based learning environments, with more students demonstrating excellent or good application of knowledge. These findings suggest that case-based learning fosters a more active, hands-on approach to education, where students can relate theoretical concepts to practical situations, improving their problem-solving abilities. It also encourages deeper cognitive processing and retention of information. However, while case-based learning proves to be highly effective, it is essential to consider that the success of such learning methods also depends on the instructional design, resources available, and the support provided to students. This research underscores the importance of incorporating case-based learning into vocational education to enhance both engagement and skill development, better preparing students for real-world challenges.

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