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Adapting to Change: The Effects of Case Study Approaches on Problem-Solving Skills

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Abstract: The purpose of this study is to determine whether the case study methodology has a substantial effect on students' problem-solving skills when compared to traditional learning approaches. The research sample consisted of 56 students divided into two groups: experimental (taught using the case study approach) and control (taught using the traditional method). The quantitative quasi-experiment approach was applied in this study. The experimental class had an average value of 70.7143, whereas the control class had an average value of 62.1429. The independent t-test yielded a significance value of 0.055, suggesting a degree of significance lower than the standard criterion of 0.05. The key conclusion of this study is that employing case studies improves soft skills during the learning process. However, the development of pupils' hard skills is still seen as minor. This study contributes to a better understanding of the influence of the case study technique on problem-solving learning. These findings may be used to provide practical recommendations to increase the efficacy of learning methodologies in acquiring both types of abilities. More study is needed to investigate the elements that impact the observed outcomes and increase the statistical significance in the development of students' skills.

Keywords: Case Study, Problem-Solving, Skill, Adapting

1. Introduction

Regulation can encourage universities to adopt new teaching approaches. Case study models based on real-world scenarios are an innovative technique to provide immersive learning experiences (Miranda et al., 2021). Regulations can emphasize the importance of curriculum relevance to the demands of the workplace. Industry-related case study models or real-world examples can assist students in comprehending how their knowledge might be utilized in the workplace. Case study learning is valued at the institution for a variety of reasons, including academic benefits, skill development, and preparation for professional life. Case study learning helps students to apply what they've learned in the classroom to real-world circumstances (Jesionkowska et al., 2020). It assists individuals in connecting academic topics with practical applications, hence improving conceptual comprehension. Students are challenged via case studies to analyze events, identify difficulties, and provide solutions. It fosters critical thinking and analytical abilities, which are essential in both academic and professional settings. Students participate actively in the learning process

while using case studies (Cortázar et al., 2021). They must not only absorb information but also solve problems and make decisions.

Case analysis necessitates effective communication skills and problem-solving collaboration. This aids pupils in the development of interpersonal and collaborative skills (Rehman et al., 2023). Students who participate in case study learning can apply the skills they gain in the classroom to the workplace. They are taught how to apply academic principles to real-world problems (Martinez, 2022). Case studies frequently include dynamic and complicated settings. This assists pupils in developing the ability to deal with future changes and obstacles. Case studies may be used in a variety of situations, sectors, and concerns. This enables pupils to comprehend a variety of commercial and professional contexts.

1.1. Case Study on Curriculum Implementation in Higher Education

The case study learning model is a learning strategy that places real-life instances or difficult situations at the center of learning. Students are exposed to real-world events that involve critical thinking, analysis, and decision-making in this approach (Quinn et al., 2020). This paradigm employs real-life events or circumstances that are relevant to the learning setting (Shamay-Tsoory & Mendelsohn, 2019). The scenarios might be pulled from actual life or designed to emphasize a specific theme. Case study learning is frequently accompanied by group or class discussions. Students actively participate in the exchange of ideas, the analysis of issues, and the formulation of solutions.

The use of case studies in curriculum implementation in higher education can give several benefits. Case studies may be used to demonstrate how theoretical principles can be used in practice. Students may see how classroom theories can be implemented in real-world circumstances. Students can learn problem-solving skills by working on difficult instances (Perusso & Baaken, 2020). They must assess the scenario, identify the problem, and devise an acceptable remedy. Students can improve their critical thinking abilities through case analysis. They must assess information, identify critical concerns, and make sound judgments (Sinatra & Lombardi, 2020). Case studies may be interdisciplinary, allowing students to examine situations from multiple angles. It can promote interdisciplinary thinking and help people appreciate the complexities of today's challenges. Investigate cases that address certain issues in the world.

Including a case study Including orientation in the university curriculum can have a significant influence on students' cognitive and psychomotor improvements. Case studies frequently give difficult, realistic issues that need critical thought (Kitchin, 2017). Students must analyze data, identify critical concerns, and develop solutions or suggestions. Students may apply what they've learned in class to real-world problems. This assists children in seeing the relevance and direct application of academic subjects. Case studies allow students to practice their problem-solving abilities (Tachie, 2019). They are confronted with difficulties and complexity that need innovative and smart thinking. Case studies need the capacity to analyze data, determine cause-and-effect linkages, and clarify pertinent facts. This can help pupils improve their analytical skills.

The "Introduction to Education" course in the Chemistry Education S-1 study program with case studies can give subtleties in a variety of areas. Case studies from the realm of chemical education might be chosen expressly for the Introduction to Education course in the Chemical Education study program. For example, how may the chemical learning technique be used in classroom learning activities? Students can apply general education principles to the context of chemistry instruction through case studies. This assists students in understanding how educational ideas may be used in real-world chemistry education scenarios. Case studies can be used as a way to assess students' comprehension of chemistry education. Lecturers can determine the extent to which students can apply educational concepts through case study analysis.

1.2. The role of problem-solving in the case study learning model

The case study learning paradigm emphasizes problem resolution. The approach is intended to help students develop their capacity to recognize, analyze, and propose solutions to difficult issues in a real-world setting. Students are challenged to think critically when presented with case studies (Lovrić et al., 2020). Problem resolution necessitates information appraisal, scenario analysis, and the selection of a suitable solution. Students are challenged to apply theoretical principles learned in class to complicated real-world circumstances (Thomassen & Stentoft, 2020). This allows them to recognize the significance and practical application of their academic knowledge. Students are asked to analyze the data presented in the case study. Identifying crucial aspects, assessing the impact of actions, and strategizing solutions are all part of this process.

Case study learning clearly emphasizes problem resolution. Students are not only presented with issues but they are also encouraged to provide workable answers. Case studies are frequently completed in groups by students (Harris et al., 2020). This promotes collaboration and fruitful debate to achieve shared issue resolution. Case studies frequently feature difficult and confusing themes that resemble real-world situations. This trains pupils to deal with ambiguity and complexity in their future careers. Students must comprehend the context and circumstances influencing their judgments and solutions (Valentine et al., 2021). This entails ethical, social, and environmental concerns. In case studies, problem-solving entails weighing many options and making conclusions. Students learn to choose the best answer based on thorough evaluation.

Students participate in problem-based learning, which requires them to not only acquire knowledge but also to develop answers on their own (Svensson et al., 2021). This gives pupils a greater sense of responsibility and freedom. In the case study learning paradigm, problem-solving not only prepares students for specific circumstances, but it also influences the way they think in general (Pohl et al., 2020). It gives a deep grasp of how information may be applied in a real-world setting and delivers an immersive learning experience.

The following are the case study learning procedures that can be used in the Introduction to Education course: 1) Choose a scenario that is directly connected to educational principles and issues. Make certain that the case presents a representative picture of numerous educational concerns. 2) Include an introduction that describes the case's history and context. Explain why studying the case is essential and how it connects to the principles being taught. 3) Lead a pre-case discussion to create previous knowledge and comprehension of the case issue among students. Leading questions may be used to get people thinking. 4) Allow pupils to analyze the situation on their own. Inquire about the primary challenges, players involved, and potential solutions. 5) Divide the class into groups and give them time to debate the case study. This enables people to interact, exchange ideas, and acquire insights from many points of view. 6) Request that each group or person provide a solution or proposal based on their findings. Encourage them to consider the practical implications and consequences of the offered solutions. 7) Allow each group or person to present the outcomes of their analysis and solutions. This can be accomplished by either an oral presentation or the creation of a written report. 8) After the presentation, facilitate a wide conversation. Encourage students to assess potential solutions, share ideas, and provide feedback to one another. 9) Instruct students to reflect on their case analysis experience. Consider which components piqued their attention or had the most meaning for them (Magolda, 2021).

The inclusion of case studies in Introduction to Education courses can have a substantial positive influence on students' critical thinking and conceptual comprehension. Case studies give a rich and complicated environment that necessitates critical thinking and extensive

study. Students must assess numerous variables, identify major concerns, and develop solutions or suggestions (Shaw et al., 2020). Case studies use academic principles in a practical setting. This allows students to see how the topics covered in the course apply and are useful in real-world educational scenarios. Students can increase their comprehension of fundamental educational ideas through case studies. They can see how these ideas interact and affect real-world events.

2. Literature Review

To ensure that the case study approach is used effectively in student learning, various standards or regulations must be followed. Select a case that is relevant and relevant to the learning goals (Ożadowicz, 2020). Make sure the case is relevant to the learning setting and covers the principles you wish to teach. Establish explicit and quantifiable learning goals. Explain exactly what students are expected to accomplish by analyzing the case. Before analyzing the case, provide students with sufficient context and introduction. Ascertain that they have a basic comprehension of the topics to be covered.

The case study method of learning is meant to assist students in overcoming diverse issues encountered in the actual world. Students encounter difficult and confusing challenges in the actual world. Exercises using case studies give practice in dealing with complicated situations, recognizing crucial aspects, and proposing integrated solutions (Paleyes et al., 2023). Limited resources such as time, money, and labor are frequently a restriction in the Real World. Students may learn to build efficient and effective solutions by analyzing the restricted resources that may exist in a case through Case Studies.

Working with teams in the real world sometimes entails difficulties such as divergences of opinion and coordination. Case Studies and Case Analysis Exercises allow students to interact, discuss, and comprehend the range of viewpoints to solve problems (Azlan et al., 2020). Rapid change and unpredictability are aspects of the work environment in the real world. Case studies expose students to circumstances that might change, assisting them in developing resilience to change and adaptive abilities. Decisions in the real world frequently include difficult ethical issues. Students can practice examining the ethical implications of actions made in a case and considering their impact through Case Studies (Chang, 2021).

In Practice: Applying academic notions in a practical situation might be difficult. Case Studies: Case studies allow students to apply theoretical concepts in real-world settings, increasing their knowledge and relevance (McCrory et al., 2020). In the Real World: Effective communication skills are required while engaging with different parties. Case Studies: In the setting of a case study, students can obtain expertise in formulating arguments, presenting facts, and communicating coherently (Masuram & Sripada, 2020). In the Real World: Critical skills include assessing information and making educated judgments. Students may be instructed in analyzing possibilities, developing judgments, and delivering strong reasoning through the Case Study. In the Real World: Employers value effective problem-solving skills. Students can improve their problem-solving skills by using Case Studies.

The integration of theories related to problem-solving activities is included in the use of theoretical notions in problem-solving strategies in learning (Priemer et al., 2020). Determine the theoretical notions that are pertinent to the topic at hand. For example, ideas from specific fields or broad notions that may be used to issue resolution. Include the theoretical notion explicitly in the case description. Show how the notion may be used or applied to solve the current challenge (Lesort et al., 2020). The integration of theoretical concepts with activities that encourage students' critical and analytical thinking is required for the use of theoretical concepts in problem-solving approaches (Tang et al., 2020). Students can experience deep and meaningful learning by presenting them with relevant and supporting case situations.

3. Research Method and Materials

Quantitative research seeks to quantify and analyze phenomena via the use of numerical and statistical data (Ahmad et al., 2019). The goal of this study is to statistically assess the influence of the case study technique on students' problem-solving abilities. The experimental design enables researchers to manipulate key factors to determine the causal influence of the case study technique on problem-solving abilities.

In the Chemistry Education S-1 study program at Tadulako University for the introductory education course, an experimental research design was used with two classes, the experimental class (Class A) and the control class (Class B). Sample: Two classes were chosen at random the experimental class (Class A) and the control class (Class B). The sample size was 56 pupils, including 28 in the experimental class and 28 in the control class. The design is quasi-experimental with a non-equivalent control group. Because random assignment was impossible, both classes were assumed to have comparable starting characteristics. Class A (Experiment): Learned in the introductory education course using the case study technique. Class B (Control): Learned in an introductory education course using the traditional technique. After the treatment, assess both classes' problem-solving abilities.

To assess students' problem-solving abilities, use credible and reliable examinations or assessment methods. In the form of case questions or practical assignments demonstrating problem-solving abilities. It comprises 3 measures, namely problem-solving ability, critical analysis, and knowledge of student concepts. consists of ten multiple-choice questions with division, four questions on critical analysis indicators, three questions on concept understanding indicators, and three questions on problem-solving indicators.

Table 1. Research Descriptive Analysis Findings

Class	N	Range	Minimum	Maximum	Sum	Mean	Std. Error	Std. Deviation	Variance
Experiment Class	28	60	40	100	1980	70.7143	2.99597	15.85316	251.323
Control Class	28	60	30	90	1740	62.1429	3.1855	16.85607	284.127

Based on the data in Table 1, the following tentative conclusions may be reached about the experimental and control classes: The experimental class received a minimum score of 40, but the control class had a minimum score of 30, suggesting that the experimental class outperformed the control class. The control class has a mean score of 62.1429, whereas the experimental class has a mean score of 70.7143. The experimental group received a maximum score of 100. The control class got a maximum score of 90, indicating that the experimental class, taught via case studies, outperforms the control class.

Table 2. Research normality test results

Tests of Normality

Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental class	0.185	28	0.015	0.936	28	0.09
Control class	0.158	28	0.072	0.939	28	0.102

The normality test findings employ the Shapiro-Wilk test to determine if the data is regularly distributed. The determined significance value (p-value) may be used to assess if the data is normal or not. The null hypothesis (normally distributed data) cannot be rejected if the significance value is larger than the preset significance threshold (typically 0.05). The normalcy test findings for the experimental and control classes are interpreted as follows: If the specified significance level is 0.05 and the significance value is 0.09, there is insufficient evidence to reject the null hypothesis that the experimental class data is regularly

distributed. As a result, the experimental class data may be deemed to be quite near to normal. If the significance threshold is set to 0.05 and the significance value is 0.102, there is insufficient evidence to reject the null hypothesis that the control class data is regularly distributed. The control class data, like the experimental class, is considered to have a pretty near-to-normal distribution.

Table 3. Independent (Parametric) T-test Results

Independent Samples Test

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
									Lower	Upper
Experimental_Control Class	Equal variances assumed	0.034	0.855	1.96	54	0.055	8.57143	4.37301	-0.19593	17.33878
	Equal variances not assumed			1.96	53.798	0.055	8.57143	4.37301	-0.19668	17.33954

The independent T-test yielded a significance value (sig.) of 0.055. This value represents the likelihood. The resulting significance level of 0.055 is near to, but not equal to, the general significance level of 0.05. If we use the general significance level of 0.05 as the decision limit, this result indicates that there is insufficient statistical evidence to conclude that there is a real mean difference between the experimental (case study) and control (conventional methods) classes. However, if we look at the descriptive analysis results, namely the higher mean value in the experimental class, we may presume that there is a difference even if it is not significant due to the significance level.

4. Results and Discussion

The different challenges found in employing case studies for chemistry subject acquisition in Tadulako University's Chemistry Education S-1 Study Programme may be attributed to a variety of variables. The complexity of the subject, the teaching methods necessary, or issues in symbolic presentation are some of the reasons why case studies meet obstacles in the context of chemistry learning. Case studies, on the other hand, more easily implemented in educational orientation and general foundation courses due to the special qualities of the content or curriculum that favor this method (Didham & Ofei-Manu, 2020). When compared to educational orientation courses or general foundation courses, the chemistry curriculum is more difficult and abstract. Chemical symbols, molecular models, and mathematical ideas used in chemistry may make comprehension more challenging for some people. Because chemistry has its own language and notation, chemical symbols frequently dominate learning (Miller et al., 2021). Case studies may create issues in explaining chemical ideas in scenarios that do not use traditional chemical iconography. The curriculum or teaching materials have constraints that do not completely support the case study method of chemical learning. A curriculum that is overly organized or focuses on certain theoretical components might be an impediment. Some chemistry education still relies on conventional teaching methods such as lectures, practicals, and hands-on demonstrations. Introducing new learning approaches, such as case studies, may need a shift in culture and teaching methodology.

For various reasons, general and basic education courses may be simpler for lecturers to model using the case study technique, including the fact that general and basic education courses frequently incorporate topics that are more easily related to students' daily experiences. Case studies that depict real-world events similar to those seen by students

may be simpler to comprehend and implement (Coughlan, 2020). When opposed to specialized courses, such as chemistry courses or other courses that focus on specific fields, material in broad foundation courses may employ simpler and less technical terminology. Using simple language can help to improve the efficacy of modeling with case studies.

The delivery of content in general foundation courses is sometimes lacking in symbolic intricacy or formality. Case studies in this context may be developed more readily without relying on specialized symbols or sophisticated notation (Leone et al., 2021). Basic education is frequently concerned with the development of broad abilities such as problem-solving, critical analysis, and creative thinking. Case studies may successfully simulate the application of these abilities in a real-world setting, giving students hands-on experience (Bennie & Erickson, 2023). Because the breadth of concepts is greater and may be altered for many circumstances, general and basic educational materials are frequently more flexible in case design. Lecturers can provide more engaging and relevant scenarios to help students comprehend the content. Remember that the success of case studies in any course is dependent on excellent preparation, case design, and delivery. Lecturers must ensure that the case studies provided are relevant to the learning objectives and help students gain a thorough comprehension of the ideas.

Although the case study learning approach has many advantages, there may be certain issues that arise when it is used. Some of the most typical issues encountered while using the case study learning approach are as follows: Case studies require adequate time to be thoroughly examined. Time availability might become an issue while working under a rigid curricular structure. Creating a good case takes much knowledge and effort. Creating high-quality instances that are related to the learning objectives can be a difficult undertaking.

It is frequently difficult to obtain adequate facts or information to establish a case. Limited resources or data availability might be an obstacle. Subjective judgment can sometimes impact the interpretation of case study data. This can make strong or objective generalizations difficult. Because each case is unique, judging and grading the outcomes of case studies can be challenging. Assessment standardization might be difficult. It might be difficult to facilitate group discussions or case presentations (Littenberg-Tobias & Reich, 2020). Classroom management abilities are essential to guarantee that all pupils participate actively. Students can understand cases in a variety of ways. Different interpretations might make it challenging to achieve certain learning objectives.

Measuring the efficacy of the case study technique in accomplishing learning objectives can be difficult. It is necessary to create clear success criteria as well as adequate evaluation methodologies. Effective learning may not occur if students are not fully involved in the case analysis. A lack of engagement may be a problem. Due to logistical and time constraints, implementing case studies on a big scale or in a class with a high number of students might be problematic (Caldarella et al., 2019). Despite the difficulties, many of these obstacles may be solved with careful preparation, lecturer training, and innovative thinking in case design and management. Furthermore, continuing evaluation on the teaching experience and adaptations to learning approaches might assist overcome some of these issues.

The difference in mean scores between the experimental class (70.7143) and the control class (62.1429) is seen in Table 1, with the experimental class having a higher mean score. There are three major explanations for this conclusion. The experimental class's learning style was more effective in enhancing students' knowledge and acceptance of the subject. The interactive case study method can help students comprehend ideas better. The experimental class's topic is more relevant or may be closely tied to students' daily life. The material's relevance can boost student enthusiasm and comprehension. Students in the experimental class are encouraged to actively participate in the learning process. Discussions, tasks, or activities that demand direct student participation can help students grasp concepts better.

Differences in teaching style or capabilities between the experimental and control courses might explain the disparities in outcomes. Innovative teaching approaches or student-centered adjustments can have a good influence. Students in the experimental class may be more motivated to learn. Student motivation may be influenced by factors such as interest in the material, perceived worth of learning, or past positive experiences. A conducive learning environment, both physical and social, might be beneficial. The experimental class could have offered a more encouraging environment for kids' academic growth. Differences in the experimental and control classes' beginning knowledge or skill levels may have an impact on the outcome. The experimental class may begin at a higher level of difficulty.

The rise in student interest and confidence in the experimental class as a result of the case study technique is a good indicator of the approach's efficacy. Here are some of the reasons why the case study learning approach is useful and may boost students' enthusiasm and confidence: Case studies provide students with a learning environment that is both authentic and relevant to their daily lives. Cases that are fascinating and relevant to their lives might pique their attention and motivate them to study (Ditta et al., 2020). The case study method encourages students to participate actively. Involving them in case analysis, debate, and problem-solving may give a more comprehensive learning experience. Students are provided the chance to improve their analytical and problem-solving abilities through case analysis. This can boost their confidence in dealing with challenging situations. Case studies frequently include an emotional component, which can boost student involvement. Understanding the circumstance or problem in the case might elicit empathy and a desire to solve the problem. Involving students in the analysis and resolution of case situations gives them ownership of their learning. This might lead to a greater sense of responsibility over the learning process. Decision-making cases can boost students' confidence in making informed and contextualized judgments.

Case studies frequently need student involvement and participation. Collaboration may foster a sense of community and confidence in working as a team. The case study technique may be more appropriate for introductory education course learning objectives (Iglesias-Pradas et al., 2021). Case studies allow for easier integration of knowledge into beginning teaching resources. Students' intrinsic motivation can be stimulated by case studies because they feel involved in meaningful learning that is relevant to their own lives. It is critical to regularly monitor and assess the efficiency of the case study learning approach, as well as to give the necessary assistance to guarantee that the gain in motivation and confidence lasts. Regular student evaluation and feedback can aid in future modifications and improvements.

The application of the case study technique in learning can help students strengthen their soft skills. The following are some of the soft skills that students develop or improve while studying utilizing the case study method: In case studies, students are used to analyzing complicated situations, finding difficulties, and proposing answers or suggestions. This contributes to the development of their analytical abilities. Case studies frequently include settings that necessitate issue resolution. Students learn to design innovative and effective solutions to problems. Students are taught to think critically about available information, evaluate arguments, and make well-considered judgments through case analysis. Students can practice articulating ideas, organizing arguments, and speaking effectively through case discussions and presentations.

Case studies frequently need teamwork and communication. Students learn how to collaborate with team members, discuss ideas, and come up with solutions together. Students are given the chance to grasp the repercussions of each decision taken and refine their decision-making abilities through case discussions. Analyzing and presenting instances can be time-consuming. Students learn how to manage their time effectively to achieve the tasks allotted to them. Solving challenges in the setting of cases frequently necessitates a novel approach. Students are encouraged to think creatively and come up with unexpected answers. Teamwork in case analysis might put students in contentious situations. They can

learn to handle conflict, communicate effectively, and reach solutions that are acceptable to all parties.

While case study learning approaches can be useful in building soft skills such as analytical, problem-solving, and critical thinking abilities, there are various reasons why this method may have a less direct impact on hard skill development. Case studies are frequently meant to reflect a particular circumstance or setting. As a result, the understanding and abilities gained are more specific to the case's context rather than broad concepts or talents that can be used in several scenarios. Case studies may be unique and contain distinctive aspects that cannot be readily generalized to a broader environment. This might make it tough to apply what you've learned in other circumstances. Case studies emphasize idea knowledge, case analysis, and higher-order thinking abilities. To address some of these challenges, an integrated learning strategy that involves case study methodologies, as well as hands-on practice, simulations, and skills exercises, is required. A mix of different learning approaches may give a complete learning experience while also supporting the development of both soft and hard abilities.

The significant value (Sig.) of 0.055 in Table 3 indicates that the difference between the experimental class (taught using case studies) and the control class (taught using traditional techniques) did not achieve the general significance threshold of 0.05. Some of the variables that may have contributed to this difference remaining negligible include: If the sample numbers in both groups are small, the ability to identify significant differences may suffer. A bigger sample size may illustrate the discrepancy more clearly. If the data in both groups is very variable, the p-value may rise, suggesting that the difference between the groups is insufficiently consistent to attain statistical significance (Bunting et al., 2019). A research design that is insensitive to group differences may result in a higher p-value. To discover tiny variations, a more rigorous or sensitive study design may be required. If extra factors impact the outcomes and are not appropriately accounted for or controlled for in the study, the results may be less significant.

Certain factors, such as environmental influences or things outside the classroom, may influence the outcomes and lower the statistical significance of the test results. Although a significance value of 0.055 is regarded as negligible, there is still a chance that a difference exists but that the statistical test will miss it (type II error). If there is a large level of individual variability among students in each group, the p-value may rise because the differences across groups may be less stable. It is critical to consider these considerations while analyzing the study's findings and, when possible, to undertake additional studies to determine the factors that may have influenced the reported significance levels. In certain circumstances, more research or changes to the study design are required

5. Conclusion

According to the findings, there is a substantial difference in mean scores between the experimental class (taught using case studies) and the control class (taught using conventional techniques). The experimental class outperformed the control class in terms of mean scores, demonstrating that the case study learning technique had a favorable influence on students' academic results. However, the significance value obtained from the independent T-test result of 0.055 suggests a degree of significance that is still at the negligible level, although it is more than the conventional cut-off value of 0.05. This means that the difference between the two groups has not achieved the statistical significance threshold that is normally considered solid evidence. If the sample size is small or the data is very variable, the degree of significance may be affected. The research design or procedures employed may have been insufficiently sensitive to identify tiny changes between groups. Other factors that were not properly accounted for in the study may have an impact on the results and their level of significance. The assessment results in the context of student skill development demonstrated an increase in students' soft skills by

applying the case study technique, while the improvement in students' hard skills was less significant. Because the learning environment can alter the efficiency of a learning approach, environmental elements may also play a part in this. As a consequence, it is advised to reconsider changing the research methodology, increasing the sample size, or discovering additional factors that may impact the results. A better knowledge of how these components interact may give deeper insights into the effectiveness of the case study technique in boosting both students' soft and hard abilities.

References

Ahmad, S., Wasim, S., Irfan, S., Gogoi, S., Srivastava, A., & Farheen, Z. (2019). Qualitative v/s. Quantitative Research- A Summarized Review. *Journal of Evidence Based Medicine and Healthcare*, *6*(43), 2828–2832. https://doi.org/10.18410/jebmh/2019/587

Azlan, C. A., Wong, J. H. D., Tan, L. K., A.D. Huri, M. S. N., Ung, N. M., Pallath, V., Tan, C. P. L., Yeong, C. H., & Ng, K. H. (2020). Teaching and learning of postgraduate medical physics using Internet-based e-learning during the COVID-19 pandemic – A case study from Malaysia. *Physica Medica*, *80*, 10–16. https://doi.org/10.1016/j.ejmp.2020.10.002

Bennie, B., & Erickson, R. A. (2023). Obtaining and Applying Public Data for Training Students in Technical Statistical Writing: Case Studies with Data from U.S. Geological Survey and General Ecological Literature. *Journal of Statistics and Data Science Education*, 1–10. https://doi.org/10.1080/26939169.2023.2195459

Bunting, K. V., Steeds, R. P., Slater, L. T., Rogers, J. K., Gkoutos, G. V., & Kotecha, D. (2019). A Practical Guide to Assess the Reproducibility of Echocardiographic Measurements. *Journal of the American Society of Echocardiography*, *32*(12), 1505–1515. https://doi.org/10.1016/j.echo.2019.08.015

Caldarella, P., Wills, H. P., Anderson, D. H., & Williams, L. (2019). Managing Student Behavior in the Middle Grades Using Class-wide Function-Related Intervention Teams. *RMLE Online*, *42*(7), 1–15. https://doi.org/10.1080/19404476.2019.1654799

Chang, V. (2021). An ethical framework for big data and smart cities. *Technological Forecasting and Social Change*, *165*, 120559. https://doi.org/10.1016/j.techfore.2020.120559

Cortázar, C., Nussbaum, M., Harcha, J., Alvares, D., López, F., Goñi, J., & Cabezas, V. (2021). Promoting critical thinking in an online, project-based course. *Computers in Human Behavior*, *119*, 106705. https://doi.org/10.1016/j.chb.2021.106705

Coughlan, T. (2020). The use of open data as a material for learning. *Educational Technology Research and Development*, *68*(1), 383–411. https://doi.org/10.1007/s11423-019-09706-y

Didham, R. J., & Ofei-Manu, P. (2020). Adaptive capacity as an educational goal to advance policy for integrating DRR into quality education for sustainable development. *International Journal of Disaster Risk Reduction*, *47*, 101631. https://doi.org/10.1016/j.ijdrr.2020.101631

Ditta, A. S., Strickland-Hughes, C. M., Cheung, C., & Wu, R. (2020). Exposure to information increases motivation to learn more. *Learning and Motivation*, *72*, 101668. https://doi.org/10.1016/j.lmot.2020.101668

Harris, B. N., McCarthy, P. C., Wright, A. M., Schutz, H., Boersma, K. S., Shepherd, S. L., Manning, L. A., Malisch, J. L., & Ellington, R. M. (2020). From panic to pedagogy: Using online active learning to promote inclusive instruction in ecology and evolutionary biology courses and beyond. *Ecology and Evolution*, *10*(22), 12581–12612. https://doi.org/10.1002/ece3.6915

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119*, 106713. https://doi.org/10.1016/j.chb.2021.106713

Jesionkowska, J., Wild, F., & Deval, Y. (2020). Active Learning Augmented Reality for STEAM Education—A Case Study. *Education Sciences*, *10*(8), 198. https://doi.org/10.3390/educsci10080198

Kitchin, R. (2017). Thinking critically about and researching algorithms. *Information, Communication & Society*, *20*(1), 14–29. https://doi.org/10.1080/1369118X.2016.1154087

Leone, D., Schiavone, F., Appio, F. P., & Chiao, B. (2021). How does artificial intelligence enable and enhance value co-creation in industrial markets? An exploratory case study in the healthcare ecosystem. *Journal of Business Research*, *129*, 849–859. https://doi.org/10.1016/j.jbusres.2020.11.008

Lesort, T., Lomonaco, V., Stoian, A., Maltoni, D., Filliat, D., & Díaz-Rodríguez, N. (2020). Continual learning for robotics: Definition, framework, learning strategies, opportunities and challenges. *Information Fusion*, *58*, 52–68. https://doi.org/10.1016/j.inffus.2019.12.004

Littenberg-Tobias, J., & Reich, J. (2020). Evaluating access, quality, and equity in online learning: A case study of a MOOC-based blended professional degree program. *The Internet and Higher Education*, *47*, 100759. https://doi.org/10.1016/j.iheduc.2020.100759

Lovrić, R., Farčić, N., Mikšić, Š., & Včev, A. (2020). Studying During the COVID-19 Pandemic: A Qualitative Inductive Content Analysis of Nursing Students' Perceptions and Experiences. *Education Sciences*, *10*(7), 188. https://doi.org/10.3390/educsci10070188

Magolda, P. M. (2021). Doing Case Study Research: A Practical Guide for Beginning Researchers. *Journal of College Student Development*, *48*(1), 123–125. https://doi.org/10.1353/csd.2007.0003

Martinez, C. (2022). Developing 21 st century teaching skills: A case study of teaching and learning through project-based curriculum. *Cogent Education*, *9*(1), 2024936. https://doi.org/10.1080/2331186X.2021.2024936

Masuram, J., & Sripada, P. N. (2020). DEVELOPING SPEAKING SKILLS THROUGH TASK-BASED MATERIALS. *Procedia Computer Science*, *172*, 60–65. https://doi.org/10.1016/j.procs.2020.05.009

McCrory, G., Schäpke, N., Holmén, J., & Holmberg, J. (2020). Sustainability-oriented labs in real-world contexts: An exploratory review. *Journal of Cleaner Production*, *277*, 123202. https://doi.org/10.1016/j.jclepro.2020.123202

Miller, J. A., Sivaramakrishnan, R., Tao, Y., Goldsmith, C. F., Burke, M. P., Jasper, A. W., Hansen, N., Labbe, N. J., Glarborg, P., & Zádor, J. (2021). Combustion chemistry in the twenty-first century: Developing theory-informed chemical kinetics models. *Progress in Energy and Combustion Science*, *83*, 100886. https://doi.org/10.1016/j.pecs.2020.100886

Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J.-M., Ramírez-Montoya, M.-S., Navarro-Tuch, S. A., Bustamante-Bello, M.-R., Rosas-Fernández, J.-B., & Molina, A. (2021). The core components of education 4.0 in higher education: Three case studies in engineering education. *Computers & Electrical Engineering*, *93*, 107278. https://doi.org/10.1016/j.compeleceng.2021.107278

Ożadowicz, A. (2020). Modified Blended Learning in Engineering Higher Education during the COVID-19 Lockdown—Building Automation Courses Case Study. *Education Sciences*, *10*(10), 292. https://doi.org/10.3390/educsci10100292

Paleyes, A., Urma, R.-G., & Lawrence, N. D. (2023). Challenges in Deploying Machine Learning: A Survey of Case Studies. *ACM Computing Surveys*, *55*(6), 1–29. https://doi.org/10.1145/3533378

Perusso, A., & Baaken, T. (2020). Assessing the authenticity of cases, internships and problem-based learning as managerial learning experiences: Concepts, methods and lessons for practice. *The International Journal of Management Education*, *18*(3), 100425. https://doi.org/10.1016/j.ijme.2020.100425

Pohl, C., Pearce, B., Mader, M., Senn, L., & Krütli, P. (2020). Integrating systems and design thinking in transdisciplinary case studies. *GAIA - Ecological Perspectives for Science and Society*, *29*(4), 258–266. https://doi.org/10.14512/gaia.29.4.11

Priemer, B., Eilerts, K., Filler, A., Pinkwart, N., Rösken-Winter, B., Tiemann, R., & Zu Belzen, A. U. (2020). A framework to foster problem-solving in STEM and computing education. *Research in Science & Technological Education*, *38*(1), 105–130. https://doi.org/10.1080/02635143.2019.1600490

Quinn, S., Hogan, M., Dwyer, C., Finn, P., & Fogarty, E. (2020). Development and Validation of the Student-Educator Negotiated Critical Thinking Dispositions Scale (SENCTDS). *Thinking Skills and Creativity*, *38*, 100710. https://doi.org/10.1016/j.tsc.2020.100710

Rehman, N., Zhang, W., Mahmood, A., Fareed, M. Z., & Batool, S. (2023). Fostering twenty-first century skills among primary school students through math project-based learning. *Humanities and Social Sciences Communications*, *10*(1), 424. https://doi.org/10.1057/s41599-023-01914-5

Shamay-Tsoory, S. G., & Mendelsohn, A. (2019). Real-Life Neuroscience: An Ecological Approach to Brain and Behavior Research. *Perspectives on Psychological Science*, *14*(5), 841–859. https://doi.org/10.1177/1745691619856350

Shaw, A., Liu, O. L., Gu, L., Kardonova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Shi, H., & Loyalka, P. (2020). Thinking critically about critical thinking: Validating the Russian HEIghten® critical thinking assessment. *Studies in Higher Education*, *45*(9), 1933–1948. https://doi.org/10.1080/03075079.2019.1672640

Sinatra, G. M., & Lombardi, D. (2020). Evaluating sources of scientific evidence and claims in the post-truth era may require reappraising plausibility judgments. *Educational Psychologist*, *55*(3), 120–131. https://doi.org/10.1080/00461520.2020.1730181

Svensson, J., Axén, A., Andersson, E. K., & Hjelm, M. (2021). Nursing students' experiences of what influences achievement of learning outcomes in a problem-based learning context: A qualitative descriptive study. *Nursing Open*, *8*(4), 1863–1869. https://doi.org/10.1002/nop2.842

Tachie, S. A. (2019). Meta-cognitive Skills and Strategies Application: How this Helps Learners in Mathematics Problem-solving. *EURASIA Journal of Mathematics, Science and Technology Education*, *15*(5). https://doi.org/10.29333/ejmste/105364

Tang, T., Vezzani, V., & Eriksson, V. (2020). Developing critical thinking, collective creativity skills and problem solving through playful design jams. *Thinking Skills and Creativity*, *37*, 100696. https://doi.org/10.1016/j.tsc.2020.100696

Thomassen, A. O., & Stentoft, D. (2020). Educating Students for a Complex Future: Why Integrating a Problem Analysis in Problem-Based Learning Has Something to Offer. *Interdisciplinary Journal of Problem-Based Learning*, *14*(2). https://doi.org/10.14434/ijpbl.v14i2.28804

Valentine, N., Shanahan, E. M., Durning, S. J., & Schuwirth, L. (2021). Making it fair: Learners' and assessors' perspectives of the attributes of fair judgement. *Medical Education*, *55*(9), 1056–1066. https://doi.org/10.1111/medu.14574