Copyright © The Author(s) 2024
Jurnal Studi Guru dan Pembelajaran, Vol. 7, No. 3, September – Desember 2024

Overview of Student Understanding in Research Statistics Lectures Using the PJBL Method

Islawati [1], Munawwarah [2]

[1, 2] Universita Negeri Makassar, Indonesia

* munawwarah@unm.ac.id

Abstract

The main issue in this study is that many students still have difficulty integrating theory with practice, particularly at the stages of data visualization and interpretation. This study aims to explore students' understanding of data collection and analysis techniques in research statistics courses through the implementation of the Project-Based Learning (PJBL) method. A qualitative descriptive approach was used in this study, involving 22 students from the Chemistry Education Program. Students were applied to each stage of PJBL, namely: (1) Determining the Main Question, (2) Compiling a Project Plan, (3) Collecting and Analyzing Data, (4) Compiling Results and Interpretation, and (5) Project Evaluation. The results showed that students demonstrated a good understanding at the initial stages, such as Determining the Main Question and Compiling a Project Plan, which reflects their ability to understand and design the data analysis process. At more complex stages, such as Data Collection and Analysis and Compiling Results and Interpretation, it was found that some students had difficulty connecting the analysis results with the research context. Students' reflections during the Project Evaluation phase indicated that they were aware of the challenges they faced, such as the in-depth understanding of data visualization and interpretation techniques, as well as the importance of applying theory to practice. This study highlights the importance of the PJBL approach in supporting experiential learning to enhance students' understanding of research statistical techniques. Through in-depth exploration, this study provides insights into the learning challenges and the potential of project-based learning strategies to enhance students' research skills in higher education.

Keywords: *General Description; Student Understanding; Research Statistics; Project-Based Learning*

Introduction

Students' understanding of research statistics is a key element in higher education, especially in study programs that emphasize research skills. This competency is an important foundation for students to be able to design and carry out research systematically (Fini et al., 2018). However, many students still have difficulty integrating statistical theory with practice, especially when faced with complex data. This shows the need for a learning approach that not only conveys theory but also provides students with direct experience (Maros et al., 2023). Research statistics is often considered a challenging subject because it involves abstract and technical concepts. Students are expected to be able to understand data collection, processing, and analysis techniques, and relate them to the research context (Ngereja et al., 2020). However, most students are only able to master basic concepts such as data distribution, without understanding how to apply more complex analysis techniques. This challenge shows a gap between theoretical understanding and practical skills that need to be addressed in the learning process (Saad et al., 2022). The main obstacle in learning research

https://doi.org/10.30605/jsgp.7.3.2024.4857

statistics is the lack of a contextual and applied approach. Many teachings still focus on knowledge transfer, while students need direct experience to truly understand the concepts and techniques of data analysis. The students often have difficulty when asked to apply theory in real situations (Sutrisno et al., 2022). This causes them to lack confidence in evaluating research data and drawing meaningful conclusions.

The Project-Based Learning (PJBL) approach is here as a solution to overcome this gap (Khandakar et al., 2020). PJBL offers project-based learning that provides students with hands-on experience in applying theoretical concepts. Through PJBL, students not only learn theory but are also trained to be actively involved in the research process, from planning to interpreting results. This approach is expected to help students overcome difficulties in understanding and applying data collection and analysis techniques. PJBL is designed to involve students in various stages of research, from formulating questions, preparing project plans, collecting data, to analyzing and reflecting on the results (Susanti et al., 2022). Each stage provides opportunities for students to develop critical and analytical thinking skills. In addition, PJBL allows students to understand the relevance of research methods in answering complex questions. With this approach, students not only learn theory but also understand how the theory is applied in practice (Wardani et al., 2021).

Previous studies have shown that PJBL can improve students' understanding of research concepts. The students who follow PJBL are better able to integrate theory with practice than those who only follow conventional learning methods (Pilot et al., 2023). However, most of these studies focus on learning outcomes, without delving deeply into the processes experienced by students during learning. Therefore, research is needed that explores students' experiences in undergoing each stage of PJBL, especially in the context of research statistics courses. Unlike previous studies, this study aims to describe in depth students' experiences in understanding and applying data collection and analysis techniques through the PJBL method. The focus of this study is on how students go through the learning process, including the challenges they face and the strategies they use to overcome them. With a qualitative descriptive approach, this study provides new insights into students' learning processes, not just the end results.

The novelty of this study lies in the in-depth exploration of the stages of PJBL, such as Determining Fundamental Questions, developing a Project Plan, Collecting and Analyzing Data, and Preparing Results and Interpretation. Each stage provides a more specific picture of students' understanding of research statistics techniques. This study not only aims to describe students' abilities but also provides insight into how the learning process can be improved. Another focus of this study is to identify the barriers experienced by students during the learning process. These barriers include difficulties in understanding data visualization techniques, linking methods to results, and compiling meaningful interpretations. This study is expected to provide relevant recommendations to improve the effectiveness of the PJBL method in supporting research-based learning b understanding these barriers. This study also seeks to contribute to the development of learning strategies that are more applicable and relevant to students' needs. This study provides an overview of aspects of learning that need to be improved. This study also offers guidance for teachers to design more effective teaching methods in research statistics courses.

The results of this study are expected to provide new insights into the effectiveness of PJBL in improving students' understanding of research statistics. This approach not only helps students understand basic concepts but also develops more complex data analysis skills.

Thus, this study makes a significant contribution to the development of project-based learning methods in higher education. The PJBL approach also provides important practical benefits for students, especially in preparing them to face challenges in the world of work and research. PJBL helps them understand the relevance of theory to practice by actively involving students in every stage of research. This provides students with a more meaningful experience compared to learning methods that only focus on theory. Reflections carried out by students during the PJBL process are also an important part of this study. Reflection allows students to evaluate their understanding, identify weaknesses, and find solutions for improvement. The students not only learn from the projects they work on but also from the learning process itself. This is one of the main advantages of the PJBL approach. This study makes a relevant contribution to the development of a more applicable curriculum in the context of higher education in Indonesia. Educational institutions can design more effective learning strategies by understanding students' experiences in undergoing PJBL. This research also provides input for the development of research statistics courses to better suit students' needs.

Method

This study uses a qualitative descriptive approach involving 22 students of the Chemistry Education Study Program, Makassar State University. The subjects of the study were students who had studied data collection and analysis techniques in the context of research. The Project-Based Learning (PJBL) approach was applied to help students understand data analysis techniques through projects that simulate real research. Each PJBL syntax was applied systematically to guide students in developing their data analysis skills.

The first stage in PJBL is the Determination of Fundamental Questions. Students are invited to formulate basic questions related to the data analysis techniques that are their focus in this project. These questions are focused on understanding data collection and analysis methods in the context of chemistry education. The second stage is the Preparation of Project Plans, where students are directed to choose two relevant studies related to learning models in chemistry education. The selected studies must be theses published or stored in the library in the last five years, which present quantitative data such as exam scores or student report card scores. Each student prepares a research evaluation plan by following a rubric that includes several main components in data analysis.

The namely Data Collection and Analysis, students evaluate selected research using the rubric that has been prepared. The evaluation is carried out in several components: Data Identification and Classification, namely students ensure that the quantitative data presented includes test scores or values, and identify the measurement scale and research variables. Frequency Distribution and Data Visualization, namely students evaluate the application of frequency distribution, data visualization (such as histograms or frequency polygons), and identify whether the data is interpreted correctly. Measures of Centralization and Data Variation, namely calculating the mean, median, and mode, and evaluating measures of variation such as range and standard deviation. Coefficient of Variation and Standard Value (Z-score) to assess data variability and the relative position of scores in the data distribution. Inferential Statistical Procedures, namely students evaluate the statistical tests used (such as t-test or ANOVA) and record the level of significance and p-value.

The fourth stage, Preparation of Results and Interpretation, is carried out after students have conducted a statistical evaluation. Students integrate and synthesize data by comparing findings from two selected studies. They identify similarities and differences in the results,

relate these findings to chemistry education theory and statistical concepts, and consider their practical implications. The final stage in the PJBL is Project Evaluation, where students reflect on their understanding of data collection and analysis techniques based on the projects they have completed. Students record personal reflections on the challenges they faced, the solutions they implemented, and the insights they gained from the process.

Data collected in the PJBL project were evaluated through a qualitative rubric that assessed student engagement, understanding, and reflection at each stage of the PJBL. The assessment was conducted by reviewing student assignments and contributions based on qualitative rubric criteria, which included the ability to identify problems, participate in group discussions, the process of collecting and organizing data, and reflecting and concluding project results. The qualitative descriptive data analysis, information obtained from observations, field notes, and interviews was analyzed through a coding and categorizing process to find themes or patterns that indicate the level of student understanding. Through this analysis, an in-depth description of the student's learning experience and the challenges they faced when applying data analysis techniques within the PJBL framework can be obtained.

This study used data triangulation techniques by verifying the findings from various sources, such as written notes, direct interviews, and observations of learning activities to ensure the validity and reliability of the findings. This triangulation technique aims to ensure that the data obtained reflects a comprehensive and accurate view of the student learning process. In addition, member checks were conducted where each finding was confirmed to the participants to verify the accuracy of the descriptions and interpretations recorded. Discussions with colleagues were also held to reduce bias, provide additional objective perspectives, and strengthen the reliability of the results through external control of the researcher's interpretation.

Results

Based the observation, student competency is assessed through several stages in the Project Based Learning Process (PBL), which includes five main syntaxes: Determining Fundamental Questions, Preparation of Project Plans, Data Collection and Analysis, Preparation of Results and Interpretation, and Project Evaluation. The following is a description of each stage based on the abilities displayed by students.

Defining Fundamental Questions

The students generally demonstrate a strong ability to formulate fundamental questions that are fundamental to their projects. Most students appear to understand the main objectives of the project and are able to identify relevant questions, indicating that they have a good foundation in determining the direction of their research or project.

Project Plan Preparation

The students showed good skills in designing systematic steps. Although some students seemed confident in developing their plans, there were some who still needed further guidance to develop a more mature and structured plan. This shows that there is variation in the level of understanding and planning skills among students.

Data Collection and Analysis

The data collection and analysis stage is one of the challenges for students. They seem to have difficulty in applying the right data collection methods and in analyzing the information they collect. Some students still need further guidance to understand the data collection and analysis procedures that are appropriate for the projects they are working on.

Preparation of Results and Interpretation

The students showed uncertainty in compiling structured results and in-depth interpretations. Some of them still need to develop the ability to present results systematically and provide interpretations that are in accordance with the research context. This indicates a need to strengthen their understanding in compiling results and critical interpretations.

Project Evaluation

The students tend to be more independent and able to assess their own projects better. They seem to understand the reflection process, both in terms of achievements and challenges they face during the project. This ability shows that students are aware of the quality of their work and are able to evaluate the effectiveness of the completed project.

Discussion

The evaluation of the understanding of 22 students was conducted by following the Project-Based Learning (PJBL) syntax which includes the main stages in educational data analysis. Each stage in the PJBL syntax has certain criteria that must be met to ensure that students have the expected competencies. The evaluation results showed variations in the level of student understanding, where most showed a good understanding in the early stages of PJBL, such as formulating questions and preparing project plans, while more complex stages, such as data analysis and interpretation, were still a challenge.

The first stage, namely Determining Fundamental Questions, aims to ensure that students are able to formulate relevant and specific questions related to data analysis techniques. The criteria at this stage include students' ability to formulate questions that are focused and in accordance with the objectives of the thesis evaluation that they are analyzing. Based on the results of observations, the majority of students showed good ability in formulating questions that are relevant to the analysis of findings from data collection and analysis methods in the thesis. Most students understand that the focus of their analysis is to evaluate how the methods used in the thesis support the research results achieved. For example, a student formulates the question, "How do the data collection methods used in this thesis support the research results?" This question reflects a deep understanding of the role of data collection methods in producing findings that are in accordance with research objectives. This understanding is important to ensure that students not only understand the concept, but are also able to analyze and evaluate the application of the method in a broader research context.

The student assignment documents also support the observation results, showing that most students were able to formulate questions that focused on the relationship between data collection methods and research results. The documents analyzed, many students highlighted the relevance of methods such as interviews or observations used in the theses they analyzed, for example, one student noted that interviews in a particular study were very effective in obtaining in-depth data from participants, which was in accordance with the exploratory nature of the study. This shows that students not only understand the methods, but are also able to relate their use to the results obtained. This understanding provides a strong basis for further analysis of the findings.

However, not all students are able to formulate questions with the same level of relevance and specificity. Some students formulate questions that are too general or not directly related to the analysis of research methods and results. An example is a question like, "What are the advantages and disadvantages of the research method?" which is too broad and less relevant to the context of a specific thesis analysis. Questions like this indicate that some students still need additional guidance to ensure that their focus remains on the analysis of the findings of the methods used. The further guidance is needed to help students narrow the scope of their questions so that they are in accordance with the objectives of the evaluation.

The observations also show that students who formulate questions well tend to have deeper analytical skills in evaluating data collection methods used in their thesis. They are able to connect questions with the data collected and the results achieved, and link their analysis to relevant supporting theories, for example, a student who uses specific questions is able to explain that the use of interview methods supports data triangulation, which ultimately increases the validity of the research results. This shows that the ability to formulate good questions plays an important role in helping students conduct more focused and in-depth analysis.

Overall, this fundamental question formulation stage is a very important initial step in analyzing findings from data collection and analysis methods in a thesis. The ability to formulate relevant and specific questions not only reflects students' understanding of their assignments but also shows their readiness to evaluate findings in a more focused and critical manner. Additional guidance is needed to help them understand the importance of relevant questions as a basis for analysis. With proper guidance, it is hoped that all students will be able to formulate questions that are not only in accordance with the context of the thesis but also allow for a more comprehensive analysis of research findings. This finding is in line which found that students' understanding in formulating research questions greatly influences the success of subsequent data analysis (Zulyusri et al., 2023).

The second stage, Project Plan Preparation, students are asked to prepare a structured research evaluation process. Competency criteria at this stage include students' ability to choose the right research and determine the analysis steps systematically. Most students demonstrate good skills in compiling a structured thesis analysis plan. The emphasizing that practical experience in preparing project plans can help students understand the complexity of variables and choose appropriate analysis methods (Lasauskiene et al., 2015). This plan includes steps to evaluate the data collection and data analysis methods used in the thesis they are analyzing. Students who have a deep understanding are able to create a plan with detailed steps that include identifying the methods used, evaluating the suitability of the methods to the research objectives, and analyzing the consistency of the application of the methods, for example, a student designs an evaluation that begins by reading the methods section of the thesis, identifying the data collected, and matching it to the data analysis conducted. These steps demonstrate that the student understands the importance of systematically evaluating methods to produce in-depth and relevant analysis.

The students' assignment documents support this observation, showing that most of them understand the need to evaluate methods with a focus on the relationship between the methods used and the research results. The several students listed important aspects that they would evaluate, such as the advantages and disadvantages of interview or survey techniques in generating relevant data, for example, one student highlighted that the use of surveys in a particular thesis was suitable for reaching a large population, but less able to

obtain the in-depth information needed for qualitative analysis. This observation reveals that students who plan well tend to be able to evaluate methods with a more critical and focused approach.

However, not all students succeeded in creating an analysis plan with structured steps. Some students only wrote an outline without sufficient details, such as listing "analyzing data collection methods" without explaining how the analysis would be carried out. This indicates that they need additional guidance to understand the importance of details in evaluation planning. Observations show that students in this category tend to feel confused when they have to apply more specific evaluation steps, such as matching the methods used with the types of data collected. This lack of planning can affect the depth of analysis they do in the next stage. Therefore, additional guidance is needed to help students who have difficulty designing a detailed and specific analysis plan. The students can be taught how to break down the evaluation steps into smaller, more easily understood parts. Strengthening the understanding of the importance of the appropriateness of the method to the research objectives can help students develop a more relevant plan. This preparation stage is very important, because a structured analysis plan will be a guide for students in evaluating methods more systematically and producing more in-depth and focused findings.

The third stage, Data Collection and Analysis, is a critical stage in PJBL that requires students to process data into interpretable information. Competence at this stage is assessed based on students' ability to compile frequency distributions and use data visualization to effectively illustrate distribution patterns. Observation results show variations in students' abilities to analyze findings from data collection and analysis methods used in the thesis. Some students were able to identify a clear relationship between the methods used and the research results obtained. Students had difficulty understanding data visualization and distribution patterns, which are important skills in statistical analysis. This finding is in line the research which states that data visualization and frequency analysis are often major obstacles for students who are not experienced in using statistical tools (Shih et al., 2017). The student with a good understanding observed that the interviews used in the thesis provided in-depth and relevant data for exploratory research purposes. The student noted, "The interviews in this thesis were effective in exploring participants' views in depth, so that the results were relevant to the exploration objectives." This analysis shows students' ability to evaluate methods based on their suitability for research objectives, as well as their understanding of the method's contribution to the quality of the results.

However, not all students are able to relate data collection methods to research results in depth. Observations show that some students have difficulty analyzing how the methods used affect research findings. There are students who only list the type of method, such as interviews or surveys, without providing further explanation of the relevance of the method to the research results. The inability to relate methods to results indicates the need to strengthen students' understanding of how data collection techniques can affect the quality and depth of the data produced. Students in this category need additional guidance to develop more critical evaluative skills.

The address this gap, more intensive support is provided to students who are still struggling, especially through discussions. This approach can include concrete examples of how data collection methods support or undermine research findings. The guidance is provided on how to relate methods to findings, for example by identifying cause-and-effect relationships between methods and the data they produce, which can help students develop

better analytical skills. With this support, it is hoped that all students can improve their understanding of the role of methods in research and produce more focused and in-depth analysis.

The Preparation of Results and Interpretation, students are expected to be able to present the results of statistical analysis and provide in-depth interpretations. Competence at this stage includes students' ability to apply advanced statistical analysis such as coefficient of variation and Z-score. Observations show that the Preparation of Results and Interpretation stage of Thesis Findings Analysis is one of the most challenging parts for students. The students are expected to be able to compile the results of advanced statistical analysis such as coefficient of variation and Z-score, and provide in-depth interpretations of the data. Many students have difficulty understanding this complex statistical concept, especially in placing individual values in the context of a broader data distribution. This difficulty is often seen from incomplete or limited interpretations, where students only present the results of the analysis without linking them to the research context or thesis objectives. Low competence here indicates that students have difficulty understanding advanced statistics, especially in interpreting data variation and placing values in the context of a broader distribution. This is in accordance with the results study which states that advanced statistical analysis like this requires a deep understanding that can only be achieved through intensive practice (Umar et al., 2022).

Students who successfully demonstrate competency at this stage are able to apply statistical analysis appropriately and provide relevant interpretations, for example, in an assignment document, a student is able to state that a high coefficient of variation indicates a significant difference in the data collected, which is relevant to explaining variation in participant responses. This student also uses Z-scores to show how a particular value can be compared to the overall average, providing a broader context to the data. Such interpretations reflect the student's ability to not only calculate statistics, but also relate them to research findings in a logical and relevant manner. Such competencies indicate that students with a deep understanding of statistics can make a stronger contribution to the analysis of findings in the thesis. The students who lack understanding at this stage tend to present statistical analysis results mechanically without providing sufficient interpretation, for example, in assignment documents, some students only include the results of calculating the coefficient of variation or Z-score without explaining the meaning of the numbers in the context of the research. This difficulty indicates that students do not yet understand how to translate statistical data into meaningful interpretations, which is the core of this stage. This low level of understanding is in line findings which state that advanced statistical analysis requires a strong conceptual understanding, which can only be achieved through intensive practice (Kokotsaki et al., 2016). Therefore, additional assistance is needed, such as focused exercises on the application of statistical concepts in the context of research, to help students improve their competence in compiling results and interpretations.

The students are expected to be able to understand the basic principles of advanced statistics and apply them correctly in analyzing thesis findings with a more systematic mentoring strategy. The approach to group discussions on the coefficient of variation and Z-score can help them master these techniques. The providing practical examples that are relevant to the research can help students connect statistical results to a broader context, so that they not only understand the calculations but are also able to provide in-depth and meaningful interpretations.

The final stage, Project Evaluation, aims to assess students' ability to reflect on the results of their projects, and relate them to relevant theory and literature. Observations showed that most students had good reflection skills, especially in assessing how the data collection and data analysis techniques used supported the research results, for example, one student noted that "The use of surveys in this thesis was effective in obtaining representative data from a large population, but was less able to capture in-depth detail." Such reflections demonstrate students' understanding of the strengths and limitations of the methods applied in the thesis they analyzed, as well as their ability to evaluate the relevance of these methods in the research context.

However, some students still provide very general and less critical evaluations of the methods used. There are students who simply state that "This method is appropriate," without explaining further why the method is considered appropriate or how it contributes to the research results. Evaluations like this indicate that the student does not fully understand how to connect data collection and analysis techniques with research results in depth. In the context of qualitative analysis, reflections like this do not explore the potential for in-depth evaluation that students should do to demonstrate their understanding of research methods and results.

The students who demonstrated deep reflection were able to relate their analysis to relevant theory and literature. The students noted that the use of simple statistical analyses in the thesis they analyzed was appropriate for the type of data collected, but they also indicated that the use of more advanced statistical analyses, such as data distribution or variability, could have provided richer insights. They were also able to assess how the techniques used in the thesis may have affected the quality of the research findings. This evaluative approach reflects the students' ability to think critically and identify areas for strengthening in the research method.

This evaluation stage provides students with the opportunity to critically assess their projects, identifying the strengths and weaknesses of the data collection and analysis methods used in the thesis being analyzed. With good reflection, students can develop insights into how research methods influence research findings. This evaluation also provides a basis for developing better analytical skills in the future, including the ability to relate research results to theoretical contexts. With more directed guidance, students can produce deeper reflections, not only on technical aspects but also on the significance of the methods to research findings. This evaluation allows students to critically assess their projects, thus providing a basis for improving their research skills in the future. Previous research also supports this approach, emphasizing the importance of reflection in improving students' statistical understanding, especially in relating research results to a broader context (Budner et al., 2018).

The Project Based Learning (PJBL) approach in this study was applied to provide students with direct experience in understanding and applying the concept of statistical data analysis. PJBL is a learning method that emphasizes the active involvement of students through real projects, where they not only learn theory but also apply the concept in a relevant context. Through PJBL, students are encouraged to act as active researchers who are responsible for every stage of the research, from formulating basic questions, preparing project plans, to collecting, analyzing, and interpreting data. The main objective of implementing PJBL is to develop analytical and critical thinking skills that are important for students, as well as to prepare them to face the challenges of the world of work that require systematic and solution-oriented thinking skills.

Previous research has shown that the Project-Based Learning (PJBL) approach is effective in improving students' understanding, both theoretically and practically. That students involved in real projects were better able to understand statistical concepts compared to those who learned through conventional methods (Handayani et al., 2021). The students who participated in PJBL reported a deeper understanding of the importance of each stage of research, because they were directly involved in the decision-making process, especially in data analysis. That PJBL can improve students' skills in choosing appropriate analysis methods and adjusting statistical approaches based on the variables analyzed in the project (Rozal et al., 2021). That PJBL can encourage students' progress in data visualization and interpretation skills, which are often obstacles in traditional statistics learning (Goldstein, 2016).

PJBL not only enhances students' academic understanding but also develops professional skills relevant to the needs of the workplace. The students learn to connect the results of statistical analysis to a broader practical context, including educational theory or other theories relevant to their field of study. This approach provides space for students to work collaboratively in developing research-based solutions, which directly builds interpersonal and communication skills. Thus, the benefits of PJBL go beyond mastering basic statistical concepts; this approach also strengthens critical thinking, collaborative thinking, and problem-solving skills, which are essential for students in preparing themselves as reliable researchers or professionals.

The results of this study support the finding that PJBL can strengthen students' understanding of the early stages of research, such as Determining Fundamental Questions and Developing a Project Plan. Good competence in these early stages is an important foundation for students to continue to more complex data analysis processes. This is in line which shows that a project-based approach helps students understand statistical concepts more deeply, especially at the planning and reflection stages of the project (Hasni et al., 2016). This finding also shows that students' direct involvement in the early stages of research through PJBL can strengthen their skills in developing a systematic research framework. However, students still face challenges in the Data Collection and Analysis and Result Compilation and Interpretation stages. These difficulties reflect the need for additional guidance in understanding advanced statistical techniques, including data visualization and in-depth interpretation of analysis results. That students often have difficulty in applying more complex data analysis techniques, especially when working with data that requires in-depth interpretation (Sari et al., 2021). The PJBL approach with intensive training support at these stages can be a solution to improve student competence, especially in understanding and applying advanced statistics (Huang et al., 2023).

Recommendations for improving students' skills include additional practice using statistical software to strengthen data visualization and interpretation skills. The collaborative approach in PJBL can also deepen students' understanding of advanced statistical concepts through discussion and group work. Intensive practice with software such as SPSS can help students explore various statistical techniques and data visualization more effectively. The students not only gain a good theoretical understanding but also hands-on experience in analyzing data with the implementation of structured and relevant PJBL, which will prepare them for future data analysis challenges. Through this approach, PJBL can make a positive contribution to the development of students' competencies in building more comprehensive and reliable research skills.

Conclusion

This study aims to explore students' understanding in research statistics courses using the Project-Based Learning (PJBL) approach. The results show that students have good abilities in formulating fundamental questions and planning projects, although there is variation in the level of planning skills. The main challenge arises at the data collection and analysis stage, where some students struggle to apply the correct methods and analyze the information they gather. At the results preparation and interpretation stage, students still feel uncertain in compiling structured results and providing deep interpretations in accordance with the research context. However, at the project evaluation stage, students demonstrate greater independence in assessing their projects and reflecting on the achievements and challenges they faced. The limitations of this study lie in the limited sample size, meaning the results may not fully represent all students. This study also focuses more on observing students' understanding without considering external factors that may influence the learning process, such as limited time or varying levels of guidance. The future research, it is recommended to expand the sample size to better capture the variation in students' understanding. Research could also focus on external factors that influence the success of PJBL implementation, such as the level of guidance and available resources. Future studies could provide more comprehensive insights into the effectiveness of PJBL in enhancing students' data analysis skills.

Acknowledgment

-

Reference

Budner, D., & Simpson, B. (2018). Project-based integrated lecture and laboratory quantitative analysis course. *Journal of Chemical Education*, *95*(9), 1533-1540. https://doi.org/10.1021/acs.jchemed.8b00146

Fini, E. H., Awadallah, F., Parast, M. M., & Abu-Lebdeh, T. (2018). The impact of project-based learning on improving student learning outcomes of sustainability concepts in transportation engineering courses. *European Journal of Engineering Education*, *43*(3), 473-488. https://doi.org/10.1080/03043797.2017.1393045

Goldstein, O. (2016). A project-based learning approach to teaching physics for pre-service elementary school teacher education students. *Cogent Education*, *3*(1), 1200833. https://doi.org/10.1080/2331186X.2016.1200833

Handayani, D., Winarni, E. W., Sundaryono, A., & Firdaus, M. L. (2021). Implementation of project-based learning model with Edmodo application in the capita selecta chemistry course. *IJORER: International Journal of Recent Educational Research*, *2*(2), 184-195. https://doi.org/10.46245/ijorer.v2i2.90

Hasni, A., Bousadra, F., Belletête, V., Benabdallah, A., Nicole, M. C., & Dumais, N. (2016). Trends in research on project-based science and technology teaching and learning at K–12 levels: a systematic review. *Studies in Science education*, *52*(2), 199-231. https://doi.org/10.1080/03057267.2016.1226573

Huang, W., London, J. S., & Perry, L. A. (2023). Project-based learning promotes students' perceived relevance in an engineering statistics course: a comparison of learning in synchronous and online learning environments. *Journal of Statistics and Data Science Education*, *31*(2), 179-187. https://doi.org/10.1080/26939169.2022.2128119

Khandakar, A., Chowdhury, M. E. H., Gonzales, A. J. S. P., Touati, F., Emadi, N. A., & Ayari, M. A. (2020). Case study to analyze the impact of multi-course project-based learning approach on education for sustainable development. *Sustainability*, *12*(2), 480. https://doi.org/10.3390/su12020480

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving schools*, *19*(3), 267-277. https://doi.org/10.1177/1365480216659733

Lasauskiene, J., & Rauduvaite, A. (2015). Project-based learning at university: Teaching experiences of lecturers. *Procedia-Social and Behavioral Sciences*, *197*, 788-792. https://doi.org/10.1016/j.sbspro.2015.07.182

Maros, M., Korenkova, M., Fila, M., Levicky, M., & Schoberova, M. (2023). Project-based learning and its effectiveness: evidence from Slovakia. *Interactive Learning Environments*, *31*(7), 4147-4155. https://doi.org/10.1080/10494820.2021.1954036

Ngereja, B., Hussein, B., & Andersen, B. (2020). Does project-based learning (PBL) promote student learning? a performance evaluation. *Education Sciences*, *10*(11), 330. https://doi.org/10.3390/educsci10110330

Pilot, Z., Suprise, M., Dinius, C., Olechowski, A., & Habib, R. (2023). Structured peer mentoring improves academic outcomes and complements project-based learning in an introductory research methods and statistics course. *Scholarship of Teaching and Learning in Psychology*, *9*(2), 185. https://psycnet.apa.org/doi/10.1037/stl0000261

Rozal, E., Ananda, R., Zb, A., Fauziddin, M., & Sulman, F. (2021). The effect of project-based learning through YouTube presentations on English learning outcomes in physics. *AL-Ishlah: Jurnal Pendidikan*, *13*(3), 1924-1933. https://doi.org/10.35445/alishlah.v13i3.1241

Saad, A., & Zainudin, S. (2022). A review of Project-Based Learning (PBL) and Computational Thinking (CT) in teaching and learning. *Learning and Motivation*, *78*, 101802. https://doi.org/10.1016/j.lmot.2022.101802

Sari, D. M. M., & Prasetyo, Y. (2021). Project-based-learning on critical reading course to enhance critical thinking skills. *Studies in English Language and Education*, *8*(2), 442-456. https://doi.org/10.24815/siele.v8i2.18407

Shih, W. L., & Tsai, C. Y. (2017). Students' perception of a flipped classroom approach to facilitating online project-based learning in marketing research courses. *Australasian Journal of Educational Technology*, *33*(5). https://doi.org/10.14742/ajet.2884

Susanti, D., Sari, L. Y., & Fitriani, V. (2022). Increasing student learning motivation through the use of interactive digital books based on Project Based Learning (PjBL). *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1730-1735. https://doi.org/10.29303/jppipa.v8i4.1669

Sutrisno, S., & Nasucha, J. A. (2022). Islamic Religious Education Project-Based Learning Model to Improve Student Creativity. *At-Tadzkir: Islamic Education Journal*, *1*(1), 13-22. https://doi.org/10.59373/attadzkir.v1i1.3

Umar, M., & Ko, I. (2022). E-learning: Direct effect of student learning effectiveness and engagement through project-based learning, team cohesion, and flipped learning during the COVID-19 pandemic. *Sustainability*, *14*(3), 1724. https://doi.org/10.3390/su14031724

Wardani, D. S., Wulandari, M. A., Nurfurqon, F. F., & Kurniawati, D. (2021). Stem-Integrated Project-Based Learning (Pjbl) Model and Lecture With Experiments Learning Model: What Is the Scientific Literacy Skills of Elementary Teacher Education Students in These Learning Models?. *Al-Bidayah: jurnal pendidikan dasar Islam*, *13*(1), 55-72. https://doi.org/10.14421/al-bidayah.v13i1.634

Zulyusri, Z., Elfira, I., Lufri, L., & Santosa, T. A. (2023). Literature study: Utilization of the PjBL model in science education to improve creativity and critical thinking skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133-143. https://doi.org/10.29303/jppipa.v9i1.2555