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# Research Competence and Critical Thinking Skills among Elementary Education Students: The Mediating Role of Statistical Literacy

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**Index Terms:**

critical thinking, mediation analysis, research competence, statistical literacy, teacher education

**Abstract.** Making sense of data is essential in developing critical thinking among future educators as it connects research competence. This study investigated how statistical literacy mediates the relationship between research competence and critical thinking skills among elementary education students. Anchored on Constructivist Learning Theory, the study employed a quantitative mediation analysis design involving third-year Bachelor of Elementary Education students from Initao College. A validated researcher-developed questionnaire was used to gather data which were then analyzed using correlation and mediation analysis. The findings revealed that students demonstrated high levels of research competence (research knowledge: M = 3.53; research skills: M = 3.40), critical thinking (analytical thinking: M = 3.34; inferential reasoning: M = 3.29), and statistical literacy (statistical understanding: M = 3.36; data interpretation skills: M = 3.29). Using Spearman rho correlation, a significant positive relationship was found between research competence and critical thinking ($r_s = 0.598$, $p < 0.001$). It indicates that higher research competence is associated with stronger analytical and inferential abilities. Moreover, mediation analysis further revealed that statistical literacy fully mediates this relationship, with a significant indirect effect ($a \times b = 0.485$, $p < 0.001$) and a non-significant direct effect ($c = 0.162$, $p = 0.169$), accounting for 74.9% of the total effect. The study concludes that statistical literacy plays a crucial role in transforming research competence into higher-order thinking skills. In response, PROJECT D.A.T.A. (Developing Analytical Thinking through Applied Statistics) is proposed as an evidence-based training program that integrates research competence and statistical literacy through applied data analysis and structured reporting using the PAIS framework. These findings highlight the importance of integrating statistical literacy within research instruction to enhance students' capacity for evidence-based reasoning and informed decision-making among future educators.

## Introduction

In contemporary teacher education, the development of students' research competence and critical thinking skills has become a fundamental goal, particularly in preparing future educators to engage in evidence-based practice and decision-making. Research competence, which involves the ability to formulate problems, apply appropriate methodologies, analyze data, and communicate findings, is widely recognized as essential in higher education, as it fosters deeper learning and intellectual independence (Castillo-Martínez & Ramírez-Montoya, 2021). More importantly, it serves as a foundation for the development of critical thinking skills, which are considered a core competency in 21st-century education (León-Díaz, 2026). However, the relationship between research competence and critical thinking is not always direct, as it may depend on students' ability to interpret and make sense of data through statistical processes.

Statistical literacy plays a crucial role in bridging this gap. It enables students to understand, analyze, and interpret quantitative data, thereby supporting sound reasoning and informed decision-making. In higher education contexts, statistics is integral to research competence, particularly in drawing valid conclusions and testing hypotheses

(Wongvorachan, 2024). Moreover, statistical literacy has been identified as closely linked to critical thinking, as both require the ability to evaluate evidence, interpret results, and apply logical reasoning in problem-solving contexts (Koga, 2022). Despite its importance, students often experience difficulty in mastering statistical concepts, which may limit the extent to which research competence translates into higher-order thinking skills.

These challenges are strongly reflected in the findings of the study of Villarin et al. (2025), which revealed that students' experiences in learning statistics are often characterized by anxiety, confusion, and difficulty in interpreting results and selecting appropriate statistical tests. While students gradually develop confidence through guided instruction, hands-on activities, and supportive teaching strategies, gaps remain in their ability to connect statistical knowledge with real-world research applications. Anchored on this responsive teaching framework, the present study argues that the development of critical thinking among elementary education students is not solely dependent on research competence, but is significantly influenced by their level of statistical literacy. While research competence provides the procedural and conceptual foundation, statistical literacy serves as the mechanism through which students interpret data and construct meaning from research findings. This suggests the need to examine not only direct relationships among these variables but also the underlying processes that explain how learning occurs.

Despite existing studies highlighting the importance of research competence, critical thinking, and statistical literacy, there remains a gap in understanding how these variables interact within a unified model, particularly in the context of teacher education. Previous research has primarily focused on correlational relationships, with limited attention given to the mediating mechanisms that explain how research competence translates into critical thinking outcomes. Addressing this gap is essential for informing instructional practices and developing responsive, evidence-based teaching frameworks.

Thus, this study investigates the relationship between research competence and critical thinking skills among elementary education students, with statistical literacy as a mediating variable. Specifically, the study seeks to answer the following questions:

1. What is the level of research competence among students in terms of:
   1.1. Research Knowledge; and
   1.2. Research Skills?
2. What is the level of critical thinking skills among students in terms of:
   2.1. Analytical Thinking; and
   2.2. Inferential Reasoning?
3. What is the level of statistical literacy among students in terms of:
   3.1. Statistical Understanding; and
   3.2. Data Interpretation Skills?
4. Is there a significant relationship between the level of research competence and the level of critical thinking skills among students?
5. Does the level of statistical literacy significantly mediate the relationship between the level of research competence and the level of critical thinking skills among students?
6. What program can be developed based on the findings?

This study is grounded in Constructivist Learning Theory, which posits that learners actively construct knowledge by integrating new information with their prior experiences. Learning is not a passive process but an active one, where students build understanding through interaction, reflection, and application (Kurt, 2021). Rooted in the works of Piaget and Vygotsky, the theory emphasizes that knowledge develops through cognitive processes and social interaction (Kretchmar, 2021). In this study, research competence serves as the foundation of knowledge, while statistical literacy enables students to actively interpret and make sense of data. Through this process, learners construct deeper understanding, leading to the development of critical thinking skills. Anchored on the responsive teaching framework, the study assumes that meaningful learning occurs when students actively engage with research and data, with statistical literacy mediating the relationship between research competence and critical thinking.

Research competence is defined as a multifaceted construct encompassing the knowledge, skills, and attitudes necessary to successfully plan, conduct, and communicate research activities (Matjašič & Vogrinc, 2024). In teacher education, these competencies are vital as they support reflective practice and enhance pedagogical effectiveness (Matjašič & Vogrinc, 2025). Key components include the ability to identify research gaps, formulate measurable objectives, and adhere to ethical standards (Castillo-Martínez & Soledad, 2021). Despite its recognized importance, there is often an "uneven" acquisition of these skills among undergraduates, with students frequently struggling with state-of-the-art reviewing and scientific communication (Ciraso-Calí et al., 2022).

Critical thinking is widely regarded as the ability to think rationally and reflectively to decide what to do or believe (Suratmi & Sopandi, 2022). It is categorized as a core 21st-century skill, essential for navigating a "continuously shifting world" (Ciraso-Calí et al., 2022). In the educational setting, it involves analytical thinking—breaking complex problems into manageable parts—and inferential reasoning—making logical conclusions based on evidence (Más & Alonso, 2025; Suratmi & Sopandi, 2022). For elementary education students, developing these skills early is crucial, as they must be trained to evaluate information logically rather than simply storing data (Mamytbayeva et al., 2022; Suratmi & Sopandi, 2022).

Statistical literacy serves as an essential component of research literacy, enabling students to read, comprehend, and evaluate quantitative findings (Yusof, 2021). It involves a range of skills, from understanding basic descriptive statistics to interpreting complex inferential results like p-values and regression analysis (Okoli, 2023; Yusof, 2021). However, students often face significant barriers in this area, including "statistics anxiety" and difficulty in selecting appropriate statistical tests (Villarin et al., 2025). Without strong statistical literacy, students may misinterpret data, which negatively impacts the quality of their research and their ability to engage in evidence-based decision-making (Riwayani et al., 2024; Yusof, 2021).

Recent studies suggest a strong predictive relationship between research-related skills and thinking abilities. Research competence is considered a fundamental part of scientific thinking, often overlapping with critical thinking skills in the evaluation of evidence (Salmento et al., 2021). Research indicates that as students' proficiency in research methodologies increases, so does their ability to analyze information carefully and identify strengths and weaknesses in scientific arguments (Katzman et al., 2024). Furthermore, statistical proficiency has been identified as a significant predictor of overall research competency, suggesting that the ability to handle data is a prerequisite for higher-level research engagement (Wongvorachan et al., 2024).

The literature suggests that research competence and critical thinking are not isolated skills but are deeply interconnected through the mechanism of data interrogation. While research competence provides the procedural framework—formulating problems and selecting methodologies (Castillo-Martínez & Soledad, 2021; Matjašič & Vogrinc, 2024)—critical thinking provides the evaluative lens through which findings are scrutinized (Dwyer, 2023; Suratmi & Sopandi, 2022). Statistical literacy acts as the bridge between these two, providing the "data interpretation skills" necessary to translate raw research results into logical, evidence-based conclusions (Koga, 2022; Riwayani et al., 2024). Effectively, for a pre-service teacher to move from research knowledge to critical application, they must possess the statistical tools to navigate and interpret quantitative evidence (Wongvorachan et al., 2024; Yusof, 2021).

Despite the growing body of literature on research competence, statistical literacy, and critical thinking, several gaps remain evident. First, there is a lack of unified mediation models, as most studies focus on correlations between research competence and critical thinking but provide limited empirical evidence on the mediating mechanisms, particularly how statistical literacy explains the pathway between the two in teacher education. Second, existing research tends to emphasize general higher education or natural sciences, with limited attention given to elementary education students in developing contexts such as the Philippines (Fitriadi et al., 2024; Más & Alonso, 2025). Third, inconsistencies in the definition and measurement of research competence among pre-service teachers persist, as different studies employ varied frameworks and instruments, resulting in fragmented findings across contexts (Matjašič & Vogrinc, 2024). Lastly, much of the literature remains correlational in nature, with insufficient focus on process-oriented approaches that explain the underlying mechanisms through which research competence contributes to higher-order thinking outcomes.

## Methodology

*Research Design*

This study employed a quantitative, non-experimental mediation research design to examine how statistical literacy functions as an intervening variable in the relationship between research competence and critical thinking skills. Mediation analysis was used to determine whether the effect of research competence on critical thinking is transmitted through statistical literacy rather than occurring as a direct relationship. Specifically, the design tested three key pathways: (1) the effect of research competence on statistical literacy, (2) the effect of statistical literacy on critical thinking, and (3) the direct effect of research competence on critical thinking when statistical literacy is controlled. By estimating the direct, indirect, and total effects, the study was able to identify whether statistical literacy significantly mediates the relationship between the two variables. This approach provides a deeper explanation of the underlying mechanism, showing how research competence contributes to critical thinking by enhancing students' statistical literacy.

*Participants and Sampling Technique*

The respondents of the study were third-year Bachelor of Elementary Education students enrolled in the Teacher Education Program of Initao College, located in Initao, Misamis Oriental, Philippines. These students were selected as they are actively engaged in research-related coursework, making them appropriate participants for examining research competence, statistical literacy, and critical thinking skills. The required sample size was determined using G*Power 3.1 through an a priori power analysis for a bivariate correlation (two-tailed, exact test). The parameters were set at a medium effect size ($r = 0.30$), a significance level of $\alpha = 0.05$, and a statistical power of 0.96. The analysis yielded a minimum sample size of 146 respondents, with an actual power of 0.9602, indicating that the study had sufficient statistical sensitivity to detect significant relationships among the variables.

*Research Instrument*

The study utilized a researcher-developed questionnaire designed to measure students' research competence, critical thinking, and statistical literacy. The instrument underwent content validation by the Vice President for Research, Development, and Extension Services and the Research Director of the Research, Development, and Extension Services Office of Initao College. It was then subjected to pilot testing and reliability analysis, yielding acceptable to excellent internal consistency. An informed consent form was attached to ensure ethical compliance. The questionnaire consisted of four parts: the first part gathered respondents' demographic profile in terms of program and group section; the second part measured research competence, including research knowledge ($\alpha = 0.839$) and research skills ($\alpha = 0.846$), with an overall reliability of 0.885 (good); the third part assessed critical thinking, covering analytical thinking ($\alpha = 0.885$) and inferential reasoning ($\alpha = 0.888$), with an overall reliability of 0.921 (excellent); and the fourth part evaluated statistical literacy, including statistical understanding ($\alpha = 0.841$) and data interpretation skills ($\alpha = 0.885$), with an overall reliability of 0.906 (excellent).

*Data Gathering Procedure*

Data were collected using a validated researcher-developed questionnaire. Prior to data collection, informed consent was secured from the respondents to ensure ethical compliance. The instrument was administered to the participants during scheduled class sessions, and responses were collected systematically to ensure completeness and accuracy of the data.

*Data Analysis Procedure*

The study employed both descriptive and inferential statistical techniques. Descriptive statistics were used to determine the level of research competence, critical thinking, and statistical literacy. Inferential statistics were utilized to address the relationship and mediation components of the study. Normality testing was conducted to assess the distribution of the data. Since the data did not meet parametric assumptions, Spearman's rho correlation was used to determine the significant relationship between research competence and critical thinking. To examine the mediating role of statistical literacy, mediation analysis was performed using regression-based procedures with bootstrapping to estimate the direct, indirect, and total effects. This approach allowed for a more robust analysis of whether statistical literacy significantly mediates the relationship between research competence and critical thinking among students.

*Ethical Considerations*

This study adhered to ethical standards in research involving human participants. Ethical approval was secured from the Research, Development, and Extension Services Office of Initao College prior to data collection. Informed consent was obtained from all respondents, ensuring voluntary participation and the right to withdraw at any time. Confidentiality and anonymity were strictly maintained, and all data were used solely for academic purposes and stored securely.

## Results and Discussion

*Problem 1: What is the level of research competence among students in terms of research knowledge and research skills?*

| Indicators | Mean | SD | Description |
|---|---|---|---|
| **Research Knowledge** | **3.53** | **0.387** | **Strongly Agree** |
| 1. I understand how to align a research title with the program's research agenda. | 3.53 | 0.501 | Strongly Agree |
| 2. I understand how to formulate clear and measurable research objectives. | 3.45 | 0.499 | Strongly Agree |
| 3. I can distinguish appropriate research designs based on the objectives of the study. | 3.43 | 0.511 | Strongly Agree |

| | | | | |
|---|---|---|---|---|
| 4. | I understand the purpose and significance of conducting a research study, including the steps involved in the research process. | 3.64 | 0.483 | Strongly Agree |
| 5. | I understand the importance of adhering to ethical considerations in research. | 3.62 | 0.486 | Strongly Agree |
| **Research Skills** | | **3.40** | **0.404** | **Strongly Agree** |
| 6. | I can identify research gaps from existing literature and studies. | 3.38 | 0.500 | Strongly Agree |
| 7. | I can develop a clear rationale or justification for a research study. | 3.27 | 0.463 | Strongly Agree |
| 8. | I can construct a conceptual framework based on relevant theories. | 3.43 | 0.550 | Strongly Agree |
| 9. | I can select appropriate participants, locale, and research tools for a study. | 3.53 | 0.501 | Strongly Agree |
| 10. | I can write essential parts of research such as the significance of the study, scope and limitations, and review of related literature and studies. | 3.37 | 0.551 | Strongly Agree |

*Legend: 1.00-1.74 = Strongly Disagree; 1.75-2.49 = Disagree; 2.50-3.24 = Agree; 3.25-4.00 = Strongly Agree*

*Table 1. Level of Research Competence among Students in Terms of Research Knowledge and Research Skills*

Table 1 presents the level of research competence among students in terms of research knowledge and research skills. The overall mean for research knowledge (M = 3.53, SD = 0.387) and research skills (M = 3.40, SD = 0.404) are both described as Strongly Agree, indicating a high level of research competence among the respondents. Among the indicators of research knowledge, the highest mean is observed in understanding the purpose and significance of research (M = 3.64) and ethical considerations (M = 3.62), while the lowest is in distinguishing appropriate research designs (M = 3.43). For research skills, the highest mean is in selecting appropriate participants, locale, and tools (M = 3.53), while the lowest is in developing a clear research rationale (M = 3.27). Overall, all indicators fall within the Strongly Agree range, reflecting consistently high self-perceived competence among students.

The findings indicate that students demonstrate strong research competence, particularly in foundational knowledge such as ethical considerations, research processes, and methodological understanding. However, slightly lower confidence in higher-order tasks, such as selecting appropriate research designs and justifying studies, suggests that advanced research skills are still developing. This pattern reflects that research competence progresses from basic understanding to more complex application. While teacher education programs effectively build foundational competence, there is a need to strengthen higher-level skills through hands-on research, mentoring, and scaffolded learning aligned with constructivist principles. These findings support the view that research competence is a multifaceted construct involving both knowledge and skills (Matjašič & Vogrinc, 2024), essential for reflective practice and pedagogical effectiveness (Castillo-Martínez & Soledad, 2021). However, its development is often uneven, particularly in complex tasks such as scientific reasoning and communication (Ciraso-Calí et al., 2022).

*Problem 2: What is the level of critical thinking among students in terms of analytical thinking and inferential reasoning?*

| Indicators | | Mean | SD | Description |
|---|---|---|---|---|
| **Analytical Thinking** | | **3.34** | **0.399** | **Strongly Agree** |
| 1. | I can analyze information carefully before making conclusions. | 3.42 | 0.496 | Strongly Agree |
| 2. | I can identify strengths and weaknesses in research studies. | 3.40 | 0.505 | Strongly Agree |
| 3. | I can evaluate evidence to support an argument. | 3.38 | 0.514 | Strongly Agree |
| 4. | I can compare different ideas or perspectives logically. | 3.27 | 0.519 | Strongly Agree |
| 5. | I can break down complex problems into manageable parts. | 3.24 | 0.516 | Agree |
| **Inferential Reasoning** | | **3.29** | **0.414** | **Strongly Agree** |
| 6. | I can make logical conclusions based on available data. | 3.18 | 0.470 | Agree |
| 7. | I can predict outcomes based on given information. | 3.25 | 0.545 | Strongly Agree |
| 8. | I can solve problems using evidence-based reasoning. | 3.34 | 0.476 | Strongly Agree |
| 9. | I can make decisions based on careful analysis of information. | 3.31 | 0.506 | Strongly Agree |
| 10. | I can justify my conclusions using appropriate evidence. | 3.37 | 0.498 | Strongly Agree |

*Legend: 1.00-1.74 = Strongly Disagree; 1.75-2.49 = Disagree; 2.50-3.24 = Agree; 3.25-4.00 = Strongly Agree*

*Table 2. Level of Critical Thinking among Students in Terms of Analytical Thinking and Inferential Reasoning*

Table 2 presents the level of critical thinking among students in terms of analytical thinking and inferential reasoning. The results show that both analytical thinking (M = 3.34, SD = 0.399) and inferential reasoning (M = 3.29, SD = 0.414) are described as Strongly Agree, indicating a high level of critical thinking skills among the respondents. For analytical thinking, the highest-rated indicator is the ability to analyze information carefully before making conclusions (M = 3.42), while the

lowest is the ability to break down complex problems (M = 3.24), which falls under Agree. In terms of inferential reasoning, the highest mean is in justifying conclusions using appropriate evidence (M = 3.37), while the lowest is in making logical conclusions based on available data (M = 3.18), categorized as Agree. Overall, most indicators fall within the Strongly Agree range, suggesting that students generally perceive themselves as competent critical thinkers.

Students exhibit a high level of critical thinking, particularly in evaluating information and making evidence-based decisions. However, lower performance in breaking down complex problems and making logical conclusions indicates challenges in higher-order reasoning. This suggests that while students are proficient in general analytical thinking, their inferential reasoning skills require further development. Enhancing these competencies through problem-based and inquiry-based learning is essential, as critical thinking is a core 21st-century skill involving both analytical and inferential processes (Suratmi & Sopandi, 2022; Más & Alonso, 2025; Ciraso-Calí et al., 2022). The observed difficulties in complex reasoning align with findings that students often struggle with higher-order thinking tasks (Dwyer, 2023).

*Problem 3: What is the level of statistical literacy among students in terms of statistical understanding and data interpretation skills?*

| Indicators | Mean | SD | Description |
|---|---|---|---|
| **Statistical Understanding** | **3.36** | **0.450** | **Strongly Agree** |
| 1. I understand the validation process of research instruments and the use of reliability testing such as Cronbach's alpha. | 3.51 | 0.515 | Strongly Agree |
| 2. I know when to use and how to interpret descriptive statistics (e.g., mean and standard deviation). | 3.34 | 0.531 | Strongly Agree |
| 3. I have the knowledge of inferential statistics and how to make sense of data (e.g. correlation, regression, comparative, mediation and moderation analysis). | 3.29 | 0.577 | Strongly Agree |
| 4. I can choose appropriate statistical tests (parametric or non-parametric) based on the data. | 3.22 | 0.569 | Agree |
| 5. I understand the meaning of statistical results such as p-values, level of significance, and the decision to accept or reject hypotheses. | 3.42 | 0.523 | Strongly Agree |
| **Data Interpretation Skills** | **3.29** | **0.439** | **Strongly Agree** |
| 6. I can interpret tables and graphs presented in research studies. | 3.27 | 0.554 | Strongly Agree |
| 7. I can explain statistical results in simple terms. | 3.30 | 0.530 | Strongly Agree |
| 8. I can interpret statistical results and make appropriate conclusions based on the findings. | 3.27 | 0.492 | Strongly Agree |
| 9. I can evaluate the normality of data using tests such as Shapiro–Wilk. | 3.32 | 0.524 | Strongly Agree |
| 10. I can check and handle missing data appropriately in a dataset. | 3.27 | 0.542 | Strongly Agree |

*Legend: 1.00-1.74 = Strongly Disagree; 1.75-2.49 = Disagree; 2.50-3.24 = Agree; 3.25-4.00 = Strongly Agree*

*Table 3. Level of Statistical Literacy among Students in Terms of Statistical Understanding and Data Interpretation Skills*

Table 3 presents the level of statistical literacy among students in terms of statistical understanding and data interpretation skills. The results show that both statistical understanding (M = 3.36, SD = 0.450) and data interpretation skills (M = 3.29, SD = 0.439) are described as Strongly Agree, indicating a high level of statistical literacy among the respondents. Among the indicators of statistical understanding, the highest mean is observed in understanding the validation process and reliability testing such as Cronbach's alpha (M = 3.51), followed by understanding statistical results such as p-values and hypothesis testing (M = 3.42). The lowest mean is in the ability to choose appropriate statistical tests (M = 3.22), which falls under Agree. For data interpretation skills, all indicators fall within the Strongly Agree range, with the highest mean in the ability to explain statistical results in simple terms (M = 3.30), and the lowest means (M = 3.27) in interpreting tables, drawing conclusions, and handling missing data. Overall, the findings indicate that students perceive themselves as competent in understanding and interpreting statistical data.

In terms of statistical literacy, students show strong competence in understanding statistical concepts and interpreting results. However, lower confidence in selecting appropriate statistical tests highlights a gap in advanced statistical decision-making. This suggests that students' skills may be more procedural than analytical, indicating the need to strengthen their ability to evaluate statistical assumptions and choices. While instruction effectively develops foundational knowledge, higher-order statistical thinking should be enhanced through applied data analysis and real-world tasks. These findings align with studies emphasizing that statistical literacy is essential for interpreting and evaluating quantitative data (Yusof et al., 2021; Okoli, 2023), yet students often encounter difficulties due to limited conceptual understanding and statistics

anxiety (Villarin et al., 2025). Insufficient statistical literacy may also hinder accurate data interpretation and research quality (Riwayani et al., 2024).

*Problem 4: Is there a significant relationship between the level of research competence and the level of critical thinking skills among students?*

| Variables | | rs value | p-value | Remarks | Decision |
|---|---|---|---|---|---|
| Research Knowledge | Analytical Thinking | 0.387 | <0.001 | Significant (Low Correlation) | Reject $H_0$ |
| | Inferential Reasoning | 0.489 | <0.001 | Significant (Low Correlation) | Reject $H_0$ |
| Research Skills | Analytical Thinking | 0.496 | <0.001 | Significant (Low Correlation) | Reject $H_0$ |
| | Inferential Reasoning | 0.581 | <0.001 | Significant (Moderate Correlation) | Reject $H_0$ |
| **Research Competence** | **Critical Thinking Skills** | **0.598** | **<0.001** | **Significant (Moderate Correlation)** | **Reject $H_0$** |

*Note: Results are considered statistically significant at a p-value of ≤ 0.05.*

*Table 4. Relationship between the Level of Research Competence and the Level of Critical Thinking Skills*

Table 4 presents the relationship between research competence and critical thinking skills among students. The results reveal that all relationships are statistically significant ($p < 0.001$), leading to the rejection of the null hypothesis in all cases. Specifically, research knowledge shows a significant low correlation with analytical thinking ($rs = 0.387$) and inferential reasoning ($rs = 0.489$). Similarly, research skills demonstrate a significant relationship with analytical thinking ($rs = 0.496$) and a moderate correlation with inferential reasoning ($rs = 0.581$). Overall, research competence is significantly correlated with critical thinking skills ($rs = 0.598$), indicating a moderate positive relationship. This suggests that higher levels of research competence are associated with higher levels of critical thinking among students.

The correlation results further reveal that research competence is significantly associated with critical thinking skills, indicating that improvements in research knowledge and skills contribute to better analytical and inferential abilities. Notably, research skills show a stronger relationship with inferential reasoning, suggesting that practical engagement in research enhances evidence-based thinking. However, the moderate relationship implies that research competence alone is not sufficient to fully explain critical thinking development. This supports the inclusion of other influencing variables, particularly statistical literacy. These findings are consistent with literature highlighting the close link between research competence and critical thinking through the evaluation of evidence and scientific reasoning (Salmento et al., 2021; Katzman et al., 2024), as well as the role of statistical proficiency in higher-order thinking (Wongvorachan et al., 2024).

*Problem 5: Does the level of statistical literacy significantly mediate the relationship between the level of research competence and the level of critical thinking skills among students?*

| Effect | Label | Estimate | Boot SE | p value | % Mediation | Remarks | Decision |
|---|---|---|---|---|---|---|---|
| Indirect | a × b | 0.485 | 0.0953 | <.001 | 74.9 | Significant | Reject $H_0$ |
| Direct | c | 0.162 | 0.1180 | .169 | 25.1 | Not Significant | Accept $H_0$ |
| **Total** | **c + a × b** | **0.648** | **0.0650** | **<.001** | **100.0** | **Significant** | **Reject $H_0$** |
| Path Estimates | | | | | | | |
| Research Competence → Statistical Literacy | a | 0.885 | 0.0611 | <.001 | | Significant | Reject $H_0$ |
| Statistical Literacy → Critical Thinking Skills | b | 0.549 | 0.0969 | <.001 | | Significant | Reject $H_0$ |
| Research Competence → Critical Thinking Skills | c | 0.162 | 0.1180 | .169 | | Not Significant | Accept $H_0$ |

*Note: Results are considered statistically significant at a p-value of ≤ 0.05.*

*Table 5. Mediation Analysis of Statistical Literacy on the Relationship between Research Competence and Critical Thinking Skills*

Table 5 presents the mediation analysis examining whether statistical literacy mediates the relationship between research competence and critical thinking skills. The results show that the indirect effect ($a \times b = 0.485$, $p < .001$) is statistically significant, accounting for 74.9% of the total effect, indicating strong mediation. In contrast, the direct effect ($c = 0.162$, $p = .169$) is not statistically significant, leading to the acceptance of the null hypothesis for the direct pathway. However, the total effect ($c + a \times b = 0.648$, $p < .001$) remains significant. Further, the path estimates reveal that research competence significantly predicts statistical literacy ($a = 0.885$, $p < .001$), and statistical literacy significantly predicts critical thinking skills ($b = 0.549$, $p < .001$). However, research competence does not directly predict critical thinking when statistical literacy is controlled ($c = 0.162$, $p = .169$).

The findings indicate a case of full mediation, where statistical literacy fully explains the relationship between research competence and critical thinking skills. This means that research competence alone does not directly enhance critical thinking; instead, its effect operates through students' ability to understand and interpret statistical data. The large proportion of mediation (74.9%) suggests that statistical literacy is the primary mechanism through which research competence translates into higher-order thinking. Students who possess strong research skills and knowledge are more likely to develop statistical literacy, which in turn enables them to analyze data, evaluate evidence, and draw logical conclusions. The non-significant direct effect further confirms that without statistical literacy, research competence may not be sufficient to produce meaningful improvements in critical thinking.

The results highlight the critical role of statistical literacy in teacher education. It is not enough to develop students' research competence alone; educators must also ensure that students acquire strong statistical understanding and data interpretation skills. This implies that statistics instruction should be integrated with research training, rather than treated as a separate component. Learning experiences should emphasize data analysis, interpretation, and evidence-based reasoning, allowing students to actively construct meaning from research findings. Moreover, the findings support the need for responsive teaching strategies, where students are guided in applying statistical concepts to real research contexts. Strengthening statistical literacy can significantly enhance students' critical thinking, preparing them for evidence-based decision-making in their future teaching practice. The findings support the view that statistical literacy serves as a bridge between research competence and critical thinking (Koga, 2022; Riwayani et al., 2024), as it enables students to construct meaningful conclusions from data. Moreover, statistical proficiency has been identified as a predictor of both research competence and critical thinking (Wongvorachan et al., 2024), reinforcing its critical role in developing evidence-based decision-making among future educators.

*Problem 6: What program can be developed based on the findings?*

| | |
|---|---|
| **Program Title:** | PROJECT D.A.T.A. (Developing Analytical Thinking through Applied Statistics) |
| **Rationale:** | Grounded on the finding that statistical literacy fully mediates the relationship between research competence and critical thinking, this program equips students with essential skills in data interpretation, statistical analysis, and evidence-based reasoning. |
| **Target Participants:** | Pre-service teachers (BEED students) |
| **Duration:** | 2-Day Intensive Training Workshop |
| **General Objective:** | To strengthen students' critical thinking skills through the integration of research competence and statistical literacy. |
| **Specific Objectives:** | At the end of the program, students will be able to:<br>Apply research knowledge in designing and justifying studies<br>Select appropriate statistical tools for data analysis<br>Interpret descriptive and inferential statistics accurately<br>Analyze data using statistical software (e.g., Jamovi)<br>Communicate findings using evidence-based reasoning (PAIS format)<br>Demonstrate analytical and inferential thinking in research contexts |

| Day/Session | Module Title | Topics Covered | Learning Activities | Expected Output |
|---|---|---|---|---|
| **Day 1 (AM)** | Research Foundations and Design | Aligning title to research agenda<br>Formulating objectives<br>Research design selection<br>Ethical considerations | Guided workshop and critique | Draft research title, objectives, and design |

| | | | | |
|---|---|---|---|---|
| **Day 1 (PM)** | Statistical Literacy Essentials | Introduction to Jamovi Validation and Reliability Testing (Cronbach's alpha)<br>Descriptive statistics (Frequency, Percentage, Mean, Standard Deviation)<br>Normality testing (Shapiro-Wilk) | Hands-on data analysis | Interpreted descriptive results |
| **Day 2 (AM)** | Inferential Statistics and Test Selection | Parametric vs non-parametric<br>Correlation (Pearson, Spearman)<br>Regression Analysis<br>Comparative tests (Independent t-test/ Mann Whitney U Test, ANOVA/ Kruskal-Wallis H Test) | Case-based analysis and Jamovi practice | Justified statistical test selection |
| **Day 2 (PM)** | Data Interpretation and Critical Thinking | Interpreting tables and graphs<br>Mediation and regression overview<br>Statistical storytelling<br>PAIS format | Group presentation and problem-solving tasks | PAIS-based presentation/report |

*Table 6. PROJECT D.A.T.A. (Developing Analytical Thinking through Applied Statistics)*

The development of PROJECT D.A.T.A. (Developing Analytical Thinking through Applied Statistics) is anchored on the key findings of the study, particularly the result that statistical literacy fully mediates the relationship between research competence and critical thinking. This implies that while students demonstrate strong research knowledge and skills, their ability to think critically is largely shaped by how well they interpret and make sense of data. In response, the program is designed as a 2-day intensive training workshop that integrates research competence with statistical literacy to enhance higher-order thinking. The first day focuses on strengthening foundational competencies in research design and statistical understanding, addressing observed gaps in selecting appropriate research designs and statistical tests. Through guided workshops and hands-on activities using Jamovi, students are provided opportunities to apply concepts such as validation, reliability testing, descriptive statistics, and normality testing.

The second day advances these skills toward inferential analysis and critical thinking by engaging students in selecting appropriate statistical tests, performing correlation and regression analysis, and interpreting results within real research contexts. Emphasis is placed on statistical storytelling and the use of the PAIS format (Presentation of Findings, Analysis, Implication, Supporting Studies), a structured approach in reporting findings where data are first presented, then analyzed and interpreted, followed by discussing their implications, and finally supported by related literature. This framework helps students communicate results clearly, logically, and with strong evidence. Overall, PROJECT D.A.T.A. serves as a responsive and evidence-based intervention that operationalizes the study's findings by positioning statistical literacy as the bridge that transforms research competence into meaningful critical thinking among pre-service teachers.

## Conclusion and Recommendations

This study concludes that elementary education students demonstrate a high level of research competence, critical thinking skills, and statistical literacy. Students exhibit strong foundational knowledge in research processes, ethical considerations, and data interpretation, as well as the ability to analyze information and make evidence-based decisions. However, slight limitations are evident in higher-order skills, particularly in complex problem-solving, research design selection, and advanced statistical decision-making. Anchored in Constructivist Learning Theory, the findings affirm that learning occurs through active engagement and meaning-making. Research competence provides the foundational knowledge, while statistical literacy enables students to interpret and construct meaning from data, leading to the development of critical thinking skills. The results further establish that research competence is significantly associated with critical thinking skills. However, this relationship is not direct, as statistical literacy fully mediates the connection between the two variables. This suggests that students develop critical thinking not merely by acquiring research knowledge and skills, but by actively engaging in data analysis and interpretation. Overall, statistical literacy serves as a crucial mechanism that transforms research competence into higher-order thinking. Without it, research competence alone may not be sufficient to enhance critical thinking. In response to this finding, PROJECT D.A.T.A. (Developing Analytical Thinking through Applied Statistics) is proposed as an evidence-based intervention that integrates research competence and statistical literacy through structured, hands-on training to strengthen students' higher-order thinking. These findings underscore the importance of integrating statistical literacy within research instruction to support active learning and develop reflective, analytical, and evidence-based future educators.

Based on the findings of the study, it is recommended that teacher education programs further enhance students' higher-order research skills, particularly in research design selection, justification of studies, and conceptual framework development, through scaffolded instruction and guided research activities. Statistical literacy should be integrated within

research instruction rather than treated as a separate component, with emphasis on data analysis, interpretation, and evidence-based reasoning to ensure meaningful application of statistical concepts. Educators are encouraged to adopt experiential and inquiry-based learning approaches, such as problem-based tasks and real-world data analysis, to strengthen students' analytical and inferential thinking skills. In addition, continuous mentoring, research workshops, and hands-on training should be provided to support students in developing both research competence and statistical literacy. Greater attention should also be given to statistical decision-making, particularly in selecting appropriate tests, evaluating data assumptions, and interpreting results accurately. Institutions may further develop responsive teaching frameworks (e.g. S.T.A.T.S. Learning Framework) that integrate research competence, statistical literacy, and critical thinking, promoting active and reflective learning. Specifically, the implementation of PROJECT D.A.T.A. as a short-term intensive training program is recommended to operationalize these goals by providing guided practice in research design, statistical analysis using tools such as Jamovi, and evidence-based reporting through the PAIS framework. Finally, future studies may explore other mediating or moderating variables, replicate the study in different contexts, or utilize mixed-method approaches to gain a deeper understanding of how critical thinking skills are developed among students.

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## Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

## References

Castillo-Martínez, I. M., & Ramírez-Montoya, M. S. (2021). Research competencies to develop academic reading and writing: A systematic literature review. Frontiers in Education, 5, 576961. https://doi.org/10.3389/feduc.2020.576961

Ciraso-Calí, A., Martínez-Fernández, J. R., París-Mañas, G., Sánchez-Martí, A., & García-Ravidá, L. B. (2022). The research competence: Acquisition and development among undergraduates in education sciences. Frontiers in Education, 7, 836165. https://doi.org/10.3389/feduc.2022.836165

Dwyer, C. P. (2023). An evaluative review of barriers to critical thinking in educational and real-world settings. Journal of Intelligence, 11(6), Article 105. https://doi.org/10.3390/jintelligence11060105

Fitriadi, F., Herpratiwi, H., Yulianti, D., Setiyadi, A. G. B., Hariri, H., Sunyono, S., Haenilah, E. Y., & Mukhlis, H. (2024). Enhancing critical thinking in elementary education: A systematic review of effective learning models. Multidisciplinary Reviews, 8(6), e2025157. https://doi.org/10.31893/multirev.2025157

Katzman, S. D., Carrion, C. A., & Hurst-Kennedy, J. (2024). The impact of primary literature-based, critical thinking activities on competency enhancement for pre-health students. Trends in Higher Education, 3(3), 725–733. https://doi.org/10.3390/higheredu3030041

Koga, S. (2022). Characteristics of statistical literacy skills from the perspective of critical thinking. Teaching Statistics. https://doi.org/10.1111/test.12302

Kretchmar, J. (2021). Constructivism. EBSCO Information Services, Inc. https://www.ebsco.com/research-starters/education/constructivism

Kurt, S. (2021). Constructivist Learning Theory. Educational Technology. https://educationaltechnology.net/constructivist-learning-theory/

León-Díaz, F., Boude, O., & Vargas-Sanchez, A. (2026). Pedagogical mediation with ICT for the development of critical thinking in primary education: A systematic review. Thinking Skills and Creativity, 60, 102085. https://doi.org/10.1016/j.tsc.2025.102085

Mamytbayeva, Z., Kyakbayeva, U., Azimbayeva, D., Kerimbayeva, R., Sarybekova, Z., & Daurenbekov, K. (2022). Formation of research competence of future teacher educators based on the technology of project training. World Journal on Educational Technology: Current Issues, 14(3), 927–939. https://doi.org/10.18844/wjet.v14i3.7319

Manassero-Mas, M. A., & Vázquez-Alonso, A. (2025). Las destrezas de pensamiento de docentes en formación: Análisis comparativo con alumnado de primaria (The thinking skills of in-training teachers: A comparative analysis with primary students). Profesorado. Revista de Currículum y Formación de Profesorado, 29(1), 1–23. https://doi.org/10.30827/profesorado.v29i1.27899

Matjašič, M., & Vogrinc, J. (2024). Research competence of pre-service teachers: A systematic literature review. European Journal of Educational Research, 13(2), 877-894. https://doi.org/10.12973/eu-jer.13.2.877

Matjašič, M., & Vogrinc, J. (2025). Supporting the development of the perceived and actual research competence of pre-service teachers. Education Sciences, 15(6), 652. https://doi.org/10.3390/educsci15060652

Okoli, O. D. (2023). Teachers as researchers: Assessing research literacy levels among pre-service teachers in Nigerian universities. International Journal for Research in Education, 47(5), 289–332. https://doi.org/10.36771/ijre.47.5.23-pp289-332

Riwayani, R., Istiyono, E., Supahar, S., Perdana, R., & Soeharto, S. (2024). Analyzing students' statistical literacy skills based on gender, grade, and educational field. International Journal of Evaluation and Research in Education, 13(2). https://doi.org/10.11591/ijere.v13i2.26299

Salmento, H., Murtonen, M., & Kiley, M. (2021). Understanding teacher education students' research competence through their conceptions of theory. Frontiers in Education, 6, Article 763803. https://doi.org/10.3389/feduc.2021.763803

Suratmi, S., & Sopandi, W. (2022). Knowledge, skills, and attitudes of teachers in training critical thinking of elementary school students. Journal of Education and Learning (EduLearn), 16(3), 291–298. https://doi.org/10.11591/edulearn.v16i3.20493

Villarin, S. J. B., Lapinig, G. C., Divino, D. G. C., Lumahang, K. P., & Echavez, L. F. J. (2025). Crafting a Responsive Teaching Framework for Data Analysis: A Phenomenological Study on Students' Experiences in Learning Descriptive and Inferential Statistics. Journal of Tertiary Education and Learning, 3(3), 8-22. https://doi.org/10.54536/jtel.v3i3.5483

Wongvorachan, T., Srisuttiyakorn, S., & Sriklaub, K. (2024). Optimizing Learning: Predicting Research Competency via Statistical Proficiency. Trends in Higher Education, 3(3), 540-559. https://doi.org/10.3390/higheredu3030032

Yusof, I. J., Abdul Latif, A., & Md Supie, H. S. (2021). Assessing statistical literacy level of postgraduate education research students in Malaysian research universities. Turkish Journal of Computer and Mathematics Education, 12(5), 1318–1324. https://doi.org/10.17762/turcomat.v12i5.1800

## Appendices

No appendices are attached to this study.