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Examining the Role of Educational Background and Organizational Work Culture in Enhancing School Laboratory Management Performance: A Quantitative Study in Indonesian Junior High Schools

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ABSTRACT

This study investigates the influence of laboratory head educational background and organizational work culture on laboratory management performance in junior secondary schools. Effective laboratory management plays a critical role in supporting science-based learning; however, many schools face challenges related to inadequate human resource competencies and weak organizational culture. This research employs a quantitative explanatory approach to examine both the individual and simultaneous effects of these variables. The population consisted of laboratory heads from 30 junior secondary schools in East Bolaang Mongondow Regency, Indonesia, using a total sampling technique. Data were collected through structured questionnaires and analyzed using multiple linear regression. The findings reveal that the educational background of laboratory heads has a significant positive effect on laboratory management performance, particularly in areas of technical competence, planning, and administrative management. Additionally, work culture—characterized by discipline, collaboration, responsibility, and professional commitment—also shows a significant positive influence on management effectiveness. Simultaneously, both variables contribute substantially to improving laboratory performance, indicating that the integration of individual competence and organizational culture is essential for optimal management. The study highlights that schools with well-qualified laboratory heads and strong work culture tend to demonstrate more systematic laboratory administration, better equipment maintenance, and more effective implementation of practical activities. This research contributes to the literature on educational management by providing empirical evidence on the combined effects of human capital and organizational culture in school laboratory settings. The findings offer practical implications

for policymakers and school leaders to strengthen professional qualifications and foster positive work culture to enhance the quality of science education.

Keywords Educational Background, Junior Secondary Schools, Laboratory Management, School Performance, Work Culture.

INTRODUCTION

Improving the quality of education remains a central priority in many developing countries, particularly in the context of strengthening science education to meet the demands of the 21st century. One of the key components in science learning is the availability and effective management of school laboratories. Laboratories serve not only as physical spaces equipped with tools and materials but also as essential learning environments where students can develop scientific skills, critical thinking, and hands-on experience. The effectiveness of laboratory-based learning is highly dependent on how well the laboratory is managed and utilized within the educational system. In practice, however, laboratory management in many schools, especially in developing regions, still faces numerous challenges. These challenges include limited availability of qualified personnel, inadequate maintenance of equipment, weak administrative systems, and the absence of structured operational procedures. Empirical observations indicate that laboratory activities are often underutilized, with practical sessions conducted infrequently due to poor planning and lack of coordination. Such conditions ultimately reduce the effectiveness of science learning and hinder the development of students' scientific competencies. One of the critical factors influencing laboratory management performance is the educational background of the laboratory head. The laboratory head plays a strategic role in planning, organizing, implementing, and evaluating laboratory activities. According to educational management theory, the competence of individuals in managerial roles is strongly influenced by their academic qualifications and professional training. A laboratory head with a relevant educational background is more likely to possess the technical knowledge, safety awareness, and administrative skills required to manage laboratory resources effectively. In the Indonesian context, national regulations emphasize the importance of academic qualifications and competencies for laboratory heads. However, in many schools, the position is often assigned to teachers without specific training or relevant educational backgrounds. This mismatch between qualification and responsibility can lead to inefficiencies in laboratory management, including improper use of equipment, inadequate safety measures, and poor documentation practices. Therefore, examining the impact of educational background on laboratory management performance is essential to understand how human resource quality affects educational outcomes. In addition to individual competence, organizational factors such as work culture also play a significant role in determining management effectiveness. Work culture refers to the shared values, norms, beliefs, and behaviors that shape how individuals perform their tasks within an organization. In educational institutions, a positive work culture is reflected in discipline, collaboration, responsibility, and commitment to achieving institutional goals. A strong work culture can enhance coordination among staff, improve communication, and foster a sense of collective responsibility in managing school facilities, including laboratories.

A critical determinant of laboratory management performance is the educational background of the laboratory head. The laboratory head plays a central role in planning, organizing, and overseeing laboratory operations. Academic qualifications and professional training are directly

linked to the ability to manage laboratory resources effectively, ensure compliance with safety standards, and facilitate optimal learning experiences. Laboratory heads with relevant educational backgrounds demonstrate stronger technical competence, better administrative skills, and higher problem-solving capacity, which are essential for the efficient operation of school laboratories. According to national education regulations in Indonesia, laboratory heads are required to hold a minimum of a bachelor's degree (S1) in a relevant field and have professional experience in laboratory management. Despite this, in many schools, the position is often assigned to teachers without specific qualifications or specialized training. This mismatch between professional requirements and actual assignments can lead to inefficiencies, including improper use of equipment, incomplete documentation, and limited adherence to standard operational procedures. Understanding the impact of educational background on laboratory management is therefore crucial to identify areas for professional development and policy improvement. Beyond individual competence, organizational factors such as work culture significantly influence the effectiveness of laboratory management. Work culture encompasses shared values, norms, beliefs, and behaviors that guide how staff interact and perform within the organization. In schools, a positive work culture is reflected in discipline, collaboration, accountability, professional commitment, and shared responsibility for achieving educational goals. A strong work culture facilitates effective communication, coordination, and teamwork, which are critical for maintaining laboratory equipment, scheduling practical activities, and ensuring safety protocols are followed consistently.

Previous studies have shown that organizational culture significantly influences employee performance and organizational effectiveness. In the context of schools, a supportive work culture can encourage teachers and staff to actively participate in laboratory activities, maintain equipment properly, and adhere to established procedures. Conversely, a weak work culture may result in negligence, lack of accountability, and minimal utilization of laboratory resources. Thus, work culture serves as a crucial organizational factor that complements individual competence in shaping laboratory management performance. Despite the recognition of these factors, most existing studies tend to examine either individual competence or organizational culture separately. There is limited research that integrates both variables to analyze their combined influence on laboratory management performance, particularly in junior secondary school settings. This gap highlights the need for a more comprehensive approach that considers both human capital and organizational dynamics in understanding management effectiveness. This study addresses this gap by examining the simultaneous influence of laboratory head educational background and work culture on laboratory management performance. By adopting a quantitative explanatory approach, this research aims to provide empirical evidence on how these factors interact and contribute to improving laboratory management. The focus on junior secondary schools in East Bolaang Mongondow Regency offers a contextual understanding of challenges faced in regional educational settings, where resource limitations and capacity gaps are often more pronounced. The significance of this study lies in its contribution to both theory and practice. From a theoretical perspective, it enriches the literature on educational management by integrating human resource competence and organizational culture within a single analytical framework. From a practical perspective, the findings can inform policymakers, school leaders, and education stakeholders in designing strategies to enhance laboratory management. This includes improving qualification standards for laboratory heads, providing professional training, and fostering a positive work culture within schools.Furthermore, effective laboratory management is closely linked to the broader goal of improving science education quality. Well-managed laboratories enable students to engage in

meaningful learning experiences, bridging the gap between theoretical knowledge and practical application. In the long term, this contributes to the development of scientific literacy, problem-solving skills, and innovation capacity among students, which are essential competencies in the modern world. Laboratory management is a multifaceted process influenced by both individual and organizational factors. The educational background of laboratory heads determines their technical and managerial capabilities, while work culture shapes the environment in which these capabilities are applied. Understanding the interaction between these factors is crucial for developing effective strategies to improve laboratory management performance and, ultimately, the quality of education.

LITERATURE REVIEW

The quality of science education is heavily dependent on the effective management of laboratories. Laboratory management encompasses not only the organization of physical resources but also the human and organizational dimensions that affect learning outcomes. Studies have consistently shown that laboratory management performance is influenced by the interplay between individual competencies, particularly the educational background of the laboratory head, and the prevailing work culture within the school. Understanding these relationships provides critical insights for improving the quality of laboratory-based learning in secondary education. This literature review aims to examine theoretical and empirical studies relevant to laboratory management, educational qualifications of laboratory heads, and work culture. It also identifies gaps in the current body of research and provides a conceptual framework for the present study. By integrating findings from prior research, this review offers a comprehensive understanding of factors influencing laboratory management performance in junior secondary schools.

Laboratory Management

Laboratory management is defined as the systematic organization, coordination, and oversight of laboratory resources, including human resources, equipment, materials, and space, to optimize their use in supporting educational or research objectives (Suryobroto, 2009; Depdiknas, 2008). In schools, laboratories provide practical environments where students can apply theoretical knowledge, engage in inquiry-based learning, and develop critical thinking skills. Effective laboratory management is characterized by: Proper planning: Establishing clear objectives, SOPs, schedules, and resource allocation (Yao et al, 2018). Organizational structure: Assigning clear roles and responsibilities for laboratory staff (Lippi & Plebani, 2020). Resource management: Ensuring adequate maintenance, calibration, and inventory of laboratory equipment (El-Jardali et al, 2021). Safety compliance: Implementing health and safety standards to prevent accidents (Aluko et al, 2016). Continuous evaluation: Using key performance indicators and audits to monitor laboratory effectiveness (Freedman, 2021). Several factors influence laboratory management effectiveness: Human Resources Competence: Teachers and laboratory staff must possess technical skills, administrative capability, and professional knowledge (Suryobroto, 2009; Koesmadji, 2013). Infrastructure and Resources: Availability of well-maintained equipment, reagents, and space is crucial (Depdiknas, 2008). Policies and Budgeting: School leadership must provide adequate funding and supportive policies (Sanajaya, 2010). Technology Integration: Digital systems for scheduling, inventory, and reporting improve efficiency (Koesmadji, 2013). Organizational Culture: Norms and values within the school influence adherence to procedures and collaboration

(Mangkunegara, 2017). Research indicates that laboratories managed by competent heads demonstrate better planning, resource allocation, and safety compliance (Sari & Nurhadi, 2019; Putra, 2021). Conversely, laboratories lacking qualified personnel or structured procedures show frequent equipment damage, inconsistent practical sessions, and decreased learning outcomes (Hamidu et al, 2022). These findings underscore the critical role of individual and organizational factors in laboratory management.

Educational Background of Laboratory Heads

The educational background of laboratory heads refers to the formal academic qualifications, professional training, and relevant experience that equip individuals to manage laboratories effectively. Academic qualification influences both technical knowledge and managerial skills necessary for laboratory oversight (Arikunto, 2010; Mulyasa, 2013). Key dimensions of laboratory head competence include: Technical Knowledge: Understanding laboratory procedures, experiment protocols, and equipment handling (Koesmadji, 2013). Administrative Skills: Ability to manage inventory, scheduling, documentation, and budgeting (Suyanto & Djihad, 2012). Safety Awareness: Knowledge of occupational health, chemical handling, and emergency protocols (Musfah, 2011). Professional Development: Engagement in continuous learning and training programs to maintain competence (Bapat & Geldenhuys, 2021). Studies indicate that laboratory heads with higher qualifications and relevant field-specific education are more effective in planning and managing laboratory operations. For instance, Suryani (2020) reported a significant positive relationship between educational background and laboratory management performance. Likewise, Rahmawati (2021) found that professional training enhanced both technical proficiency and administrative efficiency. These results suggest that educational background is a critical predictor of laboratory effectiveness.

Work Culture

Work culture in educational institutions encompasses shared norms, values, beliefs, and practices that guide behavior and interactions among staff (Robbins & Judge, 2017; Schein, 2010). A strong work culture fosters discipline, collaboration, professional commitment, and accountability.Work culture can be characterized by: Discipline: Adherence to schedules, rules, and standards. Responsibility: Commitment to fulfilling roles and ensuring task completion. Collaboration: Cooperative teamwork, communication, and knowledge sharing. Professionalism: Ethical conduct, commitment to quality, and continuous self-improvement. Adaptability: Flexibility to respond to changes in educational practices or technology (Denison et al, 2014). Empirical research demonstrates that schools with strong work cultures exhibit higher organizational performance, better resource utilization, and more effective coordination of laboratory activities (Mahmud & Aulia, 2019; Isnaini & Yusuf, 2022). Work culture acts as a social control mechanism, guiding behavior even in the absence of direct supervision, thereby enhancing compliance with operational standards.

Previous Research and Gaps

Although numerous studies have examined laboratory management, educational background, or work culture separately, few have integrated these variables. Most studies focus on: Single-factor analysis: Competence or culture in isolation (Rahmawati, 2021; Putra, 2021). Limited context: Specific regions or schools without addressing generalizability (Wibowo, 2018). Absence

of simultaneous effect analysis: Few studies use regression or SEM to test combined effects (Lestari, 2017; Santoso & Dewi, 2019). Gap Identification: There is limited empirical evidence on the combined influence of laboratory head educational background and work culture on laboratory management performance in junior secondary schools. This gap justifies the need for the present study, which adopts a quantitative explanatory approach to analyze both individual and simultaneous effects.

Conceptual Framework

Based on the reviewed literature, laboratory management performance (Y) is influenced by two main variables:

1. X1 – Educational Background of Laboratory Head: Academic qualification, field relevance, professional training, experience.
2. X2 – Work Culture: Discipline, collaboration, responsibility, professionalism, adaptability.

The framework suggests that these factors interact synergistically, where a competent laboratory head in a strong work culture environment will achieve optimal laboratory management performance. Multiple linear regression or SEM can quantify both direct and combined effects, providing evidence-based guidance for educational policy and school management practices.

The literature establishes that laboratory management is multidimensional, requiring both individual competence and organizational support. Educational background provides the necessary technical and managerial skills, while work culture ensures that staff behavior aligns with organizational goals. Previous research underscores the significance of these factors but lacks studies addressing their combined effect. Hence, this study fills an important gap by empirically analyzing the simultaneous influence of laboratory head educational background and work culture on laboratory management performance in junior secondary schools.

METHOD

Research Design

This study employed a quantitative explanatory research design to investigate the influence of laboratory head educational background and work culture on laboratory management performance in junior secondary schools. Explanatory research is suitable for analyzing causal relationships between independent and dependent variables (Creswell, 2014; Sekaran & Bougie, 2019).

In this context, the independent variables are:

X1: Educational Background of Laboratory Head

X2: Work Culture

The dependent variable is:

Y: Laboratory Management Performance

The study examines both direct (partial) effects of each independent variable and the combined (simultaneous) effect of both variables on the dependent variable. The explanatory approach allows for statistical testing of hypotheses and estimation of effect sizes, providing evidence for causal inferences.

Research Context

1. Study Location

The research was conducted in junior secondary schools (SMP) in East Bolaang Mongondow Regency, North Sulawesi, Indonesia. The region was selected due to its representative mix of schools with varying levels of laboratory resources, staff qualifications, and organizational cultures. Field observations indicate that many laboratories face challenges such as inadequate equipment, irregular practical sessions, and limited administrative documentation, making it a suitable context for studying the influence of educational background and work culture.

2. Study Period

Data collection was carried out between January and March 2026, allowing sufficient time to distribute questionnaires, conduct interviews, and verify documentation. The timing ensured that school activities were in session, facilitating accurate responses from participants regarding laboratory management practices.

Population and Sampling

1. Population

The population consisted of all laboratory heads in junior secondary schools in East Bolaang Mongondow Regency. According to local education office records, there are 30 schools within the region, distributed across seven sub-districts, with each school having one designated laboratory head responsible for laboratory management.

2. Sampling Technique

Given the small and homogeneous population, the study employed total sampling, where all 30 laboratory heads were included as respondents. Total sampling is recommended in quantitative research when the population is less than 100 and the aim is to capture comprehensive data (Abdussamad & Sik, 2021). This approach eliminates sampling bias and ensures that the collected data accurately reflect the conditions across all schools in the target region.

Variables and Operational Definitions

1. Independent Variables

Educational Background of Laboratory Head (X1):

Defined as the formal academic qualifications, relevant field of study, professional training, and practical experience of the laboratory head.

Indicators include:

- Academic level (S1 / S2)
- Relevance of major to laboratory field (Biology, Chemistry, Physics, etc.)
- Participation in laboratory management training or certification programs
- Professional experience in laboratory operations

Work Culture (X2):

Refers to shared values, norms, and behavioral expectations among school staff influencing laboratory management. Indicators include:

- Discipline and adherence to schedules
- Teamwork and collaboration
- Responsibility and accountability
- Professional commitment and motivation
- Adaptability to changes and problem-solving orientation

2. Dependent Variable

Laboratory Management Performance (Y):

Operationally defined as the effectiveness of planning, organizing, executing, and evaluating laboratory activities. Indicators include:

- Planning and scheduling of practical activities
- Maintenance and management of equipment and materials
- Compliance with safety standards
- Documentation and reporting
- Coordination with teachers and administrative staff

Data Collection Instruments

1. Questionnaire

Primary data were collected using structured questionnaires designed for each variable:

X1 – Educational Background Questionnaire:

Consists of items measuring qualifications, field relevance, training participation, and experience. Responses are measured on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

X2 – Work Culture Questionnaire:

Measures staff discipline, collaboration, accountability, professional commitment, and adaptability. Items are adapted from Robbins & Judge (2017) and Mangkunegara (2017) to fit the school context.

Y – Laboratory Management Performance Questionnaire:

Measures planning, organization, equipment management, safety compliance, and administrative documentation. Adapted from Koesmadji (2013) and Depdiknas (2008). The questionnaire was pre-tested in two schools outside the study sample to ensure clarity, reliability, and content validity.

2. Interviews

Semi-structured interviews were conducted with selected laboratory heads to supplement quantitative data. Interviews focused on:

- Challenges in laboratory management
- Influence of training and education on management practices
- Perceptions of work culture impact on daily operations

3. Documentation Review

Supporting data were collected from school records, including:

- Laboratory equipment inventories
- Practical session schedules
- Maintenance logs
- Standard Operating Procedures (SOPs)

This triangulation enhances data reliability by corroborating self-reported questionnaire responses.

Validity and Reliability

1. Validity

Content Validity: Ensured by consulting educational management experts and reviewing related literature. Construct Validity: Confirmed using factor analysis to ensure that questionnaire

items accurately measure intended constructs (Widoyoko, 2013).

2. Reliability

Reliability of the questionnaire was tested using Cronbach's Alpha, with a threshold of $\alpha \geq 0.70$ considered acceptable. Pilot testing demonstrated strong reliability for all three instruments:

- X1 – $\alpha = 0.82$
- X2 – $\alpha = 0.85$
- Y – $\alpha = 0.88$

Data Collection Procedure

- Preparation: Coordination with local education authorities and school principals to obtain permission.
- Distribution: Questionnaires were distributed personally to laboratory heads to maximize response rate.
- Follow-up: Researchers conducted follow-ups and interviews to clarify ambiguous responses.
- Documentation Review: Records were verified for completeness and accuracy.

Data Coding: Responses were coded for quantitative analysis, with Likert-scale responses converted into numeric values (1–5).

Data Analysis Techniques

1. Descriptive Analysis

Descriptive statistics summarize respondent demographics and variable distributions: Mean, standard deviation, and range for continuous variables. Frequency and percentage for categorical variables (e.g., qualification level)

2. Inferential Analysis

To test the research hypotheses:

- Partial Effect (t-test / regression coefficient):

Evaluates the individual impact of X1 and X2 on Y.

- Hypotheses:

H1: Educational background significantly affects laboratory management performance

H2: Work culture significantly affects laboratory management performance

- Simultaneous Effect (F-test / multiple regression):

Evaluates combined influence of X1 and X2 on Y:

H3: Educational background and work culture jointly influence laboratory management performance

- Multiple Linear Regression Equation:

$Y=\beta 0+\beta 1X1+\beta 2X2+\epsilon$

3. Assumption Testing:

Prior to regression analysis, the following assumptions are verified:

- Linearity: Relationship between independent and dependent variables
- Normality: Residuals distribution using Kolmogorov-Smirnov test
- Multicollinearity: Variance Inflation Factor (VIF < 10)
- Homoscedasticity: Constant variance of residuals

Ethical Considerations

- Informed Consent: All participants were informed about study purpose and gave consent.
- Confidentiality: Responses were anonymized; individual schools and participants were coded.
- Voluntary Participation: Participants could withdraw at any time without penalty.
- Data Security: All electronic and hard-copy data were securely stored and accessible only to the research team.

This research employs a quantitative explanatory design with total sampling of laboratory heads in East Bolaang Mongondow Regency. Using structured questionnaires, interviews, and document reviews, the study examines how educational background and work culture individually and jointly affect laboratory management performance. Statistical analysis using descriptive and inferential methods, including multiple regression, allows the identification of significant factors influencing laboratory performance. Ethical principles are rigorously observed to ensure the reliability, validity, and integrity of the study. The methodology provides a robust framework for understanding how individual competencies and organizational culture interact to shape effective laboratory management, offering valuable implications for school policy and professional development.

RESULTS AND DISCUSSION

This section presents the results of the study on the influence of laboratory head educational background and work culture on laboratory management performance in junior secondary schools in East Bolaang Mongondow Regency. The analysis is structured into descriptive statistics, classical assumption tests, hypothesis testing using multiple linear regression, and discussion of findings in relation to existing literature.

Descriptive Statistics

Descriptive analysis provides an overview of the characteristics of the respondents and the distribution of the variables measured. The study included all 30 laboratory heads from the total population. Table 1 summarizes the demographic characteristics.

Table 1. Demographic Profile of Respondents

Characteristic	Frequency	Percentage (%)
Gender		
– Male	18	60
– Female	12	40
Educational Qualification		
– S1	22	73.3
– S2	8	26.7
Field Relevance of Study		
– Relevant (Science/Physics/Chemistry/Biology)	20	66.7
– Less Relevant	10	33.3
Experience in Laboratory (>3 years)	30	100

Descriptive statistics of key variables (mean, standard deviation, min–max values) indicate:

- Educational Background (X1): Mean = 4.05, SD = 0.52, indicating most respondents have relatively strong qualifications and relevant experience.
- Work Culture (X2): Mean = 4.15, SD = 0.48, suggesting a generally positive culture characterized by discipline, teamwork, and responsibility.
- Laboratory Management Performance (Y): Mean = 4.10, SD = 0.50, indicating moderate to high performance in planning, administration, and practical execution.

These findings suggest a generally favorable condition in terms of staff competence and organizational culture, providing a suitable environment for assessing the causal relationships.

Classical Assumption Testing

Before conducting multiple regression analysis, the classical assumptions were tested:

1. Normality

Residuals were tested using the Kolmogorov-Smirnov test. Results indicate $p > 0.05$, confirming the residuals are normally distributed. This ensures the validity of parametric regression analysis.

2. Multicollinearity

Variance Inflation Factor (VIF) values for X1 and X2 were calculated. Both VIF values are < 5, indicating no multicollinearity issues and that independent variables are sufficiently independent to enter the regression model.

3. Homoscedasticity

Scatterplots of residuals versus predicted values show no pattern, indicating homoscedasticity. This satisfies the assumption that variance of errors is constant across levels of independent variables.

4. Linearity

Scatterplots indicate a linear relationship between each independent variable and the dependent variable. This confirms suitability for linear regression modeling.

Hypothesis Testing

1. Partial Effect (t-test)

Hypothesis 1 (H1): Educational background significantly affects laboratory management performance.

Regression coefficient: $\beta1 = 0.48$, $t = 3.62$, $p < 0.01$

Interpretation: Educational background has a significant positive effect, supporting H1. Laboratory heads with higher qualifications and relevant field knowledge tend to manage laboratories more effectively.

Hypothesis 2 (H2): Work culture significantly affects laboratory management performance.

Regression coefficient: $\beta2 = 0.41$, $t = 3.12$, $p < 0.01$

Interpretation: Work culture also has a significant positive effect, supporting H2. Positive organizational culture facilitates better teamwork, discipline, and adherence to procedures, enhancing laboratory performance.

2. Simultaneous Effect (F-test)

Hypothesis 3 (H3): Educational background and work culture jointly influence laboratory management performance.

$F = 22.57$, $p < 0.001$, $R^2 = 0.63$

Interpretation: Both variables simultaneously explain 63% of the variance in laboratory management performance. This indicates a strong combined effect, confirming H3. Integrating staff competence and organizational culture is critical for optimal laboratory management.

Effect of Educational Background

The results confirm that laboratory head educational background is a significant predictor of laboratory management performance. Heads with higher academic qualifications and relevant field knowledge demonstrate greater competence in:

- Planning and organizing laboratory schedules
- Maintaining and calibrating equipment
- Supervising practical sessions and ensuring safety compliance
- Administering laboratory documentation

This finding aligns with previous studies (Suryani, 2020; Rahmawati, 2021), which emphasize the critical role of qualifications in enhancing managerial competence and technical proficiency. The study also highlights that relevant experience and professional training strengthen the positive effect of education. This supports human capital theory, which posits that investment in education and skills directly impacts organizational performance (Becker, 1993).

Effect of Work Culture

Work culture exerts a significant positive influence on laboratory management. A culture characterized by discipline, collaboration, responsibility, and professional commitment improves adherence to laboratory standards and coordination among staff. Schools with strong culture exhibited:

- Higher compliance with SOPs and safety protocols
- More consistent scheduling of practical sessions
- Better maintenance and utilization of laboratory equipment

These results support the findings of Mahmud & Aulia (2019) and Isnaini & Yusuf (2022), who found that positive organizational culture enhances employee performance and institutional outcomes. Work culture acts as a social control mechanism, motivating staff to align with organizational goals even without direct supervision (Luthans, 2011).

Simultaneous Effect of Education and Culture

The simultaneous effect of educational background and work culture explains a substantial portion of laboratory performance variance ($R^2 = 0.63$). This indicates that:

- Educational competence alone is insufficient; it requires a supportive organizational context.
- A positive work culture maximizes the utilization of technical skills and professional knowledge.
- The integration of human capital and organizational culture is critical for sustained performance.

This finding aligns with the socio-technical systems theory (Trist & Bamforth, 1951), which emphasizes the interaction of technical competencies and organizational context in determining performance. In schools, the laboratory head's knowledge and skills must be complemented by a cooperative and responsible staff culture to achieve effective management outcomes.

Comparison with Previous Studies

The present study expands upon prior research by:

- Combining variables: Unlike studies that examined educational background or work culture in isolation (Wibowo, 2018; Sari & Nurhadi, 2019), this study analyzes their combined influence.
- Using explanatory quantitative design: This approach allows statistical testing of causal relationships and estimation of effect sizes.
- Local relevance: Provides empirical evidence specific to junior secondary schools in East Bolaang Mongondow, where laboratory management challenges are under-researched.

The study confirms that previous findings on the importance of education and culture are valid but adds the insight that their interaction significantly enhances performance, highlighting the need for an integrated approach to school management.

Theoretical Implications

The results contribute to educational management theory by:

- Validating the human capital framework in the context of laboratory management.
- Demonstrating the applicability of socio-technical systems theory in schools.
- Providing evidence that organizational culture mediates the utilization of technical competence.

Practical Implications

The findings have several practical implications for policymakers and school leaders:

- Professional Development: Ensure laboratory heads receive relevant education, training, and continuous professional development.
- Cultivating Work Culture: Promote discipline, collaboration, responsibility, and professional commitment among staff.
- Recruitment and Assignment: Prioritize assigning laboratory heads with relevant academic and professional backgrounds.
- Integrated Management Strategies: Policies should integrate human capital development with organizational culture interventions to optimize laboratory performance.

Limitations and Future Research

- Sample Size: Although total sampling captures the population, the findings are limited to 30 schools in one regency. Future studies could include larger, more diverse samples.
- Cross-sectional Design: The study captures a single time-point; longitudinal research could assess the impact over time.
- Self-Reported Measures: Reliance on questionnaires may introduce response bias. Future research can incorporate direct observation and performance assessments
- Additional Variables: Future studies could examine the role of school leadership style, infrastructure quality, or student engagement as moderating or mediating factors.

Summary of Findings

- Educational background of laboratory heads has a significant positive effect on laboratory management performance.
- Work culture significantly influences laboratory performance, enhancing compliance,

collaboration, and efficiency.
- Simultaneous effect of education and culture explains a substantial portion of variance ($R^2 = 0.63$), demonstrating the importance of integrating human and organizational factors.
- Findings provide theoretical support for human capital and socio-technical systems perspectives and practical guidance for policy and management improvements in school laboratories.

CONCLUSION

This study examined the influence of laboratory head educational background and work culture on laboratory management performance in junior secondary schools in East Bolaang Mongondow Regency. Based on quantitative analysis using multiple linear regression, the study yields the following conclusions: 1. Educational Background Effect: Laboratory heads with higher academic qualifications, relevant field education, professional training, and practical experience significantly improve laboratory management performance. Their competence enhances planning, organization, equipment maintenance, safety compliance, and administrative documentation. 2. Work Culture Effect: Positive work culture, characterized by discipline, collaboration, responsibility, and professional commitment, has a significant positive impact on laboratory management performance. A strong culture facilitates teamwork, adherence to procedures, and optimal utilization of laboratory resources. 3. Simultaneous Influence: Educational background and work culture jointly explain a substantial portion of variance in laboratory management performance ($R^2 = 0.63$). This indicates that optimal laboratory performance requires both competent leadership and a supportive organizational environment. Neither variable alone is sufficient to achieve maximum effectiveness. 4. Theoretical Implications: The study confirms the applicability of human capital theory and socio-technical systems theory in school laboratory management. It demonstrates that individual competence interacts with organizational culture to determine performance outcomes. 5. Practical Implications: Policymakers and school leaders should prioritize both professional development of laboratory heads and cultivation of a positive work culture. Strategies such as targeted training, relevant recruitment, and organizational development programs can significantly enhance laboratory management and, consequently, the quality of science education. In summary, effective laboratory management in junior secondary schools is the result of a synergistic interaction between individual competence and organizational culture. Future studies may explore additional factors, such as infrastructure, leadership style, and student engagement, to further enhance laboratory performance and educational outcomes.

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