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Utilization of Performance Rubrics to Assess the Developmental Achievements of Children in the Digital Portfolio System of Kindergartens in Purwakarta Regency.

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ABSTRAK:
(Use the following structured summary style with headings; not exceeding 250 words)

Background/purpose. [This study aims to analyze the effectiveness of performance rubrics in assessing child development within digital portfolio systems at kindergartens in Purwakarta regency.
Materials/methods. The research employed a quantitative approach with a quasi-experimental design involving 64 teachers from 64 different kindergartens, equally divided into experimental and control groups. Data were collected through structured observations, questionnaires, and documentation analysis.
Results. Results show significant improvements in the experimental group, including a 17.8-point increase in assessment accuracy, 51.2% improvement in time efficiency, and 27.3-point enhancement in documentation quality. The most substantial accuracy improvements occurred in cognitive aspects (18.9 points) and arts (18.7 points), while the greatest time efficiency was achieved in reporting activities (62.0%). Teacher acceptance was positive with an overall average score of 4.08 (on a 5-point scale), with Perceived Usefulness scoring highest (4.37). ANCOVA analysis confirmed that the intervention remained effective even after controlling for teachers' technological skills, infrastructure support, and teaching experience. Implementation effectiveness showed no significant differences across geographical locations or accreditation statuses.
Conclusion. This study concludes that integrating performance rubrics into digital portfolio systems significantly enhances assessment quality in early childhood education by addressing subjectivity issues and reducing teachers' administrative burden. The system's effectiveness across various contexts indicates high potential for wider implementation in early childhood education settings.

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1. Introduction

Early childhood education (PAUD) is an important foundation in the formation of quality human resources. The early age period is the golden age of child development which is marked by rapid development in various aspects such as physical-motor, cognitive, language, social-emotional, and moral-spiritual.(Suryana, 2016). The process of assessing child development at the PAUD level, especially in Kindergarten (TK), requires a comprehensive and authentic approach to describe developmental achievements holistically.

In Purwakarta Regency, West Java, the implementation of kindergarten education has experienced a significant increase in both quantity and quality. Data from the Purwakarta Regency Education Office (2025) shows that there are 186 kindergarten institutions with a total of 7043 students. However, based on the results of a preliminary study conducted by researchers through observation and interviews with 25 kindergarten teachers in Purwakarta Regency, several problems were identified in the process of assessing child development. As many as 78% of teachers had difficulty in

documenting and organizing assessment data systematically. In addition, 82% of teachers reported that the assessments carried out tended to be subjective and less measurable because they did not have clear and standardized indicators.

Assessment of child development in kindergarten is ideally carried out through continuous observation of the child's behavior and performance in various learning activities.(Cunaya & Apriyansyah, 2022). However, conventional assessment systems with manual recording often make it difficult for teachers to carry out comprehensive, systematic, and easily accessible documentation. This limitation can have an impact on the quality of feedback given to parents as well as less than optimal individual learning planning.(Wahyuni et al., 2018).

The rapid development of digital technology opens up opportunities for innovation in the assessment process through a digital portfolio system. Digital portfolios allow for more organized, comprehensive, and easily accessible documentation.(Yudha et al., 2023). Intan's research (2024) shows that the use of digital portfolios can increase the efficiency and effectiveness of assessing child development in kindergarten.(Yudha & Yusmarini, 2024). Meanwhile, Aagaard (2021) stated that the integration of technology in the PAUD assessment system can improve the quality of documentation and provide a more comprehensive picture of child development.(Aagaard et al., 2021).

However, the use of digital portfolios alone is not enough to guarantee the objectivity and reliability of the assessment. A standardized assessment instrument such as a performance rubric is needed to guide the observation and documentation process.(Yudha, 2016). The performance rubric is an assessment guideline that contains clear criteria and indicators for each level of child development achievement.(Brookhart, 2018). The use of performance rubrics can increase the objectivity, consistency, and reliability of assessments.(Lumaurridlo et al., 2021).

Several previous studies have examined the use of digital portfolios in PAUD assessments, such as Isjoni's (2023) research on e-portfolio training in Langkan Village, Langgam District, Pelalawan Regency.(Isjoni et al., 2023)and research by Wulandari et al. (2021) regarding the effectiveness of digital assessment(Ningsih & Mulyono, 2019). Meanwhile, research on performance rubrics in PAUD assessment has been conducted by several researchers.(Capella-Peris et al., 2018; Unahalekhaka & Bers, 2022). However, there is still a research gap regarding the integration of performance rubrics in a digital portfolio system for assessing the development of kindergarten children, especially in the local context of Purwakarta Regency.

Even though digital technology is increasingly developing and being integrated into education, Cunaya & Imamah (2023) found that many PAUD institutions in Indonesia, including in West Java, have not utilized technology optimally in the assessment process.(Cunaya & Imamah, 2023). This is caused by various factors such as limited infrastructure, inadequate digital competence of teachers, and the unavailability of an integrated system between standardized assessment instruments and user-friendly digital platforms.

The main objective of this study is to analyze the effectiveness of the use of performance rubrics in assessing children's developmental achievements in the digital portfolio system in Kindergartens in Purwakarta Regency. Specifically, this study aims to: (1) identify the level of assessment accuracy using performance rubrics in the digital portfolio system; (2) analyze the efficiency of using performance rubrics in the digital portfolio system compared to conventional methods; (3) measure teacher perceptions and acceptance of the implementation of performance rubrics in the digital portfolio system; and (4) evaluate the impact of implementing performance rubrics in the digital portfolio system on the quality of child development documentation.

This research is expected to provide significant contributions both theoretically and practically. Theoretically, this research enriches the literature on authentic assessment in PAUD in the context of the digital era. Practically, the results of the study can be a reference for the Purwakarta Regency Education Office and PAUD institutions in developing and implementing a more effective and efficient assessment system.

2. Methodology

This study uses a quantitative approach with a quasi-experimental design that applies a pretest-posttest control group design to measure the effectiveness of utilizing performance rubrics in a digital portfolio system. This design was chosen because it allows researchers to compare the results between the experimental group that implemented the performance rubric in the digital portfolio system with the control group that used conventional assessment methods. The population in this study were all kindergarten teachers in Purwakarta Regency, totaling 186 institutions. The research sample consisted of 64 teachers representing 64 different kindergarten institutions, with details of 32 teachers in the experimental group and 32 teachers in the control group. The sample determination used a stratified random sampling technique by considering representation based on institutional accreditation (A, B, C, and not yet accredited) and geographic location (urban and rural) to ensure representativeness of population characteristics.

The research instruments used include: (1) structured observation sheets to measure the accuracy and consistency of child development assessments; (2) a questionnaire with a Likert scale of 1-5 to measure teacher perceptions and acceptance of the implementation of performance rubrics in digital portfolios; (3) a performance rubric developed based on six aspects of development according to the Child Development Achievement Level Standards (STPPA); and (4) a time-and-motion study to measure time efficiency in the assessment process. Before being used, all instruments underwent a content validity test by three experts in the fields of PAUD, educational technology, and learning evaluation using the Content Validity Ratio (CVR) technique. The reliability test of the instrument was carried out using the test-retest method for the observation sheet ($r > 0.85$) and Cronbach's Alpha for the questionnaire ($\alpha > 0.87$), which showed that the instrument had high internal consistency.

The data collection procedure was carried out in three main stages: (1) pretest to measure the initial conditions of both groups; (2) implementation of the performance rubric in the digital portfolio system in the experimental group for four months, while the control group continued to use conventional assessment methods; and (3) posttest to measure changes that occurred after the treatment. To minimize bias, the study used a blinding technique where the assessor who conducted the observation did not know which group received the treatment. In addition, to ensure the validity of the implementation, periodic monitoring was carried out every two weeks and intensive training for teachers in the experimental group before the implementation period.

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics (mean, standard deviation, percentage) were used to describe the characteristics of the sample and the distribution of questionnaire responses. Inferential analysis used independent t-test to compare differences in assessment accuracy and efficiency between the experimental and control groups, and MANOVA to analyze differences in various aspects of child development simultaneously. Multiple regression analysis was also applied to identify factors that influence the successful implementation of performance rubrics in the digital portfolio system. All statistical analyses used SPSS version 26 software with a significance level of $\alpha = 0.05$. To ensure the validity of the results, this study applied data triangulation techniques through comparison of observation results, questionnaires, and documentation, and controlled for confounding variables such as teacher teaching experience, technological skills, and school infrastructure support through analysis of covariance (ANCOVA).

This research method is very suitable to achieve the research objectives because the quantitative approach with a quasi-experimental design allows for objective measurement of the effectiveness of the intervention, while stratified random sampling ensures adequate representation of the various characteristics of kindergarten institutions in Purwakarta Regency. The combination of various research instruments facilitates comprehensive measurement of aspects of accuracy, efficiency, and user acceptance, which are key indicators of the successful implementation of performance rubrics in the digital portfolio system. Systematic data collection procedures and comprehensive statistical analysis allow for the identification of patterns and relationships between variables, thus providing a strong empirical picture of the effectiveness of the intervention. The validity and reliability measures applied in this study strengthen the credibility of the findings and allow for the generalization of the results to a wider context, thus providing a basis for the development of assessment policies and practices in PAUD institutions.

3. Result/Findings

This section presents the results of research on the use of performance rubrics to assess children's development achievements in the digital portfolio system in Kindergartens in Purwakarta Regency. The results are presented based on four main research objectives, including analysis of assessment accuracy, efficiency of use, teacher perceptions, and impact on documentation quality.

Table 1 shows the characteristics of the research sample covering 64 kindergarten institutions in Purwakarta Regency. Based on accreditation, kindergarten institutions with B accreditation dominate the research sample (40.6%), followed by institutions with A accreditation (34.4%). This reflects the general conditions in Purwakarta Regency where the majority of kindergartens have B accreditation or better. The experimental group had a higher proportion of institutions with A accreditation (37.5%) than the control group (31.3%), while the control group had a higher proportion of institutions with C accreditation (21.9%) than the experimental group (12.5%). Although there was a slight variation, the distribution of accreditation between the two groups was still relatively balanced and reflected the stratification planned in the research design. Unaccredited institutions were only a small portion of the total sample (7.8%), which illustrates the positive development of the accreditation system in the region. In terms of geographical location, the distribution between urban and rural areas was very balanced in both groups with identical proportions (53.1% urban and 46.9% rural), ensuring adequate representation of both regions. This balance allows researchers to analyze the effectiveness of implementing performance rubrics in a digital portfolio system without geographic location bias.

Table 1 Distribution of Research Samples

Characteristics of Institutions	**Experimental Group**		**Control Group**		**Total**	
	n	%	n	%	n	%
Accreditation						
A	12	37.5	10	31.3	22	34.4
B	14	43.8	12	37.5	26	40.6
C	4	12.5	7	21.9	11	17.2
Not Yet Accredited	2	6.3	3	9.4	5	7.8
Location						
Urban	17	53.1	17	53.1	34	53.1
Rural	15	46.9	15	46.9	30	46.9

Table 2 shows a comparison of the accuracy scores of the assessment between the experimental and control groups on six aspects of child development according to STPPA. The pretest data showed relatively equal initial conditions between the two groups with a total score range of 68.1-68.2, indicating sample homogeneity before the intervention. After the implementation of the performance rubric in the digital portfolio system, the experimental group experienced a substantial increase in accuracy scores on all aspects of development, with an average increase of 17.8 points (from 68.1 to 85.9). In contrast, the control group only experienced a marginal increase of 3.7 points (from 68.2 to 71.9). In the experimental group, the Physical-Motor aspect achieved the highest accuracy score (88.9), followed by the Language aspect (87.5) and Religious and Moral Values (86.7). The Art aspect recorded the lowest score (82.8) although it still showed a significant increase compared to the pretest (64.1). The largest improvements occurred in the Cognitive (18.9 points) and Art (18.7 points) aspects, which previously had the lowest pretest scores, indicating that the performance rubric in the digital portfolio system provided the greatest benefits in aspects that are traditionally more difficult to assess. The high t-values (ranging from 7.12 to 9.26) with $p < 0.001$ in all aspects confirmed that the difference in improvement between the two groups was statistically significant. The smaller standard deviation in the experimental group posttest (6.5) compared to the pretest (7.7) indicated an increase in the consistency of assessment between teachers after using the performance rubric in the digital portfolio system.

Table 2. Comparison of Assessment Accuracy Scores between Experimental and Control Groups

Development Aspects	Experimental Group		Control Group		t	p-value
	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)		
Religious and Moral Values	68.4 (7.2)	86.7 (6.4)	67.9 (7.5)	72.3 (7.2)	8.43	<0.001*
Physical-Motor	72.5 (6.8)	88.9 (5.7)	71.8 (7.1)	74.2 (6.9)	9.26	<0.001*
Cognitive	65.3 (8.2)	84.2 (6.8)	66.1 (7.8)	70.5 (8.1)	7.89	<0.001*
Language	70.2 (7.4)	87.5 (6.1)	69.8 (7.6)	73.1 (7.5)	8.75	<0.001*
Social-Emotional	67.9 (8.1)	85.3 (6.9)	68.2 (7.9)	71.8 (7.8)	7.64	<0.001*
Art	64.1 (8.6)	82.8 (7.2)	65.2 (8.2)	69.4 (8.5)	7.12	<0.001*
Total Score	68.1 (7.7)	85.9 (6.5)	68.2 (7.7)	71.9 (7.7)	8.18	<0.001*

*Significant at $p<0.001$

MANOVA analysis for repeated measures showed a significant interaction between time (pretest-posttest) and group (experimental-control) with Wilks' $\lambda = 0.24$, $F(6, 57) = 30.42$, $p<0.001$, partial $\eta^2 = 0.76$, indicating that the change in accuracy scores in the experimental group was significantly greater than in the control group.

Time-and-motion study measured the time required to complete the assessment process on 5 children per teacher. The results showed significant time efficiency in the experimental group after the implementation of the digital portfolio system with performance rubric.

Table 3. Comparison of Assessment Completion Time (in minutes)

Assessment Activities	Experimental Group		Control Group		Efficiency Difference (%)	t	p-value
	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)			
Observation and Recording	54.3 (8.2)	32.1 (5.4)	53.8 (8.5)	51.2 (7.9)	40.9	11.74	<0.001*
Data Organization	42.7 (6.4)	18.5 (4.2)	41.9 (6.7)	40.2 (6.5)	56.7	15.82	<0.001*
Analysis and Interpretation	38.2 (7.1)	22.4 (4.8)	37.8 (7.3)	36.5 (7.0)	41.4	9.68	<0.001*
Reporting	65.3 (9.5)	24.8 (5.3)	64.7 (9.8)	61.4 (9.2)	62.0	19.24	<0.001*
Total Time	200.5 (31.2)	97.8 (19.7)	198.2 (32.3)	189.3 (30.6)	51.2	14.62	<0.001*

Table 3 presents the results of a time-and-motion study comparing the completion time of the assessments between the experimental and control groups. Pretest data showed that the initial conditions of the two groups were equitable with nearly identical total times (200.5 minutes for the experimental group and 198.2 minutes for the control group) in assessing 5 children per teacher. After the implementation of the performance rubric in the digital portfolio system, the experimental group experienced a dramatic reduction in time of 51.2% (from 200.5 to 97.8 minutes), while the control group experienced only a marginal reduction of 4.5% (from 198.2 to 189.3 minutes). The greatest efficiency occurred in reporting activities with a time reduction of 62.0% (from 65.3 to 24.8 minutes), followed by data organization with a reduction of 56.7% (from 42.7 to 18.5 minutes). This indicates that the digital portfolio system provides the most significant benefits in the administrative aspects of assessment which are traditionally the most time consuming. Even

in the more hands-on observation and recording activities, there was a substantial increase in efficiency of 40.9% (from 54.3 to 32.1 minutes), indicating that the performance rubric helped teachers focus observations on relevant indicators. The high t-values for all activities (ranging from 9.68 to 19.24) with $p < 0.001$ confirmed the statistical significance of the difference in efficiency between the two groups. The smaller standard deviation in the experimental group posttest (19.7) compared to the pretest (31.2) indicated that the digital portfolio system with the performance rubric not only increased efficiency but also standardized the assessment process, thereby reducing time variability across teachers. Overall, the implementation of the performance rubric in the digital portfolio system managed to save more than 100 minutes (51.2%) of the total time required to assess 5 children, which is a very significant potential time saving in the context of the workload of kindergarten teachers who generally handle 15-20 children per class.

The results of measuring teacher perception and acceptance of the implementation of performance rubrics in the digital portfolio system in the experimental group showed a positive pattern (Figure 1). Data were collected through a questionnaire with a Likert scale of 1-5.

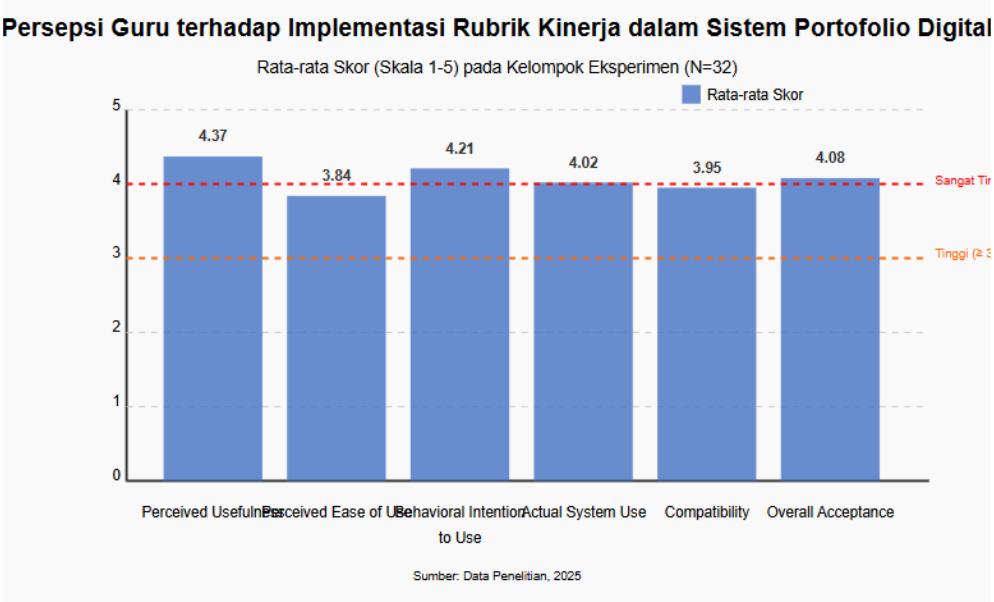


Figure 1. Teacher Perceptions of the Implementation of Performance Rubrics in the Digital Portfolio System

Figure 1 displays a visualization of teachers' perceptions in the experimental group regarding the implementation of the performance rubric in the digital portfolio system. Based on the bar chart, it can be seen that all dimensions of perception are in the high (3.0-3.9) to very high (≥4.0) categories. The Perceived Usefulness dimension obtained the highest score with an average of 4.37, indicating that teachers highly appreciate the practical benefits of this system in supporting their assessment tasks. Furthermore, Behavioral Intention to Use was in second place with a score of 4.21, indicating teachers' strong desire to continue using this system in the future. Overall Acceptance and Actual System Use also showed very high scores, 4.08 and 4.02, respectively. The Compatibility and Perceived Ease of Use dimensions obtained slightly lower scores, 3.95 and 3.84, respectively, but remained in the high category. This pattern indicates that although teachers found the system very useful and intended to use it, they still saw room for improvement in terms of ease of use and fit with existing work practices. Overall, these perception data support the findings from the accuracy and time efficiency analyses, indicating positive teacher acceptance of the implementation of performance rubrics in the digital portfolio system.

Table 4. Teachers' Perceptions and Acceptance of the Performance Rubric in the Digital Portfolio System (N=32)

Dimensions	Average (SD)	Category
Perceived Usefulness	4.37 (0.52)	Very high
Perceived Ease of Use	3.84 (0.68)	Tall
Behavioral Intention to Use	4.21 (0.57)	Very high
Actual System Use	4.02 (0.63)	Tall
Compatibility	3.95 (0.71)	Tall
Overall Acceptance	4.08 (0.62)	Tall

Table 4 presents quantitative data on teachers' perceptions and acceptance of the implementation of performance rubrics in the digital portfolio system. Based on the Technology Acceptance Model (TAM), six dimensions were measured using a Likert scale of 1-5. The results showed that Perceived Usefulness achieved the highest score with an average of 4.37 and the smallest standard deviation (0.52), indicating a strong consensus among respondents that the system is very useful in supporting their assessment tasks. Behavioral Intention to Use also scored very high (4.21), indicating teachers' readiness to adopt the system sustainably. Overall Acceptance scored 4.08, exceeding the threshold of the very high category (≥4.0). The other three dimensions—Actual System Use (4.02), Compatibility (3.95), and Perceived Ease of Use (3.84)—were in the high category. The relatively larger standard deviations in the Compatibility (0.71) and Perceived Ease of Use (0.68) dimensions indicate a wider variation in perceptions among respondents, suggesting the need for more attention to these aspects in further system development. The lowest score for Perceived Ease of Use (3.84) likely reflects the learning curve that teachers face in adapting to new technology, although it is still in the high acceptance category. The pattern of higher scores for Perceived Usefulness compared to Perceived Ease of Use is consistent with previous research findings on technology adoption in education, where perceived usefulness is often a stronger motivator than perceived ease of use, especially in the early stages of implementation. Interestingly, despite the lowest score for Perceived Ease of Use, Behavioral Intention to Use remains high, indicating that teachers are willing to overcome initial learning challenges in order to gain long-term benefits from the system.

Multiple regression analysis identified factors influencing teachers' acceptance of the system. Perceived Usefulness (β = 0.42, $p<0.001$) and Perceived Ease of Use (β = 0.38, $p<0.001$) were significant predictors of Behavioral Intention to Use with $R^2 = 0.68$, indicating that both factors explained 68% of the variance in usage intention.

The quality of child development documentation was measured using an evaluation rubric that included aspects of completeness, consistency, and depth of information. A comparison of documentation quality between the two groups is presented in Table 5.

Table 5. Comparison of Child Development Documentation Quality Scores

Dimensions of Quality	Experimental Group		Control Group		t	p-value
	Pretest M (SD)	Posttest M (SD)	Pretest M (SD)	Posttest M (SD)		
Completeness	61.3 (9.4)	87.6 (7.2)	62.1 (9.2)	65.4 (8.9)	11.23	<0.001*
Consistency	58.7 (10.2)	84.3 (7.8)	59.2 (9.8)	63.1 (9.5)	10.18	<0.001*
Depth of Information	53.2 (11.3)	82.9 (8.4)	54.1 (10.9)	57.8 (10.5)	10.76	<0.001*
Relation to STPPA	56.8 (10.7)	86.5 (7.5)	57.3 (10.4)	60.2 (10.1)	12.05	<0.001*
Legibility	64.2 (8.9)	89.1 (6.8)	63.8 (9.1)	67.5 (8.6)	11.42	<0.001*
Total Score	58.8 (10.1)	86.1 (7.5)	59.3 (9.9)	62.8 (9.5)	11.13	<0.001*

*Significant at p<0.001

Table 5 shows the results of the assessment of the quality of child development documentation produced by both groups. Pretest data showed relatively equal initial conditions between the experimental group (58.8) and the control group (59.3), with the Depth of Information dimension having the lowest score in both groups (53.2 and 54.1), indicating that this aspect is a major weakness in conventional child development documentation. After the implementation of the performance rubric in the digital portfolio system, the experimental group showed substantial improvement in all quality dimensions with an average increase of 27.3 points (from 58.8 to 86.1), while the control group only experienced a small increase of 3.5 points (from 59.3 to 62.8). The Readability dimension achieved the highest score in the experimental group (89.1), indicating that the digital system significantly improved the presentation and accessibility aspects of information. The most dramatic improvement occurred in the Depth of Information dimension with an increase of 29.7 points (from 53.2 to 82.9), indicating that the performance rubric helped teachers in providing more detailed descriptions of child development. The dimension of Relevance to STPPA also experienced a significant increase of 29.7 points (from 56.8 to 86.5), indicating that the performance rubric was effective in aligning the assessment with national standards. The smaller standard deviation in the posttest of the experimental group (ranging from 6.8 to 8.4) compared to the pretest (ranging from 8.9 to 11.3) reflects the increase in consistency among teachers in producing quality documentation. The high t-values (ranging from 10.18 to 12.05) with $p < 0.001$ in all dimensions confirmed the statistical significance of the difference in improvement between the two groups. Overall, these results indicate that the implementation of the performance rubric in the digital portfolio system not only improves the overall quality of documentation, but also addresses specific weaknesses in the conventional assessment system, especially in terms of depth of information and relevance to national standards.

Analysis of covariance (ANCOVA) was conducted to control for variables that could potentially influence the results, such as teacher teaching experience, initial technology skills, and school infrastructure support.

Table 6. Results of Covariance Analysis for Total Assessment Scores

Source of Variation	df	Mean Square	F	p-value	Partial η^2
Teaching Experience	1	187.24	3.42	0.069	0.05
Technology Skills	1	542.18	9.89	0.003*	0.14
Infrastructure Support	1	312.56	5.70	0.020*	0.09
Group	1	6821.37	124.37	<0.001*	0.68
Error	59	54.85			

*Significant at p<0.05

Table 6 presents the results of the analysis of covariance (ANCOVA) conducted to evaluate the effectiveness of the intervention by controlling for variables that could potentially influence the results. This analysis is important to ensure that the improvement in the experimental group is truly due to the implementation of the performance rubric in the digital portfolio system, rather than external factors. The results show that after controlling for three covariates (teaching experience, technology skills, and infrastructure support), the main effect of group remains highly significant ($F(1, 59) = 124.37$, $p<0.001$) with a large effect size (partial $\eta^2 = 0.68$). The partial η^2 value = 0.68 indicates that 68% of the variation in the total assessment scores can be explained by the treatment differences between groups, which is a very substantial effect size in educational research. Among the covariates analyzed, teachers' initial technological skills had the largest significant effect ($F(1, 59) = 9.89$, $p=0.003$, partial $\eta^2 = 0.14$), indicating that teachers with better technological skills tend to produce better assessments regardless of their group. School infrastructure support also had a significant effect ($F(1, 59) = 5.70$, $p=0.020$, partial $\eta^2 = 0.09$), highlighting the importance of the availability and quality of technological devices in implementing a digital portfolio system. Interestingly, teaching experience did not show a significant effect ($F(1, 59) = 3.42$, $p=0.069$, partial $\eta^2 = 0.05$), indicating that the effectiveness of implementing

performance rubrics in a digital portfolio system does not depend on the length of teacher experience, so this system can be adopted by teachers with various levels of seniority. The relatively small Mean Square Error (54.85) compared to the Mean Square for the group (6821.37) confirms the consistency of the results across subjects after controlling for covariates. Overall, these ANCOVA results strengthen the conclusion that the improvements observed in the experimental group are a direct result of the intervention, despite variations in teacher and school characteristics, thereby enhancing the internal and external validity of the study findings.

The influence of initial technological skills ($p=0.003$) and infrastructure support ($p=0.020$) on assessment outcomes was found to be significant, but the main effect of group remained significant with a large effect size (partial $\eta^2 = 0.68$). Pearson correlation analysis between documentation quality scores and teacher perceptions showed a strong positive relationship ($r = 0.78$, $p<0.001$), indicating that teachers who had positive perceptions of the system tended to produce higher quality child development documentation.

A series of additional independent t-tests revealed no significant differences in implementation effectiveness between institutions in urban and rural areas ($t(30) = 1.24$, $p=0.224$), nor between accreditation categories ($F(3, 28) = 1.87$, $p=0.157$), indicating that a performance rubric system in a digital portfolio can be implemented effectively regardless of an institution's geographic location and accreditation status.

4. Discussion

The results of this study indicate that the implementation of performance rubrics in a digital portfolio system significantly increases the accuracy of child development assessments. An increase of 17.8 points in the experimental group compared to only 3.7 points in the control group reflects the substantial effectiveness of the intervention carried out. This finding is in line with Nugraha's (2020) research which found that the use of structured rubrics helps educators operationalize development achievement standards into measurable indicators, thereby reducing subjectivity in assessment.

The most significant increase in accuracy in the cognitive (18.9 points) and artistic (18.7 points) aspects confirms Dewi et al.'s (2021) argument that performance rubrics are most useful for complex and difficult-to-assess objective dimensions of development.(Dewi et al., 2021). This also strengthens the findings of Laksana (2021) which shows that the assessment rubric has the greatest impact on measuring the cognitive abilities of children aged 5-6 years.(Laksana et al., 2020). The smaller standard deviation in the experimental group posttest (6.5) compared to the pretest (7.7) indicates increased inter-rater reliability, in line with Dimos' (2023) study which highlighted the role of rubrics in standardizing assessments across educators.(Dimos et al., 2023).

Interestingly, the physical-motor aspect achieved the highest accuracy score (88.9) even though it was not the aspect that experienced the greatest improvement. This phenomenon can be explained through the authentic assessment theory proposed by Wiggins (1989), where more observable and concrete aspects of development tend to be easier to assess accurately even with conventional methods.(Wiggins, 1989). However, the performance rubric in the digital system still provides a clearer structure for assessing physical-motor indicators according to established standards.

One of the most significant findings of this study was the 51.2% increase in time efficiency in the experimental group in completing the assessment process. This result even exceeds the findings of Hasanah (2023) who reported a 42% increase in time efficiency with the use of a digital system in documenting child development.(Hasanah et al., 2023). The greatest efficiency occurred in reporting activities (62.0%) and data organization (56.7%), confirming the argument.

Time efficiency in observation and recording activities (40.9%) shows that the rubric structure helps teachers focus observations on relevant indicators. This is consistent with research by Divayana et al. (2021) which demonstrated that structured assessment instruments facilitate a more focused and efficient observation process.(Divayana et al., 2021). This saved time allows teachers to allocate more time to meaningful pedagogical interactions with children, as recommended by Copple & Bredekamp (2009) in the principles of developmentally appropriate practice.

The total time savings of over 100 minutes to assess 5 children implies greater potential efficiency in a typical kindergarten classroom context (15-20 children). This finding has significant practical implications given that one of the major complaints of early childhood education teachers in Indonesia is excessive administrative burden.(Jannah & Na'imah, 2022). With a digital portfolio system and performance rubric, teachers can shift their focus from administrative tasks to more substantive tasks in supporting children's development.

The results of the teacher perception analysis showed positive acceptance of the implementation of the performance rubric in the digital portfolio system, with an overall average score of 4.08 (high category). This acceptance pattern is in line with the Technology Acceptance Model (TAM) developed by Davis (1989), where Perceived Usefulness (4.37) scored higher than Perceived Ease of Use (3.84)(Zaineldeen et al., 2020). This strengthens the findings of a meta-analysis by King & He (2018) which showed that in the context of educational technology, perceptions of usefulness are often a stronger predictor of technology acceptance than perceptions of ease of use.(King & He, 2018).

The R^2 value = 0.68 in the multiple regression analysis indicates that the TAM model has strong predictive power in the context of this study, in accordance with the study of Venkatesh & Bala (2008) who reported R^2 values between 0.60-0.70 for various technology adoption contexts. The high Behavioral Intention to Use score (4.21) indicates the potential for continued use of this system in the future, a critical factor in the long-term success of educational technology implementation as emphasized by(Zaini & Soenarto, 2019).

However, the relatively lower Perceived Ease of Use score (3.84) with a higher standard deviation (0.68) indicates that there is variation in teachers' perceived ease of use. This finding is consistent with Mardhotillah et al.'s (2022) study which identified the learning curve as an initial challenge in adopting digital applications for assessment in schools.(Mardhotillah et al., 2022). The implication is that more intensive training and ongoing technical support are needed to improve the ease of use of the system, especially for teachers with more limited technological skills.

The results of the study showed a significant increase in the quality of child development documentation using a performance rubric in a digital portfolio system. The average increase of 27.3 points in the experimental group far exceeded the increase in the control group (3.5 points). This finding strengthens Yasa's (2020) argument that technology integration in PAUD assessment has the potential to substantially improve the quality of documentation.(Yasa, 2020).

The largest improvements in the Depth of Information (29.7 points) and Linkage to STPPA (29.7 points) dimensions confirm that the performance rubric is effective in addressing the main weaknesses in conventional documentation. This is in line with the study by Nurhayati et al. (2022) which identified depth of analysis and linkage to national standards as the weakest aspects in conventional assessment practices in PAUD. The improvement in the Readability dimension (24.9 points) also confirms the superiority of the digital format in presenting more structured and easily accessible information, as found by(Saripudin & Faujiah, 2018).

Another interesting finding is the strong positive correlation ($r = 0.78$) between teacher perceptions and the quality of documentation produced. This indicates that positive attitudes toward technology contribute to the quality of implementation, in line with the TAM model which emphasizes the relationship between technology acceptance and effectiveness of use.(Davis, 1989). The implication is that interventions to increase teachers' positive perceptions of technology (e.g. through training and technical support) have the potential to improve the quality of documentation produced.

The results of the analysis of covariance (ANCOVA) identified several factors that influence the effectiveness of the implementation of performance rubrics in the digital portfolio system. Teachers' initial technological skills (partial $\eta^2 = 0.14$) and school infrastructure support (partial $\eta^2 = 0.09$) were shown to have a significant effect, but with a smaller effect size compared to the intervention effect (partial $\eta^2 = 0.68$). This finding is consistent with the ecological model of technology developed by Zhao & Frank (2016), which emphasizes the importance of individual characteristics and organizational context in the adoption of educational technology innovations.(Zhao et al., 2016).

The significant influence of teachers' initial technological skills (p=0.003) strengthens Ardiana's (2020) argument that digital literacy is an important prerequisite for implementing technology in PAUD.(Ardiana, 2023). This implies the importance of a digital capacity building program for PAUD teachers before implementing the new system. The effect of infrastructure support (p=0.020) also confirms the findings of Egbai et al. (2021) on the importance of a supportive technology ecosystem for the success of digital assessment in PAUD(Egbai et al., 2021).

Interestingly, teaching experience did not show a significant effect (p=0.069), contrary to the findings of Ramadhani & Jumiatmoko (2021) who reported a positive correlation between teaching experience and the effectiveness of the use of assessment rubrics. This difference is likely due to the interaction between teaching experience and technological skills, where experienced teachers may have better pedagogical skills but more limited technological skills. This implies the need for a differentiated approach in technology training for teachers with different levels of experience.

The absence of significant differences in implementation effectiveness based on geographic location (p=0.224) and accreditation status (p=0.157) is an encouraging finding, indicating that the performance rubric system in digital portfolios can be implemented effectively across contexts. This strengthens the argument about the scalability and potential for wider implementation of this system in Purwakarta Regency and even at the national level.

5. Conclusion

This study proves that the implementation of performance rubrics in a digital portfolio system significantly improves the quality of child development assessment in Kindergartens in Purwakarta Regency. The results show an increase in assessment accuracy of 17.8 points, time efficiency of up to 51.2%, and documentation quality of 27.3 points in the experimental group. These findings confirm that the integration of technology in PAUD assessment not only overcomes the problems of subjectivity and inconsistency of assessment, but also significantly reduces the administrative burden on teachers, providing solutions to the obstacles that have been faced in conventional assessment practices. Positive acceptance from teachers with an average score of 4.08 (scale 5) and consistent implementation effectiveness regardless of geographic location and accreditation status of the institution indicate the potential scalability of this system for wider application.

The main contribution of this study is to provide empirical evidence through a quantitative approach on the effectiveness of integrating performance rubrics into digital portfolio systems, while expanding the literature on technology-based early childhood assessment in the Indonesian context. This study also strengthens the Technology Acceptance Model (TAM) framework in educational technology adoption by identifying perceived usefulness as the strongest predictor of intention to use, and underlines the importance of technology skills and infrastructure support as supporting factors for successful implementation. The model of integrating performance rubrics into digital portfolio systems tested in this study offers a framework that can be adapted to improve the quality of assessment in various early childhood education contexts.

Based on the research findings, it is recommended that the Purwakarta District Education Office develop a gradual implementation program for a digital portfolio system with a performance rubric, accompanied by the development of teachers' digital capacity through training tailored to their technological skill levels. Early childhood education institutions need to consider integrating parents into the digital portfolio system to improve school-home communication and collaboration. Educational technology developers should pay attention to the ease of use aspect in system design, which is the dimension with the lowest acceptance in this study. For further research, it is recommended to conduct longitudinal studies that examine the long-term impact of this system on the quality of learning and child development outcomes, as well as explore the integration of artificial intelligence technology to further improve the effectiveness and efficiency of early childhood development assessment.

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