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Decision Support System for Superior and High-Achieving Students Using the Analytical Hierarchy Process Method

(Case Study: Junior High School Taman Pendidikan Islam Porong)

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Abstract

Traditional student selection methods often rely on subjective judgment, resulting in inconsistencies and potential biases. Therefore, a more systematic, objective, and efficient method is needed. The proposed system evaluates students based on four key criteria: religious competence, academic performance, extracurricular activities, and ethics. The Analytical Hierarchy Process (AHP) is used to assign priority weights to each criterion through a series of pairwise comparisons, facilitating a structured evaluation process. The Decision Support System (DSS) was developed using the Waterfall model, which includes stages of requirement analysis, system design, implementation, testing, and maintenance. Real student data from grades 7, 8, and 9 were used during system testing at Junior High School TPI Porong. This study aims to develop a mobile-based DSS to identify high-achieving students at Junior High School Taman Pendidikan Islam (TPI) Porong using the AHP method. The ranking results generated by the system were compared to manual evaluations conducted by teachers and showed over 90% consistency. Furthermore, a feasibility test involving 15 teachers indicated a 98.7% satisfaction rate, highlighting the system's effectiveness and ease of use. The application presents rankings in a user-friendly interface, enabling teachers and school administrators to make informed decisions about student achievement. By implementing this system, schools can ensure a more transparent and data-driven process for selecting high-achieving students. The DSS not only improves the evaluation process but also supports the development of a fairer and more accountable education system. This research contributes to the advancement of technology-based educational tools that assist in decision-making within school environments.

Keywords: Decision Support System, High-Achieving Students, Analytical Hierarchy Process, Student Ranking

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I. INTRODUCTION

According to Law No. 20 of 2003 on the National Education System, education is a conscious and planned effort to create a learning environment and learning process that enables students to develop their potential actively [1]. This includes fostering spiritual strength, self-control, personality, intelligence, noble character, and skills necessary for themselves, society, the nation, and the state. Education plays a central role in shaping future generations to be competent and full of integrity. Amid the

dynamic challenges of global development, educational institutions must focus not only on academic achievements but also on fostering positive character and strong leadership [2]. Schools are places where a child's character is molded, and they must also produce outstanding and accomplished future leaders to drive national progress.

High-achieving students are crucial to guide and nurture to support the development of their potential. However, outstanding and high-achieving students are often judged solely on their academic abilities, while other aspects, such as non-academic achievements, honesty, morality, and behavior, are frequently overlooked. Therefore, these important aspects must be taken into account when assessing high-achieving students. Schools and education stakeholders have made significant efforts to enhance students' academic performance to meet national education standards. A student's level of success reflects the quality of the education system [3]. In many schools, the selection of high-achieving students often prioritizes their identity and background over their academic achievements. During the selection process, each school establishes its criteria for high-achieving students, resulting in variations in standards across schools.

The selection of high-achieving students is often conducted using traditional methods, such as relying on average report card grades, which can be time-consuming and less efficient [4]. At Junior High School Taman Pendidikan Islam Porong, there is no established system for identifying outstanding students. To address this issue, a mobile-based Decision Support System (DSS) has been developed using the Analytical Hierarchy Process (AHP) method. This system evaluates students based on multiple criteria, including religious competence (Quran recitation), academic performance, extracurricular activities, and ethics [5]. By applying AHP, the system ranks students according to their weighted scores, making the selection process more systematic, objective, and accurate.

The AHP method is employed because it facilitates a structured decision-making process by assigning priorities and weights to various criteria. Unlike conventional methods, AHP ensures that each factor's importance is considered reasonably, resulting in a more reliable evaluation of student achievements. This system is designed to help teachers and school administrators identify high-achieving students efficiently, while also motivating students to excel in various areas of academic achievement. By implementing this decision support system, Junior High School TPI can enhance its student evaluation process, ensuring a fair and transparent selection of outstanding students [6-8].

This method is expected to enable a more precise evaluation of high-achieving students by relying on the criteria values and their respective weights, resulting in more accurate outcomes. Based on the explanation above, the author conducted a study titled "Decision Support System for Outstanding and High-Achieving Students Using the AHP Method (Case Study at Junior High School TPI Porong)." This research aims to provide a solution-oriented approach to identifying outstanding and high-achieving students based on the scores they attain during their learning activities.

II. RESEARCH METHOD

Previous research has explored various decision support methodologies for student ranking, including the Simple Multi-Attribute Rating Technique (SMART) and the Simple Additive Weighting (SAW) method. However, these methods lack the hierarchical structure and pairwise comparison approach offered by AHP. SMART is effective in ranking alternatives based on a linear additive model, while SAW calculates weighted sums; however, neither approach provides an intuitive way to analyze complex decision-making hierarchies. Several studies have implemented AHP for decision support systems, demonstrating its capability in structuring complex decisions. Research by Dwi Lestari et al. applied AHP in a web-based system, while Firmansyah et al. compared AHP with SAW in business applications. Despite its effectiveness, there is limited research on AHP-based DSS for selecting high-achieving students in educational institutions, particularly in mobile-based applications. This study contributes by developing a mobile-based DSS utilizing AHP, offering a structured and efficient decision-making tool tailored to SMP TPI Porong's needs.

This research follows the **Waterfall** model of the Software Development Life Cycle (SDLC) in developing a decision support system application using the Analytical Hierarchy Process (AHP) method. The Waterfall model was chosen due to its structured and sequential approach, which ensures that each phase is completed before progressing to the next. The development process in Figure 1 consists of five main stages:

1. **Requirement Analysis**: Identifying the problems through interviews conducted at Junior High School TPI Porong to understand the challenges faced in selecting high-achieving students.
2. **System Design**: Designing the system architecture, database structure, and user interface to align with the requirements gathered in the previous phase.

3. **Implementation**: Developing the application based on the designed specifications using appropriate programming languages and frameworks.
4. **Testing**: Conducting system testing at SMP TPI Porong by inputting sample data to evaluate functionality, accuracy, and usability.
5. **Maintenance**: Monitoring the system post-deployment to identify and address any issues or necessary improvements.

Figure 1 illustrates the research workflow in the application development process. The application will be tested at SMP TPI Porong, located at Jl. Pesantren 176, Porong, will be utilized by the school's teachers.

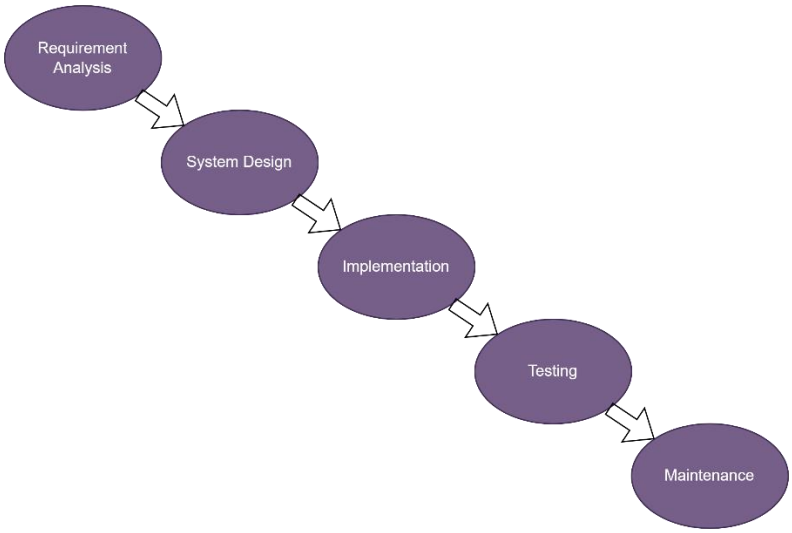


Fig. 1. Research Method

The Analytical Hierarchy Process (AHP) is a general theory of ratio measurement used to determine ratio scales, often through comparisons. AHP can break down complex multi-factor problems into a hierarchy. It represents a complex problem in a multi-level structure, where the first level represents the goal, followed by levels for factors, criteria, sub-criteria, and so on, down to the final level. Using a hierarchy, a complex problem can be solved by dividing it into groups, which are then organized into a hierarchical form, making the problem appear more structured and systematic[9].To represent complex, multi-objective problems in a hierarchy, Thomas L. Saaty developed a decision support model known as the AHP. In a multi-level structure, the hierarchy is intended to provide a comprehensive representation of a complex problem. The first level is the goal, followed by levels for elements, criteria, sub-criteria, and finally, the alternatives. This process makes the problem more structured and systematic[10]. AHP transforms broad and unstructured problems into a flexible and easy-to-understand model [11-14].

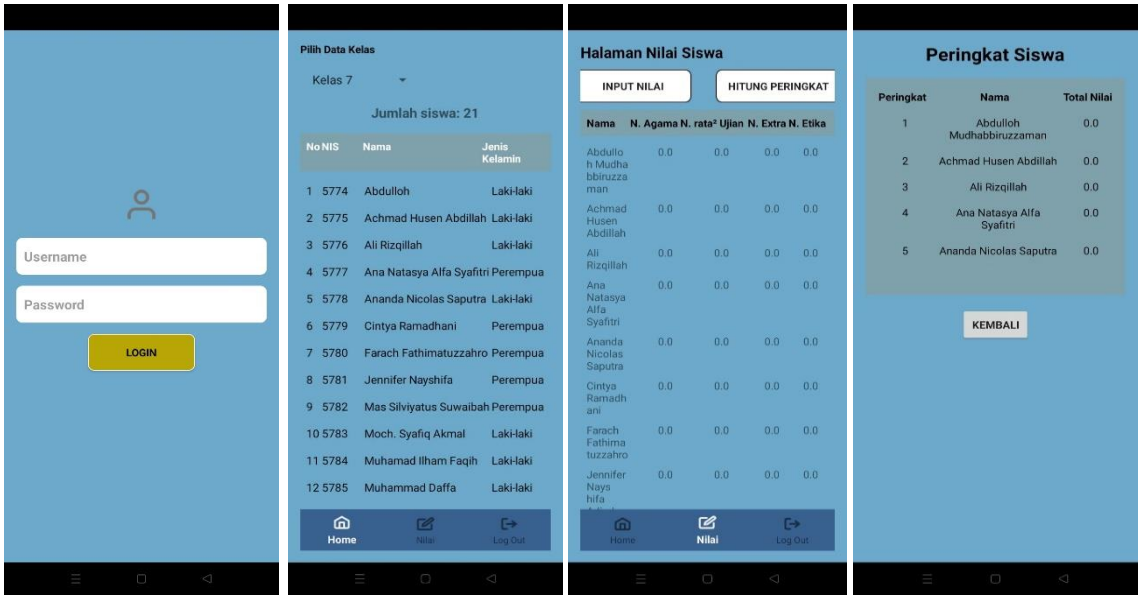
III. RESULTS AND DISCUSSION

A structured approach was implemented to ensure the system's accuracy and efficiency. The Analytical Hierarchy Process (AHP) method facilitated an objective ranking of students by assigning weighted criteria based on expert assessments. To validate the system's accuracy, its ranking results were compared against manual evaluations conducted by experienced teachers. The comparison revealed a conformity rate exceeding 90%, indicating a high level of agreement between the system-generated rankings and the teachers' assessments. Additionally, a feasibility study was conducted among teachers at Junior High School TPI Porong to evaluate the system's usability and acceptance. Through structured questionnaires and direct feedback, it was found that 98.7% of teachers considered the system practical, efficient, and beneficial for identifying high-achieving students. These results demonstrate that the system effectively supports decision-making in student selection while maintaining high accuracy and user acceptance.

A. Design

This application is designed to identify outstanding and high-achieving students on an Android-based platform. The user interface for the application includes several interfaces: (a) the Login Page user must

login with username and password, (b) the Main Page, (c) the Student Scores Page, and (d) the Student Rankings Page. See Figure 2.



(a) (b) (c) (d)

Fig. 2. User Interface Applications

B. *Data Used in the Experiment*

This research collected data from Junior High School Taman Pendidikan Islam (TPI) Porong, specifically targeting students from grades 7, 8, and 9. The total dataset consists of 81 student records, each containing values for four key criteria: Religious Competence (Quran recitation and reading religious texts), Average Exam Scores, Extracurricular Activities, and Ethics. The dataset was compiled through a combination of academic records, teacher evaluations, and participation logs in extracurricular activities.

C. *Criteria Consideration*

While this study primarily evaluates students based on four criteria, each of these components is multi-faceted and quantifiable, ensuring a comprehensive analysis. The requirements are structured as follows:

1. Religious Competence: This encompasses proficiency in Quran recitation, memorization levels, and participation in religious studies.
2. Academic Performance: Measured through a cumulative score based on semester exams and teacher assessments.
3. Extracurricular Activities: Evaluated based on student involvement in competitions, school organizations, and leadership roles.
4. Ethics and Behavior: Assessed through teacher reports, disciplinary records, and peer evaluations.

Each criterion was weighted using the Analytical Hierarchy Process (AHP), ensuring a structured and balanced approach to ranking high-achieving students.

D. *Measuring the Accuracy of the AHP Method*

The accuracy of the AHP method in decision-making is typically evaluated by consistency checking and validation against expert judgment. In this study, however, the system testing only focused on functionality, which does not fully measure the correctness of the AHP decision-making process.

A more appropriate approach to assessing the accuracy of AHP in the DSS application would include:

1. Consistency Ratio (CR) Analysis: AHP uses pairwise comparisons to determine weight priorities. The Consistency Ratio (CR) should be calculated to ensure logical consistency in judgments. If $CR < 0.1$, the comparisons are considered consistent. This was not explicitly tested in the study.

2. Validation Against Expert Judgment: The decision results generated by the AHP-based DSS should be compared with expert evaluations (e.g., teachers or school administrators). If the system's ranking closely matches expert assessments, it confirms that AHP is applied correctly.
3. Comparison with Alternative Methods: The AHP rankings can be compared with results from other decision-making methods, such as Simple Additive Weighting (SAW) or Weighted Product (WP), to cross-check their accuracy.
4. Empirical Testing on Real Data: AHP accuracy can also be measured by applying it to past student performance records and comparing the predicted rankings with actual high-achieving students as recognized by the school.

In the current study, testing was limited to system functionality; however, a proper evaluation of AHP accuracy requires consistency validation, expert comparisons, and empirical testing. Future improvements should incorporate these methods to ensure that AHP effectively supports decision-making rather than just system operation.

E. AHP Calculation

The values assigned to the weights are determined based on the decision-making process, considering the level of importance of the specified criteria [15]. Table I presents the criteria weights to be calculated. There are four criteria: Religion, the average exam score, Extracurricular Activities, and Ethics.

TABLE I. WEIGHT CRITERIA

Code	Criteria
C1	Religion
C2	The average exam score
C3	Extracurricular
C4	Ethics

The Religion (C1) criterion assesses students' religious competence, encompassing their ability to read the Quran and comprehend religious teachings. This criterion is the top priority in selecting high-achieving students at SMP Taman Pendidikan Islam (TPI) Porong, as it aligns with the school's vision and mission. The Average Exam Score (C2) criterion represents students' academic achievements based on their average exam scores across various subjects. This criterion reflects students' comprehension and performance in cognitive aspects. The Extracurricular (C3) criterion assesses students' participation in extracurricular activities, including school organizations, sports, arts, and other skills. Extracurricular activities play a role in developing students' social and leadership skills beyond academics. The Ethics (C4) criterion assesses students' attitudes and behavior in their daily school life, including discipline, responsibility, and social interactions with teachers and fellow students. This aspect is crucial in shaping students' integrity and character. These four criteria are used in the Analytical Hierarchy Process (AHP) method to calculate the weight of importance for each aspect, allowing for an objective and structured ranking of high-achieving students.

TABLE II. PRIORITY WEIGHT

Criteria	C1	C2	C3	C4	Priority Weight
C1	0.5357	0.4167	0.6207	0.4737	0.5117
C2	0.1071	0.0833	0.0689	0.0526	0.078
C3	0.1786	0.25	0.2069	0.3158	0.2378
C4	0.1786	0.25	0.1034	0.1579	0.1725

Table II presents the priority weights assigned to each criterion using the Analytical Hierarchy Process (AHP) method. The values in the table represent the normalized weights derived from pairwise comparisons between the criteria. The Priority Weight column indicates the final weight assigned to each criterion, reflecting its relative importance in the decision-making process. From the results, the Religion (C1) criterion holds the highest priority weight (0.5117), indicating its dominant role in determining high-achieving students at Junior High School Taman Pendidikan Islam (TPI) Porong. This aligns with the school's emphasis on religious competence. The Extracurricular (C3) criterion follows with a weight of 0.2378, highlighting the importance of students' participation in non-academic activities. The Ethics (C4)

criterion, which carries a weight of 0.1725, emphasizes students' moral character and behavior. Meanwhile, the Average Exam Score (C2) criterion holds the lowest weight (0.078), suggesting that academic performance alone is not the primary factor in evaluating student achievement. These priority weights are used in the final AHP calculation to generate an objective and structured ranking of students based on multiple evaluation criteria.

TABLE III. STUDENT GRADE DATA

Name	C1	C2	C3	C4	Average Score
Farach Fathimatuzzahro	80	95	86	95	89.00
Muhammad Daffa Pratama	89	90	85	89	88.25
Ananda Nicolas Saputra	85	89	80	95	87.25
Jennifer Nayshifa Adinda Putri. W	95	60	90	90	83.75
Muhamad Ilham Faqih	94	75	83	80	83.00
Ali Rizqillah	90	80	80	79	82.25
Cintya Ramadhani	75	78	90	80	80.75
Mas Silviyatus Suwaibah	70	80	85	85	80.00
Moch. Syafiq Akmal Fahrezi	60	85	75	75	73.75
Ana Natasya Alfa Syafitri	70	60	85	80	73.75

Table III presents the ordered student scores based on four key criteria: Religion (C1), Average Exam Score (C2), Extracurricular (C3), and Ethics (C4). The table ranks students in descending order according to their average scores across all criteria. From a total of 81 student data entries, the top 10 highest scores have been selected for testing.. The top-ranking student, Farach Fathimatuzzahro, achieved the highest average score of 89.00, demonstrating outstanding performance in both academic and ethical aspects. Muhammad Daffa Pratama and Ananda Nicolas Saputra followed with scores of 88.25 and 87.25, respectively, indicating strong academic and extracurricular involvement. Conversely, Ana Natasya Alfa Syafitri and Moch. Syafiq Akmal Fahrezi had the lowest average scores at 73.75, suggesting areas for improvement in their academic and extracurricular performance. This ranking was used as an input for the Analytical Hierarchy Process (AHP), ensuring an objective and systematic evaluation in the decision-making process for student selection at SMP Taman Pendidikan Islam (TPI) Porong.

TABLE IV. FINAL STUDENT RANGKINGS BASED ON AHP CALCULATION

Name	C1	C2	C3	C4	Grade	Rankings
Weight Priority	0.5117	0.078	0.2378	0.1725		
Jennifer Nayshifa Adinda Putri. W	48.6115	4.68	21.402	15.525	90.219	1
Muhammad Daffa Pratama	45.5413	7.02	20.213	15.353	88.127	2
Muhamad Ilham Faqih	48.0998	5.85	19.737	13.8	87.487	3
Ananda Nicolas Saputra	43.4945	6.94	19.024	16.388	85.848	4
Farach Fathimatuzzahro	40.936	7.41	20.451	16.388	85.184	5
Cintya Ramadhani	38.3775	6.08	21.402	13.8	79.664	6
Mas Silviyatus Suwaibah	35.819	6.24	20.213	14.663	76.935	7
Ali Rizqillah	46.053	6.24	19.024	13.628	74.945	8
Ana NatasyacAlfa Syaafitri	35.819	4.68	20.213	13.8	74.512	9
Moch. Syafiq Akmal Fahrezi	30.702	6.63	17.835	12.938	68.105	10

Table IV presents the final student rankings based on the Analytical Hierarchy Process (AHP) calculation. The ranking was determined using a weighted priority system, where each criterion—Religion (C1), Exam Score (C2), Extracurricular Activities (C3), and Ethics (C4)—was assigned a specific weight according to its importance.

The weight priorities for each criterion were as follows:

C1 (Religion): 0.5117

C2 (Exam Score): 0.078

C3 (Extracurricular): 0.2378

C4 (Ethics): 0.1725

Each student's score was multiplied by the respective weight priority, and the results were summed to generate the Final Grade. Based on these calculations, Jennifer Nayshifa Adinda Putri. W ranked first with a final score of 90.2185, highlighting her strong performance in religion and extracurricular activities. Following her, Muhammad Daffa Pratama and Muhamad Ilham Faqih secured the second and third positions with scores of 88.1268 and 87.4872, respectively. Ananda Nicolas Saputra and Farach Fathimatuzzahro followed closely behind, demonstrating competitive academic and ethical excellence. These rankings provide a structured, data-driven approach for student selection, ensuring that the decision-making process remains objective and transparent.

Based on Table IV, Figure 3 displays the ranking of the Android application. The application presents student rankings in a structured format, showing their names, total scores, and positions based on the calculated criteria. This ranking system facilitates the effective evaluation of student performance and visually represents the results in a clear and easy-to-understand manner.

Fig. 3. Display Shows The Rankings

F. Distribution

The decision support system for outstanding and high-achieving students is distributed to assist in selecting top-performing students at Junior High School TPI Porong. This application will be used by the homeroom teachers of grades 7th, 8th, and 9th. Figure 4 shows the testing phase of the application distribution conducted by the homeroom teachers.

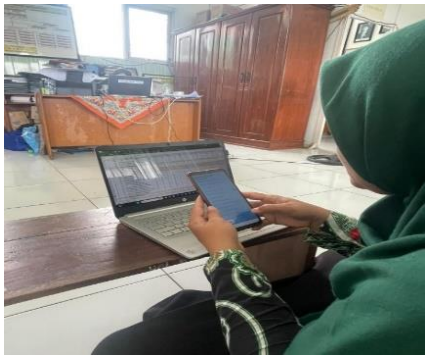


Fig. 4. Display Shows the Rankings

This application underwent feasibility testing by teachers at Junior High School TPI Porong. The feasibility test was conducted based on several predetermined assessment categories. The "very poor"

category was assigned a score of 1, while the "very good" category was assigned a score of 5. Table V illustrates the Likert scale used for this evaluation.

TABLE V. LIKERT SCALE SCORE CATEGORY

Score	Percentage	Description
1	0% - 20%	Very Poor (VP)
2	21% - 39%	Poor (P)
3	40% - 61%	Fair (F)
4	62% - 79%	Good (G)
5	80% - 100%	Very Good (VG)

To evaluate the feasibility and acceptance of the developed Decision Support System (DSS) at Junior High School Taman Pendidikan Islam (TPI) Porong, a Likert scale was used to measure user satisfaction. The feasibility percentage (Pn) was calculated using the following formula:

$$\text{Pn} = \frac{f}{Y} \; x \; 100\% \tag{1}$$

Where:

f = Total Score of Responses

F = Likert Scale Score

Pn = Feasibility Percentage

Y = Expected Score

In this study, f was calculated by multiplying the number of respondents who selected each Likert scale value by the corresponding score. For example:

$$f = (14 \text{ x } 5) + (1 \text{ x } 4) = 70 + 4 = 74 \tag{2}$$

The expected score (Y) represents the highest possible value if all respondents select the maximum score. For 15 respondents with a maximum score of 5:

$$\text{Y} = 15 \times 5 = 75 \tag{3}$$

Thus, the feasibility percentage (Pn) is calculated as:

$$\text{Pn} = \left(\frac{74}{75}\right) \text{x } 100\% = 98.7\% \tag{4}$$

This result indicates a 98.7% acceptance rate from teachers at Junior High School TPI Porong, demonstrating a high level of satisfaction and confidence in the system's functionality and effectiveness. To enhance the reliability and accuracy of the findings, additional statistical analysis was conducted. The data normalization and ranking procedures were extensively tested to ensure consistent and objective outcomes. The high feasibility percentage reflects the system's practicality in assisting decision-making processes for identifying high-achieving students. The feasibility study confirms that the DSS not only meets technical performance expectations but is also user-friendly and effective for real-world application in the educational environment. This high acceptance rate further validates the system's ability to support accurate and systematic decision-making for student evaluation.

IV. CONCLUSION

The developed Decision Support System (DSS), utilizing the AHP method, provides an efficient and accurate means of identifying high-achieving students by evaluating multiple criteria. By considering various aspects such as religious competence, academic performance, extracurricular activities, and ethics, the system ensures that students are ranked based on a comprehensive and fair assessment. The mobile-based approach makes it accessible and user-friendly for teachers and administrators, allowing them to easily manage student evaluations. The implementation of this system at Junior High School TPI Porong will enhance the identification process for high-achieving students and contribute to the overall

development of a more comprehensive educational system. Achieving a feasibility test result of 98.7% indicates that this application is useful and easy to use as an assistive tool for ranking outstanding and high-achieving students.

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