Analysis of Decision Support System for Character Assessment of Elementary School Students to Improve Teacher Assessment

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***Abstract*—The purpose of this research is to analyze the decision support system for student character assessment in elementary schools. This is done so that the assessment of student character by the class teacher is objective. This research uses a quantitative method with a pretest and posttest control group design. The research subjects, conducted with a random sample technique, were 45 people consisting of teachers and principals in 8 elementary schools in Kasihan Bantul, Indonesia. A questionnaire design was conducted to collect the data to measure the system implementation effectiveness. The data analysis was completed by analyzing the system effectiveness. The results present a fact that the decision support system can provide a more objective and consistent assessment of student character. The teachers and principals found that the system provides valuable insights in monitoring the character development of the students and identifying indicators that need more attention. Challenges in implementing the system include a lack of knowledge of the decision support systems and assistance for teacher training implementation. This research contributes to provide insights to enhance the character assessment of elementary school students. The research implication is that the system implementation should be supported by adequate teacher education and support to assure its effectiveness. It is concluded that the decision support system is an important system applied to improve student character education in elementary schools, and teachers' understanding and support are crucial to the successful implementation of this system.**

***Keywords*—decision support system, character assessment, objective, elementary school, random sample**

I. Introduction

Character education portrays a critical role in developing morals and positive values of elementary school students [1, 2]. Elementary schools are considered as the students' initial foundation to understand the principles of ethics, honesty, empathy, cooperation, and other positive characters shaping them into responsible individuals and ethical members of society [3]. Elementary schools have an autonomous morality [4] which can be seen from children's judgement that something is good depending on its purpose. Thus, character education is critical at this age to help children internalize good values [5]. Presidential Regulation No. 87/2017 on Character Strengthening Education to streamline the role of schools in character building was issued by the government [6] aiming to enhance student character by combining ethics, aesthetics, literacy, and kinesthetics with collaboration among schools, families, and communities [7].

Character Strengthening Education Program [8] is based on the philosophy of Ki Hajar Dewantara, while the development is spirituality; academic ability; moral integrity, art, and culture; and also, sports is meant to be healthy and able to actively participate as citizens. It is implemented by implementing Pancasila values to character education [9]. Religious values, honesty, tolerance, discipline, hard work, creativity, independence, democracy, curiosity, nationalism, spirit, love for the country, achievement respect, communication, peace-loving, fondness for reading, environmental care, social care, and responsibility are considered as Pancasila values [10, 11]. The eighteen values are simplified into five main character values covering religion, nationalism, independence, integrity, and mutual cooperation at the Education Assessment Center.

In this modern era, there has been an increase of efforts to improve the character education effectiveness at the elementary school level. One approach that is starting to develop is the application of decision support systems [12, 13] in assessing student character. This system [14, 15], has the potential to assist educators and schools in understanding and measuring student character more objectively and systematically. Some research that have been done including research [16] about a system to determine exemplary students, research [17] about a system for determining eligibility for promotion, research [18] about a problematic student prediction and research [19] about a student character assessment system using five aspects. The four studies have different methods and aspects of assessment. The implementation is carried out at one school, but there has been no research that analyses the objectivity of teachers when inputting the value of the aspects used as the basis for assessment.

There are many methods in decision support systems [20] including simple additive weighting, analytic hierarchy process, fuzzy logic, TOPSIS, and weight product, each of which has differences in the calculations described in Table 1.

The research purpose is to analyze the decision support system of student character assessment in elementary schools to improve the assessment objectivity conducted by teachers. This system [21, 22] has applied the simple additive weighting method as the character assessment

calculation basis, because this method [23] is simpler and able to find the best decision from a number of alternatives with certain criteria that match the problem, namely student character assessment to improve teacher objectivity. The analysis conducted includes an evaluation of the effectiveness of these systems [24, 25] in providing meaningful character assessment, as well as how these systems [26] can contribute to improve student character education in the elementary school curriculum. The question of how student character is measured and improved is an ever-relevant issue, hence this study is expected to provide deeper insights into the role of character assessment systems, especially with simple methods [27] to support the character education at the elementary school level. The study implications are expected to make beneficial contributions to a more effective character education development system in the future.

Table 1. Decision support system method

No.	Method	Calculation
1	Simple Additive Weighting	A method done to select the best choice from a set of alternatives based on a certain criterion.
2	Analytic Hierarchy Process	An implemented method to find the best alternative of all with many criteria by comparing each pair of alternatives and criteria.
3	Fuzzy Logic	A method used to deal with uncertainty in problems that have many answers.
4	TOPSIS	Multicriteria decision-making based on the principle that the chosen option is the one to be the furthest from the negative ideal solution and the one that is most distant from positive ideal solution.
5	Weight Product	A technique to relate attribute ratings involving multiplication which the rating must first be multiplied by the weight of the attribute in question

II. METHODS

The quantitative method has been implemented with a before and after decision support system design to assess the student character assessment in elementary school. The research subjects were teachers and principals at eight elementary schools in Kasihan, Bantul, Yogyakarta. There were 45 people as the sample based on random sampling [28] techniques conducted in March 2023.

The decision support system [29, 30] was developed by applying a simple additive weighting method [31] because it is easier for teachers and principals to use this system. The simple additive weighting calculation uses the following calculation procedure:

1) Alternative determination (*Ai*);
2) Determining the criteria as reference material (C_j);
3) Giving a suitability rating value to each alternative and criteria;
4) Giving weight (*W*) to each criterion, $W = [W_1\ W_2\ W_3\ W_4]$;
5) Creating a decision matrix (*X*) from the match rating table (each alternative (A_i) and each criterion (C_j)) that has been determined, where $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$, in Eq. (1).

$$X = \begin{Bmatrix} C_{11} & C_{12} \ldots\ldots C_{1j} \\ C_{i1} & C_{i2} \ldots\ldots C_{ij} \end{Bmatrix} \quad (1)$$

where, *X*: matrix
C: Criteria

6) Doing normalization process by doing a calculation of the normalized performance rating value (r_{ij}) of alternative Ai on criteria C_j, with the following formula: If *j* is a benefit as in Eq. (2), then

$$R_{ij} = (X_{ij}\ (maxs\ \{X_{ij}\}) \quad (2)$$

R_{ij}: normalized matrix
X_{ij}: matrix
If *j* is a cost as in Eq. (3), then

$$R_{ij} = (min\{X_{ij}\}/X_{ij}) \quad (3)$$

R_{ij}: normalized matrix
X_{ij}: matrix
With: R_{ij} = normalized performance rating value
The results of the above calculations will form a normalized matrix (*R*)

7) Normalized matrix in Eq. (4).

$$R = \begin{Bmatrix} C_{11} & C_{12} \ldots\ldots C_{1j} \\ C_{i1} & C_{i2} \ldots\ldots C_{ij} \end{Bmatrix} \quad (4)$$

R: normalized matrix
C: Criteria

8) The preference result (*Vi*) was obtained from the sum of the multiplication of the rows of the normalized matrix (R) with the preference weights (*W*) according to the matrix column (*W*) in Eq. (5).

$$V_i = \sum nj = i\ W_j R_{ij} \quad (5)$$

V_i: ranking for each alternative
W_j: weight value of each criterion
R_{ij}: normalized performance rating value
If in ranking V_i the value is greater, then it will be selected as an alternative.

The data analyses used in the study include review of the system to media experts, material experts and teachers as users and product effectiveness analysis. It is determining the character education assessment decision support system effectiveness using inferential statistical quantitative analysis techniques which a prerequisite test is carried out before hypothesis testing.

1) Prerequisite tests are carried out to determine whether the research data are statistically parametric or non-parametric by means of both tests namely tests of normality and homogeneity.

A normality test is conducted to determine if a data distribution is normal. A homogeneity test is carried out to determine if the sample data obtained in the study has a homogeneous variance, carried out by means of the Test of Homogeneity of Variance.

Based on the test criterion, if the significance value shown is > 0.05, Ho is rejected. It can be infered that the data has a homogeneous variance.

2) Statistical tests are carried out after the prerequisite test. Then, the type of statistical test used to determine the difference can be determined. If the data has a normal

distribution and homogeneous variance, a parametric statistical test can be carried out. While, a non-parametric statistical test is carried out if the data is not normally distributed. Before conducting statistical testing, the hypothesis is formulated first:

Hypothesis 1:

H1o: There is no difference in character assessment using the Decision Support System.

H1a: There is a difference in character assessment using the Decision Support System.

Hypothesis 2:

H1o: There is no difference in increasing the objectivity of character assessment using a Decision Support System for teachers.

H1a: There is a difference in increasing the objectivity of character assessment using a Decision Support System for teachers

A. Research Design

The case diagram [24, 32] presents four actors, namely teachers, administrators, principals, and student parents who will use and have their respective access rights in the system. Five use-cases are presented, namely to sign-in, to input sub-criteria weights to view class character assessment reports, to input student, teacher, principal, and class data, and to view student character assessments. The further explanation of the use case diagram of the character assessment system presented in Fig. 1.

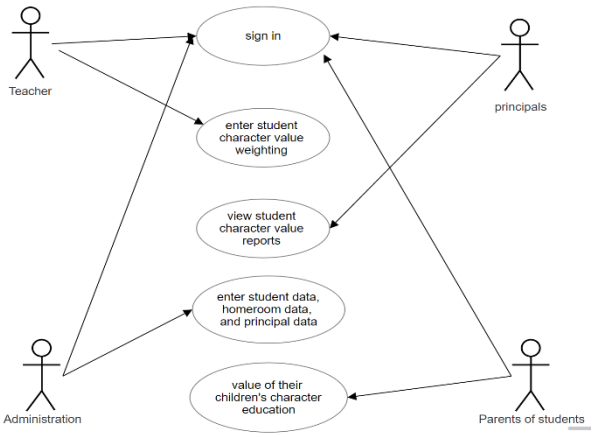

Fig. 1. Use-case diagram of character assessment system.

In Fig. 1, explain that the use-case diagram has four actors, namely admin, teachers, principals and parents of students who each have different access rights, admin has access rights to enter student data, homeroom data, and principal data, teachers have access rights to enter student character value weighting factors, principals have access rights to view student character value reports in each class, while parents of students can access their child's character education value.

B. Criteria

According to the findings of interviews between the research team and the school, as well as references from the Education Assessment Center, there are five assessment criteria to determine the character and elementary school students' attitude assessment of presented in Table 2.

The criterion attributes are beneficial. It can be inferred that when the value is higher, the outcomes is better. The five criteria in this study are independence, religion, nationality, integrity, and mutual cooperation in which each criterion includes a sub-criterion.

Table 2. Assessment criteria

No.	Criteria	Attribute	Information
1	Nationalism	Advantage	Thinking process, acting, and caring demonstrating devotion to care for, and high regard for the nation language, environments of physical, social, cultural, economic, and political that prioritizes the nation and state interests over one's own and the group's.
2	Religion	Advantage	Attitudes and actions that uphold their religion's principles, are accepting of other religions' practices, and coexist peacefully with those who practice them
3	Integrity	Advantage	Acting in a way that demonstrates his best attempts to establish his reliability in all of his words, deeds, and labor
4	Independent	advantage	Attitudes and actions that don't rely on others as much and put effort, thinking, and time into realizing goals and ideals
5	Mutual cooperation	advantage	attitudes that are representative of behaviours that cherish the cooperative spirit and collaborate to solve challenges

C. Weighting

By assigning a certain amount of weight to each of the numerous aspects involved in a process, weighting is a technique for making decisions. The process of allocating weights can be done either scientifically using statistical calculations or subjectively by doing so.

Table 3 shows that the sub-criteria include the weighting of behavioral indicators. The provisions that are deemed as priority weighting 5, less priority weighting 4, and the not a priority weighting 3.

Table 3. Weighting indicator

No.	Scale	Weighting
1	Priority	5
2	Less Priority	4
3	Not a Priority	3

The modified criteria as the behavior indicator with a preset value are assigned a value, which is the behavior indicator value.

The indicator values described in Table 4 present the value of cultivating (cultured) has a weight of 4, developing has a weight of 3, starting to develop has a weight of 2, and requiring assistance (needs guidance) has a weight of 1.

Table 4. Scores of behavioral indicators

No.	Scale	Weighting
1	Cultured	4
2	Developing	3
3	Starting to Develop	2
4	Needs Guidance	1

The behavioural indicators of the five criteria are described in Table 5, which includes: the first criterion of religion in number 1 and number 2, the second criterion of nationalism in number 3 and number 4, the third criterion

of integrity in number 5 and number 6, the fourth criterion of independence in number 7 and number 8, and the fifth criterion of mutual cooperation in number 9 and number 10.

Table 5. Behavioral indicators

No.	Behavioral Indicators	Weighting
1	Religious event participation done at school or another place.	5
2	Loving every God creation.	4
3	Attending school flag ceremony	5
4	Singing the national anthem	4
5	Always going alone	4
6	Doing own homework	5
7	Cleaning the classroom	5
8	Throwing garbage in the trash	3
9	Applying honesty in every activity	5
10	Always being disciplined at school/home	4

III. Results and Discussion

A. Results

Decision support system for character education assessment in elementary school students using simple additive weighting methods before being implemented in eight schools in the Kasihan Bantul Region, application and media testing are carried out, testing character education material by reviewers who are experts in the field of applications and media and material. The app and media reviewer for this developed application is Mr. Muhammad Fairuzabadi, M.Kom., who is a media, information systems, and software expert.

Table 6 explains that there are two aspects used to assess the system: appearance design, visual communication and software engineering with each indicator having good criteria.

Table 6. Results of system expert review

No.	Aspect	Indicator	Criteria
1	Display Design and Visual Communication Product Display	Product Display	Good
		Facilities to the User	Good
		Sound effects, text and images	Good
		Design, shape and layout	Good
		Interactivity and ease of understanding	Good
2	Software Engineering	Reliability	Good
		Manageability	Good
		Usability	Good
		Appropriateness of application selection	Good
		Compatibility	Good
		Programmed packaging	Good
		Completeness of documents in the programmed	Good
		Reusability	Good

The material expert review was conducted by Dr. Ari Wibowo, M.Pd., who is a material expert in the field of character education and civic education. Table 7 explains that there are five indicators used to review the education material character contained in the character of education assessment guidelines. The results of the review by the material experts are three indicators that have very suitable criteria, while the other two indicators have suitable criteria.

In order for the system to be built in accordance with the character education guidelines and in accordance with the user, it is necessary to have a review from the user (the teacher) to find out the interaction of humans and computers. The teacher who gave the review was one of the teachers who served at Brajan public elementary school, Mrs. Suti Harni, S.Pd.

Table 7. Results of material expert review

No.	Indicator	Criteria
1	The characters assessed in the developed system are appropriate for character strengthening assessment.	very suitable
2	The attitude/behavior indicators to be assessed in the developed system are theoretically appropriate for assessing the characters to be assessed.	very suitable
3	The attitudes/behavior to be assessed in the developed system support the overall system development objectives.	very suitable
4	The statements of attitudes/behavior to be assessed, are easy to understand and unambiguous.	Appropriate
5	The attitudes/behavior of the characters to be assessed are attitudes or behavior that can be encountered/observed during learning.	Appropriate

Table 8 explains that there are five indicators used to review material on character education contained in the system. Two of the five indicators have very good criteria, while the other three indicators have good criteria.

Table 8. Results Review of material and system usage

No.	Indicator	Criteria
1	The menu of the system for determining the character values of elementary school students according to the teachers' need in conducting character assessments.	Very Good
2	Appropriateness of button placement and usage	Good
3	Ease of system operation for teachers	Good
4	The time required when this system is running	Good
5	This system has a function for teachers in conducting character assessments	Very Good

The sample used was 45 people based on random sampling techniques carried out at 8 primary schools in Kasihan, Bantul, Indonesia. The demographics of respondents are described in Table 9 which the variables are age, latest education and position.

Table 9 explains that the 45 respondents consisted of 8 principals/head masters, 7 teachers of certain subjects and 30 homeroom teachers, where the last education was 43 undergraduates and 2 masters with an age range of 30 years to 60 years.

Table 9. Respondent demographics

No.	Category	Frequency
Age	20–35 years old	15
	36–50 years old	20
	51–65 years old	10
Education	Bachelor	43
	Master	2
	Doctorate	0
Position	Class Teacher	30
	School Principal/head master	8
	Teachers of specific subjects	7

Based on Kolmogorov-Smirnov and Shapiro-Wilk, a normality test is conducted to determine if the data utilized in this investigation is regularly distributed. The difference between the two is in the number of samples used. If the

sample is greater than 50, Kolmogorov-Smirnov is used. If the sample is smaller than 50, it is better to use Shapiro-Wilk, as shown in Table 10.

Table 10. Results of normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre-test	0.144	45	0.020	0.964	45	0.169
Post-test	0.162	45	0.004	0.961	45	0.139

a: Lilliefors Significance Correction

Table 10 explains that in Shapiro-Wilk, the significance value for the pre-test is 0.169 and the post-test significance value is 0.139. It states that the significance value is greater than 0.05 which means that the research is normally distributed. While, in Kolmogorov-Smirnov, the pre-test significance value is 0.020 and the post-test significance value is 0.004. It shows that the research is not normally distributed. In this study, because the sample (df) is 45, it is advisable to implement the Shapiro-Wilk normalization test. Meanwhile, the results of the pretest scores of 45 samples are described in Fig. 2.

In Fig. 2, it is explained that of the 45 samples used in the pretest, the lowest score was 45 with 1 respondent; the highest score was 60 with 10 respondents; and the average was 55.82 with a standard deviation of 6.365.

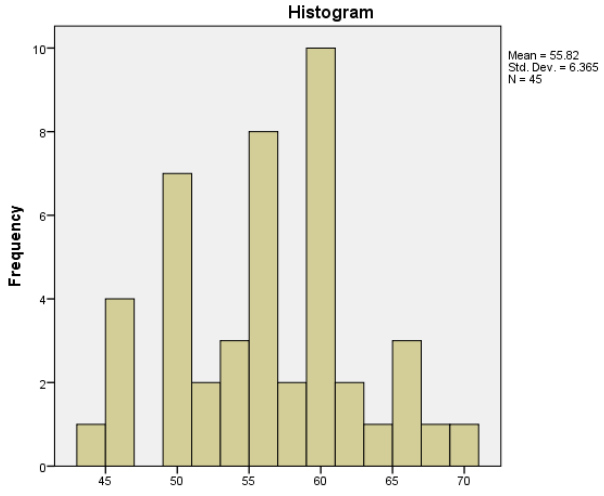

Fig. 2. Result pre-test.

In Fig. 3, it is explained that there are some values above and below the straight line but not too far from the straight line. It states that the pretest values are not too far apart.

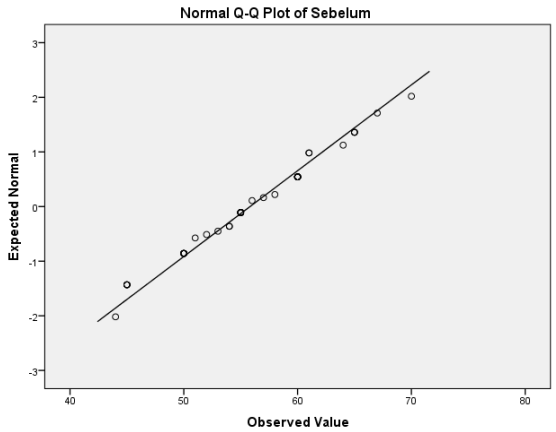

Fig. 3. Graphics normal Q-Q plot pre-test.

Fig. 4 explains the pre-test score distribution from a range of 40 to a range of 70, which has the same range between the bottom and the top. During the system implementation, another questionnaire was distributed to 45 respondents who were assigned to do the pretest, with the results shown in Fig. 5.

Fig. 5 explains that out of 45 respondents, 70 was the lowest post-test score, as many as 1 respondent. The highest post-test score was 95 (4 respondents). The average value was 85.6 with a standard deviation of 5.933.

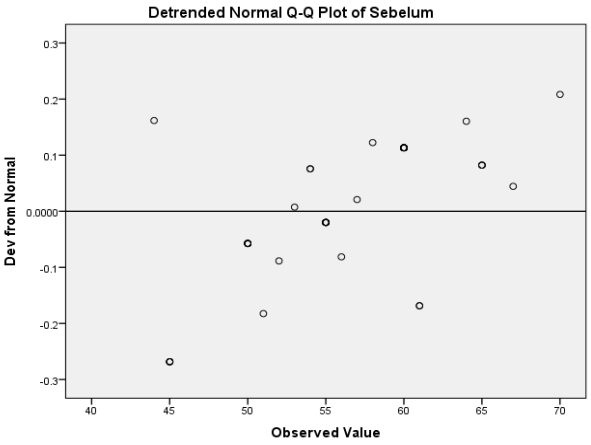

Fig. 4. Graphics detrended normal Q-Q plot pre-test.

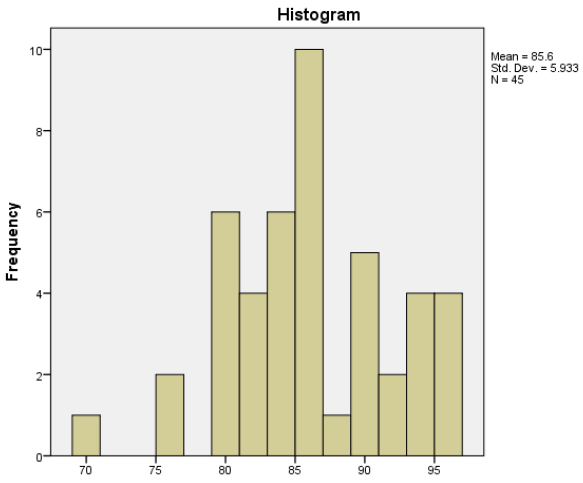

Fig. 5. Result post-test.

Fig. 6 explains that there are some values above and below the straight line but not too far from it. It means that the post-test values are not too far apart.

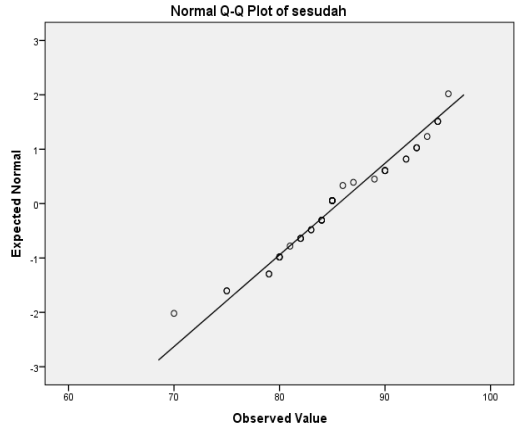

Fig. 6. Graphics normal Q-Q plot prot-test.

Fig. 7 explains the post-test score distribution from range 70 to 95, which has a different range between the bottom and the top. A homogeneity test is to find out if the variation of some data from the population has the same variance and to determine the next statistical test.

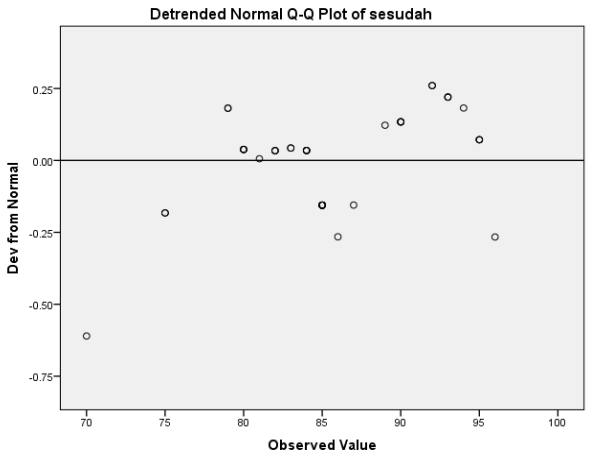

Fig. 7. Graphics detrended normal Q-Q plot post-test.

Table 11 presents the homogeneity test result. It is explained that the signification (sig) value is 0.487 which means that the sig value is greater than 0.05. It shows that the variants of two or more population data (the results of the pre-test and post-test) are the same (homogeneous).

The t-test was to find out the average difference from two samples or related samples (Table 12).

Table 11. Homogeneity test result

Levene Statistic	df1	df2	Sig.
0.487	1	88	0.487

Table 12. T-Test result

	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	55.82	45	6.365	0.949
Post-test	85.60	45	5.933	0.884

From the results, the pre-test mean score was 55.82 with a standard deviation of 6.365, according to the paired samples statistic data, whereas the post-test mean score was 85.60 with a standard deviation of 5.933.

Testing the link between the pre-test and post-test variables is the goal of the paired sample correlations table. Table 13 explain that the correlation value is 0.500 and the significance value is 0.000 based on the test findings. It is possible to conclude that there is a link between variables of the pre-test and post- because the significance value is less than 0.05.

Table 13. Paired samples correlation

	N	Correlation	Sig.
Pre-test and Post-test	45	0.500	0.000

Table 14 explains that the results of the paired sample t-test, obtained a calculated t value of –32.426; df value of 44; and a significance value (2-tailed) of 0.000. If the significance value (2-tailed) is smaller than 0.05, then H2o is rejected and H2a is accepted. That is, there is a difference in increasing the objectivity of character assessment by using a decision support system for teachers.

Table 14. Paired Samples Test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig.(2-tailed)
				Lower	Upper			
Pre-test–Post-test	–29.778	6.160	0.918	–31.629	–27.927	–32.426	44	0.000

B. Discussion

By assigning weights (W) to each criterion for each character, creating a decision matrix based on criteria (Ci), normalizing the matrix depending on the kind of attribute, and generating a normalized matrix (R), testing is done using normalization to demonstrate the system. A normalization table of religious criteria and calculation results is also shown to the choices that the two students entered during implementation, as seen in the accompanying picture. Table 15 displays the data on the religious criteria of two students as well as the normalization findings.

Table 15. Normalization matrix

Initial data		
Student Name	**Loving Fellow creature of God**	**Celebrating religious days at school/outside if school**
Jennie	**4**	**3**
Andi	2	3
Normalizon Matrix		
Student Name	**Loving Fellow creature of God**	**Celebrating religious days at school/outside if school**
Jennie	1	1
Andi	0.5	1

As shown in Table 15, the input results of the value of the behavioral indicators of the religious criteria:

The decision matrix is X, as in Eq. (1).

The decision matrix in Table 15 is $X=\begin{Bmatrix}4 & 3\\ 2 & 3\end{Bmatrix}$

Normalization process

The normalizing procedure is performed by computing the normalized performance rating the alternative value based on the criteria using the formula:

If the benefit attribute as infollowing equation, then

$$R_{ij} = (X_{ij}\,(\text{maxs}\ \{X_{ij}\})$$

In religion criteria, the normalisation matrix calculation uses the benefit attribute as follows:

$$R_{11}=\frac{4}{\max\{4,2\}}=\frac{4}{4}=1 \qquad R_{12}=\frac{3}{\max\{3,3\}}=\frac{3}{3}=1$$

$$R_{21}=\frac{2}{\max\{4,2\}}=\frac{2}{4}=0.5 \qquad R_{22}=\frac{3}{\max\{2,3\}}=\frac{3}{3}=1$$

Normalized matrix $R_{ij}=\begin{Bmatrix}1 & 1\\ 0.5 & 1\end{Bmatrix}$

After acquiring the normalization matrix, the next step is

to compute the religion indicator values. Table 16 shows the results of the accumulation of religious criterion values.

Table 16. Calculation of religious criteria

Student Name	Loving Fellow creature of God	Celebrating religious days at school/outside if school	Result
Jennie	**5**	**4**	**9**
Andi	2.5	4	6.5

In Table 16, the results of each student's religious criteria are automatically derived from the number of behavioral indicator values in the system, while the manual calculation is weight, as in Eq. (6).

$$\text{The sum of the weights}=C1+C2 \quad (6)$$

C: criteria

The weighting results are as follows for Student 1 and Student 2:

Student 1 = (4+1) + (3+1) = 9

Student 2 = (2+0.5) + (3+1) = 6.5

To calculate the total of all criteria, a comparable examination is performed using the indications on the criterion. The value of each criteria that has been inputted and normalized according to the behavioral indications for each criterion is shown in Table 17.

Table 17. Results report

No.	Character	Score
1	Religious	9
2	Nationalist	5.25
3	Self-sufficient	9
4	Mutual cooperation	8
5	Integrity	6.418

In Table 17 demonstrates that the results of all criteria (religious, nationalist, independent, mutual cooperation and integrity) are obtained by summing the values of each criterion behaviour indicators.

In Table 18, the following illustrates how student achievement is assessed using daily behavioral markers. These findings can be utilized as a reference and decision assistance for teachers when making action recommendation in class.

Table 18. Achievement category results

No.	Achivement Category	Explanation
1	Need Guidance	Student have not displayed the behavior stated in the behavior rubric.
2	Starting to Develop	Student display the behavior stated the behavior rubric are not consistent.
3	Develop	Student begin to consistenly display the behavior stated in the hebavior rubric.
4	Civilize	Student always consistenly display the behavior stated in the behavior rubric.

Table 18 presents the conclusion of each student achievement. This system explains the achievement category starting from guidance needs, starting to grow, growing and cultivation as well as an explanation of each category for student character development categories.

IV. Conclusion

The results mention that the decision support system can provide a more objective and consistent assessment of student character. Teachers and principals found that the system provides valuable insights in monitoring students' character development and identifying indicators that need more attention. Challenges in implementing the system include a lack of understanding of the use of decision support systems and support for teacher training. The contribution is that it provides insights in improving student character assessment in elementary schools. The implication of this research is that the implementation of the system should be accompanied by adequate teacher education and support to ensure its effectiveness. In conclusion, the decision support system for student character assessment in elementary schools using the simple additive weighting method is very important for teachers and principals as input for objective decision making on student character education in elementary schools. In the future, it is hoped that there will be further research that discusses character education assessment using different variables and methods, in order to get improvements.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Setia Wardani found the main topic, drafted the proposal, conducted the research and drew conclusions from the research findings. Rianto Rianto developed the decision support system to assess elementary student character. Arita Witanti verified the data, reviewed the manuscript. Selly Rahmawati analyzed data obtained from the field.

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