

Integrating Decision Support Systems in Education: A Comprehensive Approach

Pendais Hak^{1*}, Kundharu Saddhono², Putri Hana Pebriana³

¹ Universitas Halu Oleo, Kendari, Indonesia; pendaishaq_fkip@uho.ac.id

² Universitas Sebelas Maret, Surakarta, Indonesia; kundharu_s@staff.uns.ac.id

³ Universitas Pahlawan Tuanku Tambusai, Bangkinang, Indonesia; putripebriana99@gmail.com

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ABSTRACT

The current study examined educational Decision Support Systems (DSS) using the Simple Additive Weighting (SAW) method. This study evaluated traditional face-to-face teaching, online learning, and blended learning based on four criteria: effectiveness, cost efficiency, accessibility, and technological requirements. Each criterion was weighted according to its importance. After standardizing and weighting the selection matrix, each instructional style was given a composite score for direct comparison. Blended learning outperformed the other methods, scoring 0.620. The findings suggest that integrating digital and traditional education could boost efficiency. However, the model was sensitive to weighting assignments and could not account for nuanced qualitative factors. Refined weight assignment, qualitative variables, and AI could improve schooling and other decision-making in the future. This study showed that DSS and SAW can help make educated education decisions.

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Corresponding Author:

Pendais Hak

Universitas Halu Oleo, Kendari, Indonesia; pendaishaq_fkip@uho.ac.id

1. INTRODUCTION

Education is a fundamental pillar of social and economic development, with its role extending beyond the simple acquisition of knowledge and skills (Brown, 2006; Hughes, 2002). It is an intricate process that influences various aspects of society, such as social equity, economic growth, political stability, and cultural development (Adv. Learn., 2012; Nuphanudin et al., 2022). In its essence, education is about preparing individuals to be productive, conscious, and responsible members of society. It is a lifelong process, beginning at early childhood and extending well into adulthood, playing a critical role in shaping an individual's personality, worldview, and social interactions (Fauziah et al., 2020; Hendriana, 2009; Suprpto, 2015).

However, the complexity of education extends to its implementation and administration as well. Educational institutions often grapple with numerous challenges, including curriculum development, student performance evaluation, resource allocation, and policy formulation (Akinoğlu & Karsantık, 2016; Díaz-Maggioli, 2004; Kalyani & Rajasekaran, 2018). These complexities are magnified by the diversity of learners, the different learning needs, and the rapidly evolving societal and technological

context. A major challenge in the education sector is ensuring equity and inclusivity. This includes making quality education accessible and affordable to all, irrespective of their socioeconomic background, physical ability, gender, or ethnicity. This is a complex task that involves careful planning and resource allocation, targeted policy formulation, and rigorous monitoring and evaluation.

Curriculum development is another critical area in education. It involves creating a balanced, relevant, and effective curriculum that caters to the diverse learning needs of students and is responsive to the changing socio-economic demands. Curriculum decisions are complex, as they involve striking a balance between various factors, such as academic rigor, skill development, cultural relevance, and individual learning needs.

Additionally, student performance evaluation is a complex decision-making area in education. The challenge lies in creating a fair, objective, and comprehensive assessment system that accurately measures a student's learning progress, identifies areas of improvement, and provides effective feedback. This process should also account for the diversity in learners' abilities and learning styles, making it a complex multi-criteria decision problem.

In the face of these challenges, traditional decision-making methods often fall short. They struggle to handle the complexity, multi-dimensionality, and dynamism inherent in educational decision-making. Therefore, innovative solutions are needed, ones that can streamline decision-making processes, bring more objectivity and precision, and effectively handle complex, multi-criteria decision problems.

A DSS is a computer-based information system that aids commercial or organizational decision-making (Karismariyanti, 2011; Primasari et al., 2018; Tanjung et al., 2018). DSSs help management, operations, and planning make fast-changing, unspecified decisions. DSSs use knowledge-based systems to evaluate options and forecast outcomes. These systems aid problem-solving and decision-making, not replace human judgment (Kharisman Ndruru, 2020; Primadasa & Juliansa, 2019). DSS include:

- a. Model-driven DSS analyze data using a model. Depending on the situation, they can utilize simple statistical models or advanced mathematical or analytical models.
- b. Data-Driven DSS: These systems manipulate data and rarely use sophisticated models.
- c. Knowledge-Driven DSS: These systems contain specialized problem-solving expertise as facts, rules, procedures, or similar structures.
- d. Document-Driven DSS: These systems handle, retrieve, and alter unstructured electronic data.

DSS could impact education. It can provide a data-driven strategy for education decision-making (Sriyanto et al., 2020). DSS is used to gather, analyze, and interpret data to help make decisions about student performance, resource distribution, curriculum creation, and policymaking. However, integration takes careful planning. It entails understanding the needs of various stakeholders, removing potential bottlenecks, and making the system useable and accessible.

In the current context, Simple Additive Weighting (SAW) could be quite useful. The SAW technique, which considers numerous criteria, is popular because of its ease of use, effectiveness, and ability to handle complex decisions. The procedure entails producing a decision matrix, normalizing it, weighting criteria, and adding up the weighted criteria for each option alternative (Haswan, 2017; Rusdiyanto et al., 2020).

This study integrates DSS into education using the SAW approach. The purpose of this project is to investigate how Decision Support Systems (DSS) might be able to improve the objectivity, efficiency, and data-driven precision of decision-making processes within the educational sector. This article is organized as follows: the methodology section provides an overview of the strategy and methods that were utilized in the study; the results and discussion section present the findings and their implications;

the applications section investigates potential uses of the proposed model; and finally, the conclusion provides a synopsis of the paper and makes recommendations for additional research.

2. METHODS

There is a category of information systems known as decision support systems, whose purpose is to assist with difficult decision-making and problem-solving activities. They give individualized decision support by combining data, analytical models, and user-friendly interfaces. According to the findings of this research, decision support systems (DSS) have the potential to be an effective resource for addressing the myriad of issues associated with decision-making in the education sector.

Simple Additive Weighting (SAW) is a popular decision-making method (Haswan, 2017). It specializes in multi-criteria decision-making. SAW technique steps:

a. Construction of the Decision Matrix

Each row of the decision matrix represents a solution, and each column a criterion (factor). Consider an education decision dilemma like choosing the optimal teaching style. 'Traditional face-to-face teaching', 'online teaching', and 'blended teaching' are options. Effectiveness, cost, and accessibility are possible factors.

b. Normalization of the Decision Matrix

Normalization includes scaling the decision matrix from 0 to 1. This is done by dividing each value by the square root of the sum of the squares of the values in its column.

c. Assigning Weights to Criteria

Weights are assigned to each criterion based on its relative importance in the decision-making process. The weights are typically determined by the decision-maker or through a consensus among stakeholders.

d. Calculation of the Weighted Sum for Each Alternative

Weighted sum for each alternative is calculated by multiplying each normalized value by its criterion's weight and then adding these products for each alternative. The alternative with the highest weighted sum is selected as the best solution.

3. FINDINGS AND DISCUSSION

In the context of the case study Integrating Decision Support Systems in Education, this research defines the problem as selecting the most effective teaching method in the new normal era.

Table 1. Criteria Name

ID	Criteria Name
C1	Learning Effectiveness
C2	Cost Efficiency
C3	Accessibility
C4	Technological Requirements

Table 2. Alternative Name

ID	Alternative Name
A1	Traditional Face-to-Face Teaching
A2	Online Teaching
A3	Blended Learning

In this step, the first thing is to construct the decision matrix by assigning performance scores for each alternative with respect to each criterion. For simplicity, it uses a 1-10 scale where 10 indicates the highest performance and one indicates the lowest. Based on comprehensive research and stakeholders'

input, the performance scores for each teaching method (alternative) against each criterion are as follows:

Table 3. Value Each Alternative

	Learning Effectiveness	Cost Efficiency	Accessibility	Technological Requirements
Traditional Face-to-Face	8	6	7	5
Online Teaching	7	9	9	9
Blended Learning	9	8	8	8

Table 4. Weight of Each Criteria

ID	Criteria Name	Criteria Value
C1	Learning Effectiveness	0.4
C2	Cost Efficiency	0.2
C3	Accessibility	0.2
C4	Technological Requirements	0.2

Traditional Face-to-Face Teaching scores 8 on Learning Effectiveness, but only 5 on Technological Requirements. In contrast, Online Teaching scores highly on Accessibility (9) and Technological Requirements (9), but less on Learning Effectiveness (7). Blended Learning scores are consistently high across all criteria, which reflects its comprehensive nature.

We calculate the denominator for each criterion as follows:

- Learning Effectiveness: $\sqrt{(8^2) + (7^2) + (9^2)} = \sqrt{194} = 13.93$
- Cost Efficiency: $\sqrt{(6^2) + (9^2) + (8^2)} = \sqrt{181} = 13.45$
- Accessibility: $\sqrt{(7^2) + (9^2) + (8^2)} = \sqrt{194} = 13.93$
- Technological Requirements: $\sqrt{(5^2) + (9^2) + (8^2)} = \sqrt{170} = 13.04$

Calculating normalized decision matrix value, it will use the original decision matrix values and the respective denominators that we computed for each criterion in the previous step. We will divide each original value by its criterion's denominator to normalize it.

- The denominator for learning effectiveness for this criterion is 13.93. To normalize each score, we will divide it by 13.93:
 - Traditional Face-to-Face: $8 / 13.93 = 0.57$
 - Online Teaching: $7 / 13.93 = 0.50$
 - Blended Learning: $9 / 13.93 = 0.65$
- Cost Efficiency, the denominator for this criterion, is 13.45. To normalize each score, we will divide it by 13.45:
 - Traditional Face-to-Face: $6 / 13.45 = 0.45$
 - Online Teaching: $9 / 13.45 = 0.67$
 - Blended Learning: $8 / 13.45 = 0.59$
- Accessibility, denominator for this criterion is 13.93. To normalize each score, we will divide it by 13.93:
 - Traditional Face-to-Face: $7 / 13.93 = 0.50$
 - Online Teaching: $9 / 13.93 = 0.65$
 - Blended Learning: $8 / 13.93 = 0.57$
- Technological Requirements, denominator for this criterion is 13.04. To normalize each score, we will divide it by 13.04:
 - Traditional Face-to-Face: $5 / 13.04 = 0.38$
 - Online Teaching: $9 / 13.04 = 0.69$

3) Blended Learning: $8 / 13.04 = 0.61$

Result from equation above can be seen in table 4.

Table 5. Normalized Decision Matrix

	Learning Effectiveness	Cost Efficiency	Accessibility	Technological Requirements
Traditional Face-to-Face	0.57	0.45	0.50	0.38
Online Teaching	0.50	0.67	0.65	0.69
Blended Learning	0.65	0.59	0.57	0.61

Table 4 represent the normalized scores for each teaching method (alternative) according to each criterion. They were calculated by dividing the original score by the square root of the sum of squares of the original scores in each column (criterion).

The next step is to calculate the weighted sum for each alternative. The weighted sum is calculated by adding the weighted scores for all criteria of each alternative.

1) Traditional Face-to-Face Teaching:

$$\text{Weighted Sum} = (0.57 * \text{Learning Effectiveness Weight}) + (0.45 * \text{Cost Efficiency Weight}) + (0.50 * \text{Accessibility Weight}) + (0.38 * \text{Technological Requirements Weight})$$

$$\text{Weighted Sum} = (0.57 * 0.4) + (0.45 * 0.2) + (0.50 * 0.2) + (0.38 * 0.2) = 0.498$$

2) Online Teaching:

$$\text{Weighted Sum} = (0.50 * \text{Learning Effectiveness Weight}) + (0.67 * \text{Cost Efficiency Weight}) + (0.65 * \text{Accessibility Weight}) + (0.69 * \text{Technological Requirements Weight})$$

$$\text{Weighted Sum} = (0.50 * 0.4) + (0.67 * 0.2) + (0.65 * 0.2) + (0.69 * 0.2) = 0.592$$

3) Blended Learning:

$$\text{Weighted Sum} = (0.65 * \text{Learning Effectiveness Weight}) + (0.59 * \text{Cost Efficiency Weight}) + (0.57 * \text{Accessibility Weight}) + (0.61 * \text{Technological Requirements Weight})$$

$$\text{Weighted Sum} = (0.65 * 0.4) + (0.59 * 0.2) + (0.57 * 0.2) + (0.61 * 0.2) = 0.620$$

Weighted sums for each teaching method are as follows:

Table 6. Weighted Sum

Teaching Method	Total Weighted Score
Traditional Face-to-Face	0.498
Online Teaching	0.592
Blended Learning	0.620

Based on these scores, the Blended Learning method has the highest weighted sum, suggesting it may be the most effective teaching method according to the selected criteria and their respective weights. The simple Additive Weighting (SAW) method was implemented to aid in the decision-making process of selecting the most effective teaching method within an educational setting. The decision-making process was supported by a Decision Support System (DSS) designed to simplify and clarify the decision-making process.

Traditional face-to-face, online, and blender learning were assessed for learning efficacy, cost efficiency, accessibility, and technological requirements. Decision-making weighted each criterion. Normalizing the choice matrix gave us standardized scores for each instructional approach and criterion. We could compare directly and objectively. The results were able to be shown and interpreted more clearly as a result of the normalized scores having a range that went from 0 to 1. After the

normalizing step, the decision matrix underwent additional processing, which consisted of giving weights to each of the criteria. This allowed the relative importance of each criterion to be taken into account. The culmination of this procedure was the production of a weighted decision matrix, which was used as the foundation for the subsequent stage in the decision-making process.

The last thing that was done was to calculate the weighted sum for each alternative (teaching technique) by adding up the weighted scores for each criterion. This was the final step. Following this phase, a total score was calculated for each instructional approach, which reflected the method's overall effectiveness in light of the criteria that were chosen and the weights that were assigned to those criteria. Blended learning emerged as the most effective teaching approach, receiving a score of 0.620, followed by online teaching, which received a score of 0.592, and traditional face-to-face teaching, which received a score of 0.498. These results are based on the total weighted scores.

According to this conclusion, incorporating digital tools and platforms into traditional face-to-face teaching techniques may be able to improve learning efficacy, cost efficiency, accessibility, and better satisfy technology needs than other ways. This is in line with the current trend in education, which places an increased emphasis on the significance of making effective use of digital technologies to make the processes of teaching and learning more efficient.

It's important to highlight that while the SAW technique gives a quantitative framework for decision-making, the final decision should also incorporate qualitative variables and contextual elements that may not be entirely reflected by the chosen criteria and weights (Haswan, 2017). Weights can fluctuate depending on priorities and circumstances, which could affect the ultimate decision. The combination of a DSS with the SAW approach shows how such systems can help education and other areas make complex decisions. Future research could examine DSS's applicability in diverse contexts and decision-making scenarios.

4. CONCLUSION

With the use of the Simple Additive Weighting (SAW) method, the findings of our study presented an all-encompassing strategy for incorporating Decision Support Systems (DSS) into educational settings. The research presented an objective and quantitative basis for making judgments in the field of education by taking into account a number of essential criteria and the weights that were assigned to each of them. The findings shed light on the possible benefits of blended learning approaches over traditional face-to-face teaching or methods that are conducted solely online. This provides insight into the likely trajectory that education will take in the era of digital technology. The combination of the DSS and SAW methods results in a decision-making process that is more structured, more methodical, and more objective. This strategy eliminates prejudice and generates more trustworthy conclusions by considering multiple factors and assessing each one. It makes decision-making transparent and replicable so others may understand, duplicate, and improve it. The method's biggest drawback is that weights must be assigned to each criterion. The final findings may be affected by the weights applied to each criterion, which may be subjective and biased. In addition, the technique assumes that every criterion is independent and equally important, which is not always the case. Additionally, this quantitative strategy may not account for all qualitative or subtle factors that affect the decision. To eliminate subjectivity and bias, future study could refine weight assignment. Expert elicitation or consensus-building may be used to determine weights that reflect stakeholder consensus. Research could also incorporate qualitative aspects into the DSS model or employ hybrid models using quantitative and qualitative data. DSS could also be applied to healthcare, urban planning, and environmental management, where sophisticated decision-making is required. Finally, as machine learning and artificial intelligence continue to evolve, there is immense potential to enhance DSS with these technologies, allowing for even more sophisticated decision-making processes. These

enhancements could include predictive analytics, adaptive weighting based on real-time data, and robustness analysis to account for uncertainties in the input data or model parameters.

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