Research Article

Learning Style Analysis Based on Felder-Silverman Index Model Using Rule Base Algorithm

Muhammad Nurhakim[1,*], Suhaila Ismail[2], Nurhafizah Moziyana Mohd Yusop[3], and Siti Rohaidah Ahmad[4]

[1] National Defense University Malaysia; nurhakimazlan@gmail.com
[2] National Defense University Malaysia; suhaila@upnm.edu.my; ORCID ID: 0000-0003-4236-2758
[3] National Defense University Malaysia; moziyana@upnm.edu.my; ORCID ID: 0000-0003-0394-7710
[4] National Defense University Malaysia; sitirohaidah@upnm.edu.my; ORCID ID: 0000-0001-5045-9803
[*] Correspondence: nurhakimazlan@gmail.com; 016-5171210.

Abstract: *Understanding everyone's unique learning style is key to achieving lasting academic success. The importance of this understanding becomes increasingly important, especially when students are not aware of effective learning strategies, which can inadvertently become an obstacle to their progress. To overcome this concern, the Learning Style Analysis System (SAGP) was developed to identify and provide recommendations based on individual learning styles. The main users of this system are students enrolled and the academic advisors in the faculty of defense science and technology. They were required to fill out a questionnaire on their learning style. This system can determine the student's learning style and provide recommendations tailored to their needs. This process benefits students and strengthens the relationship between educators and students, ensuring a more individual or personal approach to learning. The system is developed using the PHP and CSS programming languages, with XAMPP and MySQL serving as the database that stores the necessary information. The Rule Base algorithm is used to classify students based on their learning style characteristics. The Agile approach is used as a development methodology, emphasizing adaptability and continuous delivery. Felder-Silverman Index learning method will be used as a learning style method in this system. The method will contain 44 questions based on four different domains of learning styles. Overall, the Learning Style Analysis System implementation is expected to positively contribute to the quality of teaching and learning at the university by aligning teaching approaches to individual learning styles. This will hopefully result in improved academic performance and increased student engagement in the learning process. Initially, a survey was conducted to assess the need for such a system to be in place. The survey had the majority saying that there is a need for such a system in UPNM.*

Keywords: Learning Style; Felder-Silverman Index; Rule Base.

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1. INTRODUCTION

For the world of education, teaching and learning that involves aspects of understanding about individual learning styles play a vital role in improving academic performance and student motivation. Learning style is an individual's way of learning to receive and process information received (Baharom & Ilyas, 2003). Without awareness of one's learning style, ineffective learning strategies may be used by students and result in less-than-optimal performance. A data analysis system about learning styles at the Universiti Pertahanan Nasional Malaysia (UPNM) is proposed to overcome the problem of less-

than-optimal performance by developing a learning style system. This system gives students, academic advisors, and administration access to vital information to enhance the learning experience. This system will be used by all UPNM Faculty of Defence Science and Technology (FSTP) students. Students will use this system to fill out a questionnaire about learning styles. The results of the analysis will provide guidance to students to improve learning based on the learning style analysed. Academic advisors can understand the individual learning style of students, as well as act by providing relevant support and guidance to help the learning and teaching process. The UPNM administration which is the Centre for Teaching and Learning (PPP) will have access to a comprehensive learning style analysis report.

The system will be developed using the Hypertext Preprocessor (PHP) and Cascading Style Sheets (CSS) programming languages, with XAMPP and MySQL used as databases. Data analysis involving the Rule Based Algorithm method and the Felder-Silverman Index Model was used to identify variations in learning styles among students. Through this system, it is hoped that the learning experience at UPNM will be conducive and comprehensive. Students will receive guidance that suits their learning style. This information will help academic advisors provide more effective support to students. The administration can also have quality data about students to improve the quality of teaching and learning at UPNM. The result of the development of this project will bring good and better benefits for UPNM students.

2. METHOD & MATERIAL

The learning material and methodology employed revolve around the Felder-Silverman Index, encompassing 11 questions per domain across four distinct domains, as detailed in the forthcoming table (Felder & Silverman, 1988). To assess the efficacy of this approach, a dataset comprising 53 responses exclusively from the Science and Technology Department at UPNM was meticulously collected via Google Form. This dataset undergoes rigorous preprocessing to refine its quality, addressing issues such as noise, missing values, and duplicates. Subsequently, leveraging the capabilities of RapidMiner Software, the pre-processed data is trained using the Naive Bayes Algorithm. This strategic combination enables the derivation of a Rule-Based Algorithm tailored to the specific learning context, poised to enhance the system's classification capabilities for optimal learning outcomes. Table 1 shows the type of domain and their number of questions based on the Felder Silverman Index, totalling 44 questions in the questionnaire.

Table 1. Questions and Category of Felder Silverman Index

Type	No of Questions
Processing Domain (Active-Reflective)	1,5, 9, 13, 17, 21, 25, 29, 33, 37, 41
Perception Domain (Sensing-Intuitive)	2, 6, 10, 14, 18, 22, 26, 30, 34, 38,42
Input Domain (Visual-Verbal)	3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43
Understanding Domain (Sequential-Global)	4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44
Total Question	44

Table 2 shows the hardware and software used in building SAGP. For example, MySQL was used for managing databases, simplifying database usage, and maintaining the SAGP database (Smith et al., 2017).

Table 2. Hardware and Software Used in SAGP

Hardware/Software	Explanation
HTML	Markup language used to build the structure and pages of websites.
PHP	Server-side scripting language commonly used to develop dynamic web applications.
PHPMyAdmin	User interface for managing MySQL databases, simplifying database usage and maintenance.
MySQL	Database management system used for storing and managing data.
JavaScript	Programming language used to provide interactivity on web pages.
Bootstrap	Utilized to expedite the development of responsive websites.
CSS	Used for styling and formatting web pages.
Sublime Text	Text editor that facilitates programming with various programming languages.
RapidMiner	Data analysis software providing tools for data processing, visualization, and modeling.
XAMPP	Hardware package providing a local development environment for web pages based on Apache, MySQL, PHP, and Perl.
Draw.io	Drawing and diagram software for creating flowcharts and conceptual visualizations.
Microsoft Office 2022	Used for preparing documentation, reports, and related information.

For the development of the SAGP System, an agile methodology was chosen to initiate the development process (Sutherland et al., 2001). The agile methodology was selected because it is suitable and involves a process in which models for system design are developed collaboratively with system users until their needs are met. Figure 1 illustrates the SAGP System Agile Model.

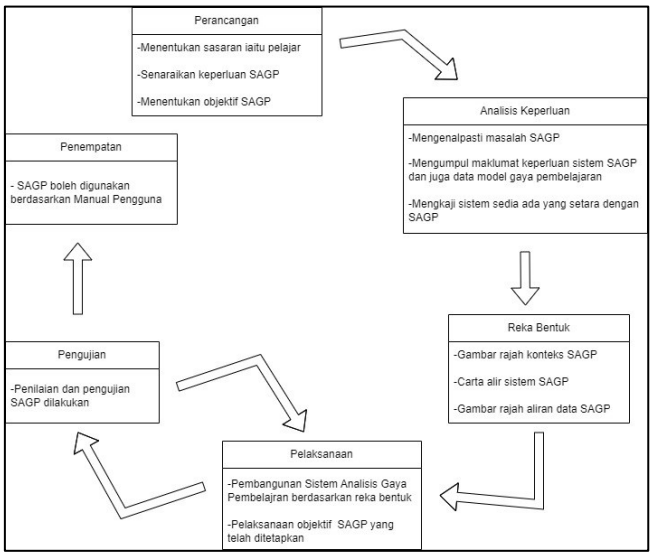

Figure 1. Agile Model of SAGP Systems

3. FINDINGS

Based on the findings, the Felder-Silverman Index learning method proves to be particularly well-suited for students within the Science and Technology Department, given its alignment with the learning domains commonly utilized in this field (Felder & Silverman, 1988). Moreover, the established website, SAGP, has been identified as a valuable resource in augmenting the learning trajectory of students at UPNM. The system's architecture is meticulously designed to accommodate the classification of learning methods based on the Felder-Silverman Index, thereby enhancing its utility and relevance for the targeted student demographic.

3.1 Naive Bayes

In this subtopic, the team delve deeper into the utilization of Naive Bayes and its pivotal role in constructing the system. Naive Bayes serves as a cornerstone in the development of the Rule-Based Algorithm (Rish, 2001). The initial phase involves data collection, where relevant datasets are gathered to fuel the algorithm's training process. Following this, meticulous pre-processing ensues to refine the data, eliminating noise, handling missing values, and addressing any duplicates. Once the data is refined, the Naive Bayes Operator within the RapidMiner Software is harnessed to construct the desired model. Through this process, Naive Bayes facilitates the creation of a robust framework for classification, enabling the system to make informed decisions based on probabilistic reasoning derived from the input data. Figure 2 shows the data modelling process in RapidMiner by using Naive Bayes to analyses student learning preferences.

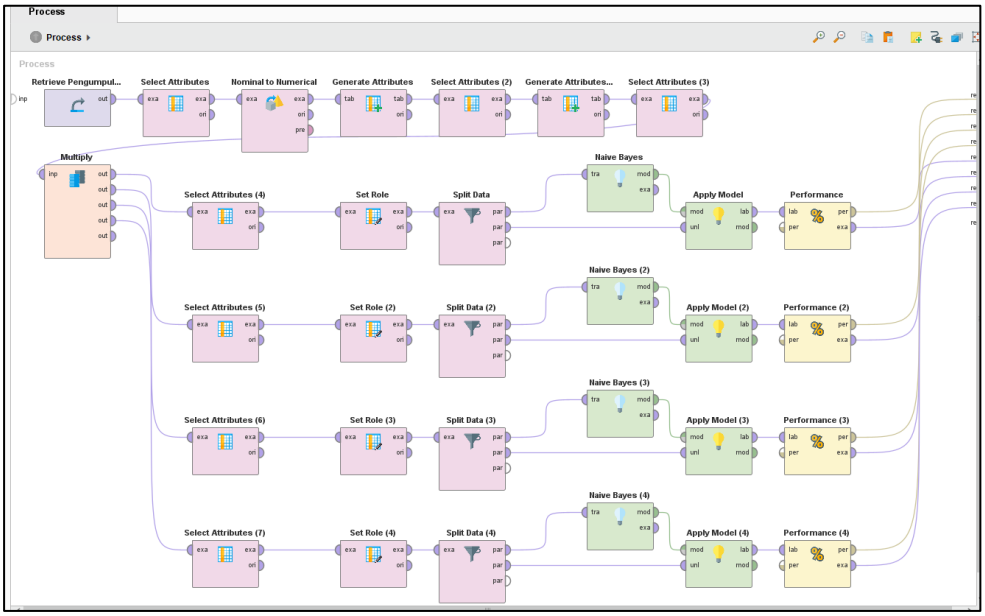

Figure 2. Data Modelling Process.

In Figure 3, the dataset in RapidMiner is depicted before the prediction process using the data modelling process. This dataset serves as the input for the Naive Bayes algorithm to train the model. In contrast, Figure 4 illustrates the dataset after prediction, with the addition of a prediction column. By comparing the prediction column before and after, the effectiveness of the Naive Bayes algorithm in classifying student learning preferences becomes evident.

Row No.	Perception ...	Sensing	Intuitive
8	Sensing	7	4
9	Sensing	7	4
10	Intuitive	5	6
11	Sensing	9	2
12	Sensing	7	4
13	Sensing	9	2
14	Intuitive	2	9
15	Intuitive	5	6

Figure 3. Set of Data Before Prediction

Row No.	Perception ...	prediction(P...	confidence(...	confidence(I...	Sensing	Intuitive
1	Sensing	Sensing	0.999	0.001	7	4
2	Sensing	Sensing	1.000	0.000	10	1
3	Sensing	Sensing	0.854	0.146	6	5
4	Sensing	Sensing	0.999	0.001	7	4
5	Sensing	Sensing	1.000	0.000	8	3
6	Intuitive	Intuitive	0.033	0.967	5	6
7	Sensing	Sensing	1.000	0.000	8	3
8	Intuitive	Intuitive	0.033	0.967	5	6
9	Intuitive	Intuitive	0.000	1.000	4	7

Figure 4. Set of Data After Prediction

3.2 Rule Based

Rule-Based Algorithm that is derived from the full data modelling process, which includes tasks like data gathering, analysis, and interpretation. This algorithm is a key part of the system architecture, having been carefully designed by considering the underlying data structures and patterns (Smith et al., 2017). It is carefully crafted to navigate through the intricacies of the dataset, ensuring strong categorization and classification of various learning approaches. It leverages insights gained from the modelling process. This method grants the system the ability to make intelligent judgments by adhering to predetermined rules and criteria established during the modelling phase, resulting in efficient and effective learning outcomes.

3.2 SAGP System

The SAGP (Learning Style Analysis System) has been successfully implemented at Universiti Pertahanan Nasional Malaysia (UPNM), earning recognition with a silver award at the International Conference on Innovation and Industrial Creativity (ICIIC). This system offers personalized recommendations based on individual learning styles, benefiting students, academic advisors, and

administrators. Students gain insights into their learning preferences, empowering them to improve academic performance, while advisors can provide tailored support, strengthening student-advisor relationships. Administrators utilize comprehensive reports to enhance teaching and learning quality. With its user-friendly interface and innovative methodologies, SAGP contributes to UPNM's commitment to excellence in education. These systems also will be show more in the I3DC video submission and the screenshot of the log in page of the system can be seen on discussion part.

4. DISCUSSION

The Learning Style Analysis System (SAGP) developed for the Universiti Pertahanan Nasional Malaysia (UPNM) offers a significant contribution to enhancing the teaching and learning experience within the institution. By focusing on individual learning styles, the system aims to address the potential obstacles students face when they are unaware of effective learning strategies (Felder & Silverman, 1988). The emphasis on understanding and accommodating various learning styles not only improves academic performance but also fosters stronger relationships between educators and students. This personalized approach to learning is essential in catering to the diverse needs of students, leading to improved engagement and academic outcomes.

The methodology employed in the development of SAGP demonstrates a comprehensive approach to analysing learning styles. By utilizing the Felder-Silverman Index and its associated domains, the system provides a structured framework for understanding and categorizing individual learning preferences. The incorporation of 44 questions across four distinct domains ensures a thorough assessment of each student's learning style, enabling personalized recommendations and guidance. Moreover, the integration of the Rule-Based Algorithm further enhances the system's capability to classify and categorize students based on their learning styles. By leveraging data collected through surveys and questionnaires, the algorithm facilitates informed decision-making, guiding both students and academic advisors towards tailored learning approaches.

The use of Naive Bayes in the system's development highlights the importance of data-driven decision-making. Through rigorous data collection, preprocessing, and modelling, the system ensures the reliability and accuracy of its recommendations. The Agile approach adopted in the development process emphasizes adaptability and continuous improvement, allowing for iterative enhancements to better meet the evolving needs of students and educators.

Overall, the implementation of the Learning Style Analysis System at UPNM holds promise for significantly improving the quality of teaching and learning. By providing personalized recommendations and guidance tailored to individual learning styles, the system fosters a conducive learning environment that promotes student engagement and academic success. Additionally, the availability of comprehensive data analysis reports empowers academic advisors and administrators to make informed decisions, further enhancing the overall educational experience at the institution.

This SAGP system will be utilized by students to assess their learning styles, academic advisors to understand the learning styles of students under their care to provide tailored assistance in learning, and administrators to manage and maintain the SAGP system efficiently. Additionally, the system will offer interactive features such as progress tracking, goal setting, and resource recommendations to further support student learning. Academic advisors will have access to comprehensive dashboards displaying student profiles, progress reports, and intervention suggestions to better guide their advisees. Furthermore, administrators will be able to oversee system usage, generate usage reports, and implement system updates to ensure optimal functionality. Figure 5 displays the logo of SAGP,

providing users with visual identification and branding within the system interface, fostering familiarity and engagement.

Figure 5. SAGP Logo.

Figure 6 shows the Log-in page for SAGP system. In this page user will log in using their name and password. Users will be given access to different interface options depending on their type of user.

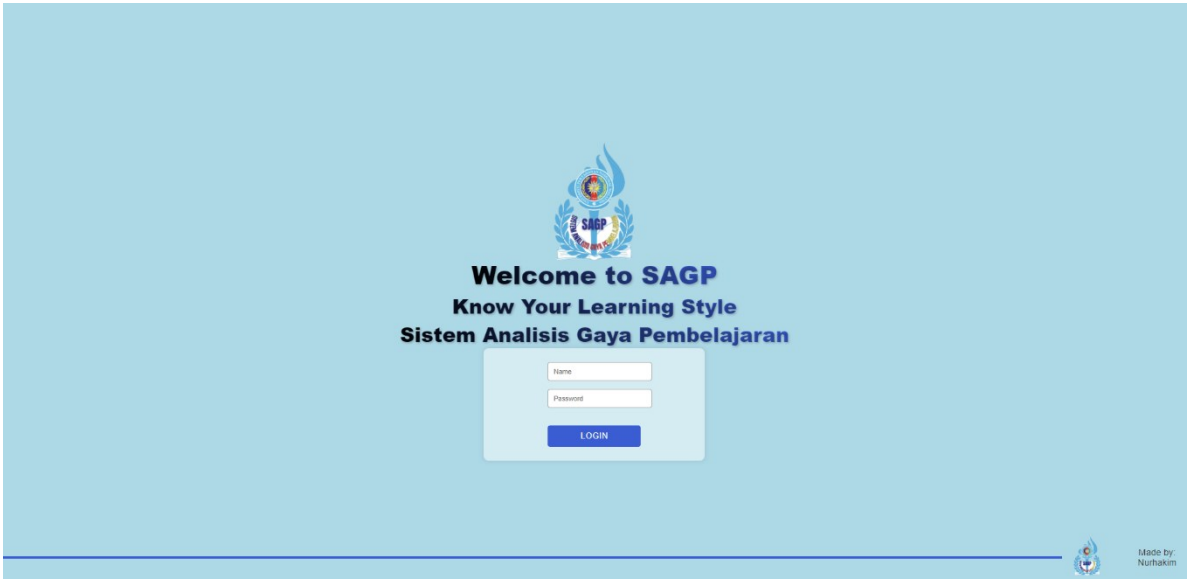

Figure 6. SAGP Log-in Page

5. CONCLUSION

The Learning Style Analysis System (SAGP) will provide numerous benefits to its users as it is developed to enhance teaching and learning at UPNM. Among its advantages, SAGP aids students and academic advisors in understanding individual learning styles, facilitating the adjustment of learning strategies to improve comprehension and academic performance (Smith et al., 2017). It also supports academic advisors in providing more relevant support, strengthening the relationship between students and academic advisors in the learning process. Additionally, SAGP enhances student awareness of their learning styles, providing them with opportunities to optimize their learning strategies. The use of Agile methodology in SAGP development ensures smooth system implementation and rapid adaptation to changing needs (Jones & Kim, 2009).The UPNM Teaching and Learning Centre (PPP) can access comprehensive learning style analysis reports to enhance the quality of teaching and learning at the university.

Moreover, SAGP offers a user-friendly interface that allows students to easily access their learning style analysis and personalized recommendations, empowering them to take ownership of their learning journey. Furthermore, the system's ability to generate detailed reports enables academic advisors to track student progress over time and tailor their support, accordingly, fostering continuous improvement in student learning outcomes. Overall, SAGP aims to improve the quality of teaching and learning at UPNM through a deep understanding of individual learning styles. In conclusion, the Learning Style Analysis System (SAGP) developed for UPNM offers a tailored approach to education by focusing on individual learning styles. Through the integration of the Felder-Silverman Index and a Rule-Based Algorithm, SAGP provides personalized recommendations and guidance to students, enhancing their academic performance and engagement. By fostering stronger relationships between educators and students and promoting a more personalized learning experience, SAGP contributes to the overall quality of teaching and learning at UPNM.

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