Student Modelling and Classification Rules Learning for Educational Resource

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Abstract. Learning management systems are commonly used to present learning content to students assuming that each student has the same characteristics in terms of expectations, culture, background, and learning style. But in reality, each student has different characteristics. This is supported by a learning concept that focuses on conveying general learning content without considering individual differences. This study aims to solve this problem by presenting student modeling specifically for e-learning/distance learning applications. In this study, a learning style modeling using the Felder-Silverman learning style model was conducted and it aimed at students' interaction with e-learning. The research results show that the method applied in the research is efficient, with an accuracy value of 96.35%.

Keywords: student modeling, e-learning, rule-based system

1 Introduction

Learning management systems (e-learning/distance learning) are generally used to present learning material to students, with the assumption that each student has the same characteristics in terms of expectations, culture, background, and way of learning [1]. But in reality, each student has different characteristics that are unique to each other. This is supported by a learning concept that focuses on providing general learning without considering differences between individuals. This condition is an important gap to be resolved, based on research [1] this problem is still a research challenge in the world of education, and research conducted by [2] found the same challenges. So research is needed that focuses on presenting material adaptively.

One of the empirical-based examples was a study conducted by [3] at Chemical and Biomolecular Engineering (CBE) at The Ohio State University (OSU). In the study, students must take the first two semesters and fulfill various requirements to enter. All students who register have a good foundation in chemical engineering. For example, the first course taken in

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the major is CBE 2200, Process Fundamentals (also known as materials or mass/energy balances). This course, like any introductory-level engineering course, expands upon knowledge from general education requirements (physics, chemistry, calculus) to provide the foundation for becoming a chemical engineer. More than 50% of students fail and many of these students retake the course. Still, according to research conducted by [3], this occurs because the implementation of learning is not in accordance with the student's learning style.

Research conducted by [3] shows that there is a relationship between Learning Style, Preferences, Self-Efficacy, and Student Performance. Self-efficacy refers to individual belief in ability (with respect to a concept, task, etc.). Self-efficacy is influenced by four factors: mastery experiences, vicarious experiences, verbal/social persuasions, and physiological states. Self-efficacy is one of the impacts of meta-knowledge [8], even though according to [3] Self-efficacy has a strong correlation with Student Performance. So this research aims to carry out meta-knowledge and learning style modeling as well as to produce better student modeling, especially for Web-Based LMSRe Research conducted by [1] tried to take a new approach to LMS with learning styles, research by [2] tried to take a new approach to LMS with learning styles, research by [5] developed an adaptive application of learning styles for learning strategies and electronic learning. This research focuses on developing adaptive applications for learning using the Felder Dimension approach. Research related to learning styles was also found in [6] which put forward learning tactics for web-based LMS, research in [7] used a product line and learning style approach to personalize learning objects. The research carried out still focuses on introducing learning styles alone and does not include other components such as meta-knowledge [8] using a product line and learning style approach to personalize learning objects. The research carried out still focuses on introducing learning styles alone and does not include other components such as meta-knowledge

This research aims to answer this problem, by presenting student modeling specifically for the use of E-Learning/distance learning using a rule-based method. The application of rule-based methods in e-learning at the Jember State Polytechnic represents a significant novelty in the field of education. By incorporating these methods into the institution's e-learning platform, the potential for improved student engagement, personalized learning experiences, and more efficient knowledge dissemination is substantial. This research holds promise for revolutionizing the way in which education is delivered and received, particularly in the context of a polytechnic institution. The potential impact of this innovation extends beyond the Politeknik Negeri Jember, as it has the potential to serve as a model for other educational institutions seeking to enhance their e-learning capabilities. By exploring the application of rule-based methods in this context, the research not only contributes to the advancement of e-learning practices, but also to the broader field of educational technology. The implications of this research are far-reaching and have the potential to significantly influence the future of e-learning in educational institutions worldwide. More detail about the implementation problems faced by research in the form of the difficulty of identifying students' Learning Style (LS) when interacting with E-Learning, similar things are relatively easier to model with direct interaction in the classroom [4], because LS is related to how students learn, process, interpreting and saving the results of the interpretation [4]. In this research, learning style modeling was carried out based on the Felder Silverman Learning Style Model which was aimed at student interaction with E-Learning. The research results show that the method applied in the research is efficient.

2 Method

The method of the research presented in Figure 1 outlines the systematic approach followed in this study. The initial phase involved a comprehensive review of existing literature to assess the current state of research and identify any gaps in knowledge. Subsequently, instruments were prepared for data collection, with a focus on modifying existing tools rather than developing new ones. The research utilized a questionnaire to gather user/student log data, which were obtained from interactions with the Elearning Web platform. The data from user logs were denoted as V1, V2, ..., Vn, while the results of the questionnaire were categorized under the "class" label. This structured methodology enabled a thorough analysis of the research objectives.

The data collected were processed using a rule-based method for system development. This involved a testing process using testing data, with the accuracy results of the testing serving as a reference for the feasibility of the method used. The process then moved on to the evaluation of the classification model, which produced student learning styles and meta-knowledge. The next stage involved validation from educational experts to ensure that the processing results of the application align with the scientific field. These stages were based on Figure 1 and were followed by implementation, which included installing the application on an online server. The process concluded with analyzing and discussing the results obtained after implementation, with the results of this analysis and discussion being used by the research to draw conclusions.

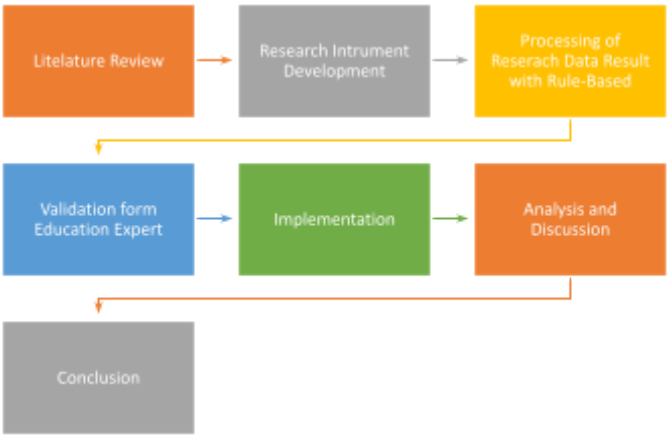
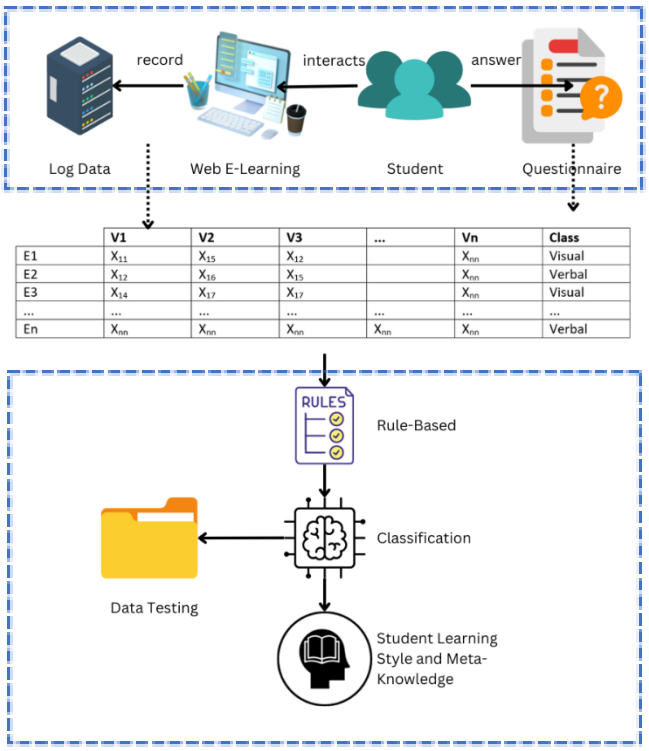


Fig. 1. Research Method

3 Results and Discussion

The system developed in the research is depicted in Figure 2. The records gathered comprise Log Data obtained from students' utilization of E-Learning, which were subsequently stored as variables, while the questionnaires completed by students were transformed into class data. The data collection served as the test data for the research. The data were obtained from 192

JTI students selected using a purposive random sampling. The results of the instrument test revealed an rtable value of 0.263 and an alpha value of 0.867, leading to the conclusion that the mentioned instrument is both valid and reliable.



	V1	V2	V3	...	Vn	Class
E1	X_{11}	X_{15}	X_{12}		X_{nn}	Visual
E2	X_{12}	X_{16}	X_{15}		X_{nn}	Verbal
E3	X_{14}	X_{17}	X_{17}		X_{nn}	Visual
...	...	...	...	...	...	...
En	X_{nn}	X_{nn}	X_{nn}	X_{nn}	X_{nn}	Verbal

Fig. 2. System Design

The collected and tested data were then processed using a rule-based system to produce conclusions. These conclusions were drawn using a classification of variables against classes, while this classification process actively involves experts in the field of education to draw quality conclusions about the correlation between variables and classes. In this classification process, testing data were of course accessed which is part of the data sharing described in the first paragraph. The use of verified data represented by testing data is an indication of accuracy in this research. The formation of research classes used the theories of learning styles proposed by Felder and Silverman [9].

The taxonomy is based on the four learning styles dimensions, LS4= {LS1, LS2, LS3, and LS4)}, each dimension on types of learning styles, LST= {(S, I),(Vi, Ve),(A, R),(Seq, G)} and on their different combinations. 24 types of combinations were utilized in this case: LSC24={(S, Vi, A, Seq), (S, Vi, A, G), (S, Vi, R, Seq), (S, Vi, R, G), (S, Ve, A, Seq), (S, Ve, A, G), (S, Ve, R, Seq), (S, Ve, R, G), (I, Vi, A, Seq), (I, Vi, A, G), (I, Vi, R, Seq), (I, Vi, R, G),

(I, Ve, A, Seq), (I, Ve, A, G), (I, Ve, R, Seq), (I, Ve, R, G)}[5], In its application, the research also refers to Bloom's cognitive levels shown in Table 1 and the adapted Felder-Silverman model of learning style shown in Figure 3.

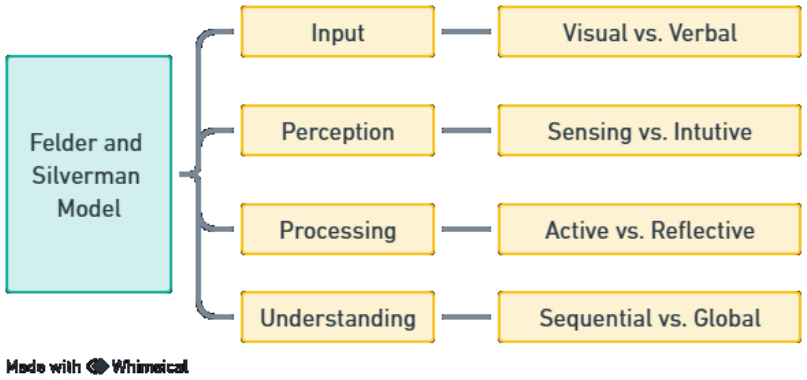


Fig. 3. The adapted learning style model (Felder-Silverman)

Table. 1. Bloom´s cognitive levels

Type of Question	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Brief Answer	√	√				
Completing	√	√				
Multiple Option	√	√	√	√		
Matching	√	√				
Alternative Answer			√	√		
Arranging	√					
Essay			√	√	√	√

Table. 2. Results Felder and Silverman LSQ [9]

Dimension	Learning Style	Number of Students
LS1 (Perception)	Sensitive	165
	Intuitive	153
LS2 (Input)	Visual	190
	Verbal	102
S3 (Processing)	Active	150
	Reflective	180

LS4	Sequential	176
(Understanding)	Global	143

The research results presented in Table 2 reveal an interesting trend at Politeknik Negeri Jember. It is evident that a significant majority of students fall into the LS2 category, indicating a strong preference for visual learning. This finding underscores the crucial role of learning tools in the educational process. Furthermore, it prompts an exploration of the interaction between students' learning styles and their usage of E-Learning platforms. By combining the LS class with the application usage log, we aim to gain deeper insights into how students' learning preferences intersect with their engagement with digital learning resources. This analysis has the potential to inform the development of more tailored and effective learning strategies at our institution.

The process of combining the data obtained from both sides to map the interaction variables with the resulting LS class is a critical step in the research. Once this data is amalgamated, it undergoes a thorough assessment by experts, as detailed in Table 3. The findings of the research highlight a total of 185 similarities between the system and the experts, indicating an impressive accuracy rate of 96.35%. In other words, the error rate is a mere 3.65%. These results underscore the reliability and effectiveness of the system in accurately capturing and interpreting the data, thus demonstrating its potential significance in the field. This high level of accuracy provides valuable insights into the robustness and precision of the system, opening up avenues for further exploration and application in relevant domains.

Table. 3. Overview of the dataset and expert

Student	Forum	Demo	Chart	…	Navigation	Course Overview	Class	Expert
001	0	0	5	…	1	0	LS2	LS2
002	1	1	4	…	5	0	LS1	LS1
003	3	4	0	…	3	1	LS2	LS2
…	…	…	…	…	…	…	…	
190	3	0	0	…	2	0	LS3	LS2
191	0	1	4	…	0	0	LS2	LS2
192	0	0	0	…	0	0	LS2	LS2

4 Conclusion

The present study focuses on learning style modeling using the Felder Silverman Learning Style Model, which aims to investigate student interaction with E-Learning. The research methodology employed in this study is highly efficient, as evidenced by the remarkable 185 similarities between the system and experts. This level of accuracy is interpreted as an impressive 96.35% accuracy rate, with only a 3.65% error rate. These findings are very promising and suggest that the results of this study can be effectively

leveraged to optimize the learning process at Politeknik Negeri Jember. The implications of this research are significant, as it has the potential to improve the overall effectiveness of E-Learning and enhance the educational experience for students. The results of this study are highly encouraging and provide a solid foundation for future research in this area.

References

[1] Alkhuraiji S, Cheetham B, Razek M A, and Bamasak O.: A flexible approach for providing adaptivity in learning management system based on learning styles *Int. Conf. Intell. Syst. Des. Appl. ISDA* 718–22, 2012

[2] Wu C H 2019 A Concept Framework of Using Education Game with Artificial Neural Network Techniques to Identify Learning Styles *Proc. - Int. Conf. Mach. Learn. Cybern.* 1–6, **2019-July**

[3] Miskioglu E E and Wood D W.: That's not my style: Understanding the correlation of learning style preferences, self-efficacy, and student performance in an introductory chemical engineering course *Proc. - Front. Educ. Conf. FIE* 2015

[4] Ikawati Y, Al Rasyid M U H, and Winarno I,: Student Behavior Analysis to Detect Learning Styles in Moodle Learning Management System *IES 2020 - Int. Electron. Symp. Role Auton. Intell. Syst. Hum. Life Comf.* 501–6, 2020

[5] Franzoni A L, Assar S, Defude B and Rojas J.: Student learning styles adaptation method based on teaching strategies and electronic media *Proc. - 8th IEEE Int. Conf. Adv. Learn. Technol. ICALT 2008* 778–82, 2008

[6] Ali Khan F, Graf S, Weippl E R and Tjoa A M.: Implementation of affective states and learning styles tactics in web-based learning management systems *Proc. - 10th IEEE Int. Conf. Adv. Learn. Technol. ICALT 2010* 734–5, 2010

[7] Labib A E, Canos J H and Penades M. C.: Integrating Product Line and Learning Style Approaches to Enforce Reusability and Personalization of Learning Objects *Proc. - IEEE 17th Int. Conf. Adv. Learn. Technol. ICALT 2017* 70–1, 2017

[8] Agustianto K, Permanasari A E, Kusumawardani S S and Hidayah I.: Design adaptive learning system using metacognitive strategy path for learning in the classroom and intelligent tutoring systems *AIP Conference Proceedings* vol 1755, 2016

[9] Felder R M and Soloman B. A. Index of Learning Styles Questionnaire *North Carolina State Univ.*