

# Fuzzy Logic based Learning Style Selection Integrated Smart Learning Management System

SPM Arachchi<sup>1</sup>, DU Vidanagama<sup>1</sup> and WMKS Ilmini<sup>1</sup>

<sup>1</sup>General Sir John Kotelawala Defense University, Faculty of Computing, Ratmalana, Sri Lanka

#36-it-0015@kdu.ac.lk

**Abstract:** *Be cognizant of things that individuals learn, promotes individual learning and motivation. Acquiring the skills and concepts based on understanding things that teachers teach inside the classroom become important. Gender, age, mindfulness, ability, interest, anterior knowledge, learning style, motivation, locus of control, self potency, and phenomenological beliefs differentiates one learner from another. The contribution of this research is to enhance the proficiency of the instructors in preparing the learning materials by considering the learning style of each learner which displayed on students' profile view of the LMS. Referring to previously written research papers, resulted in figuring out that most of the methodologies that are used to detect learning styles are based on advanced pattern recognition techniques which are based on huge datasets. This study results that the use of this inventing feature called fuzzy logic, can reduce the complexity of learning style selection. Rather than using complex algorithms to detect learning styles it works similarly to human reasoning, any user can easily understand the structure of Fuzzy Logic, it does not need a large memory, algorithms can be easily described with fewer data, and easily provides effective solutions to problems that have high complexity and uncertainty while be easily modify the rules in the FLS system. Trials of the learning style selection feature will be tested as the evaluation process. This refers to the process of analyzing the survey results from students. A group of students who knows their learning style via a psychological session will be selected out of a University and each student will be evaluated by a test regarding their learning style as similar to LMS. Results will be compared and find the probability of the truth of the learning style selection feature.*

**Keywords:** *FLS system, MATLAB, Visual and Text Based Learners*

## 1. Introduction

Learning Management Systems (LMS), Learning Content Management System (LCMS), Learning Design System (LDS) and Learning Support Systems (LSS) are the major four types E-Learning systems. Learning management systems can be used as both virtual learning environment as well as course management system. LMSs provide set of tools and frameworks which allows to create online course contents, attractive teaching, and various interactions with students. Typical LMS provide instructor/

moderator to assess students, monitor students, setting and delivering course contents, and interactive features such as video conferencing, discussion forums, and threaded discussions[21].

Assessment engines, surveys engines, file repositories, certifications, features to improve gamification, calendars, discussion forums, video conference support, automatic email notifications, skill gaps identification and testing, multi-tenancy, integrate with third-party applications, operability, and multilingual are the most common features that use in modern Learning Management Systems [22].

Digital learning platforms affected students' cognitive abilities and scrutinization levels. Scrutinization level is based on learning materials. Learning materials that contain the entities of each learning style can increase the understanding level of each individual. Felder Silverman proposed a learning style model for engineering learners. Felder Silverman Learning Style Model contains four dimensions. Each of them generates two learning styles that are opposite to each other. Preprocessing dimension produces active and reflective learners. The perception dimension produces sensing and Intuitive learning styles. Input dimension produces visual and verbal learning styles. Understanding dimension produces sequential and global learning styles.

This study is based on major two learning styles that compare above mentioned each learning style. Each learning style can be categorized into either visual which contains images, graphs, audio, videos, and many other attractive objects, or reading which is based on texts, that creates a calm environment that allows each learner to imagine from their minds.

This research aims to implement a Learning Management System that enables learning style selection features using Fuzzy Logic that enables instructors to prepare learning materials based on each individual's learning preference which increases the level of observation in engineering subjects. Instructors interact with the information displayed on the UI and prepare lecture presentations accordingly. This feature will encourage the student's active understanding. In brief research questions of this study are,

1. How can instructors identify the number of learners going under a specific learning style.

2. How to prepare the learning materials using different objects that generate professional outcomes such as performance and satisfaction.

## 2. Literature Review

### A. Evaluate Learning Management Systems

Learning Management Systems (LMS), Learning Content Management System (LCMS), Learning Design System (LDS) and Learning Support Systems (LSS) are the major four types E-Learning systems. Learning management systems can be used as both virtual learning environment as well as course management system. LMSs provide a set of tools and frameworks which allows to create online course contents, attractive teaching, and various interactions with students. Typical LMS provide instructor/moderator to assess students, monitor students, setting and delivering course contents, and interactive features such as video conferencing, discussion forums, and threaded discussions [1].

Thailand is one of the countries that have the willingness to prepare their youth to meet the demands of a digitally enabled, knowledge worker with critical thinking skills demanded by global industry. Results of the analysis which evaluated the student's satisfaction concerning their use of the PUCSC Model as a learning management tool says, critical thinking ability and learning achievement with the students had a higher critical thinking ability. It also recognized that LMSs are powerful tools in the preparation of critical thinking. Therefore, LMSs such as Moodle becoming widely popular in tertiary education [2].

Study which aimed to investigate whether the adoption of LMS is able to fill their potential through analyzing literatures on LMS usage says, that use of emerging technologies in education can defeat the challenges facing higher education in sub-Saharan Africa. Researchers say success of LMS in the region can be measured through assessing the intensity and quality of use in each system. Improving usability, enhancing supported services, reviewing policies, increasing awareness, making use of mobile applications, and complementing with social media are the strategies that can be used to increase the LMS usage. As a result, if the institutions are unable to implement the educational technologies they will not reach the success of learning [3].

A survey which was conducted through a target population of students and instructors of HSE – Nizhny Novgorod campus says, both students and teachers are at ease with computers and using LMS is not perceived as presenting any difficulty for them. Learners perceived that user-friendly can imply LMS's usefulness as a learning tool. Some perceptions coincide in terms of its usefulness as a bank of course materials. Testing, online tasks,

communication activities, and face-to-face learning were preferred as their learning processes [4].

Ref. [5] says that LMS must have positive characteristics such as user-friendliness, flexibility, openness, supports the social and personal needs of students, facilitates feedback, integrated with other systems such as e-portfolios, Web 2.0, email systems, mobile learning services and other systems used at universities, facilitate students' learning, and facilitate students to use the LMS easy to navigate and effective in managing content and user management of effective information, clear instructions and assignments, interactivity, and simple communication tools must include as the important characteristics of LMSs.

### B. Several Findings Related to the Learning Management System

Ref. [6] promote a new method to automatically and dynamically select the learning style that proposed by Felder-Silverman based on the number of visits and number of hours spent on learning objects. This research chooses an AI course to evaluate and nine weeks time intervals with 204 learning objects. The method was only based on indications of learner behaviour whilst learning an online course and as well as it uses simple mapping rule. It doesn't consider the system architecture. Therefore, the proposed method can be used to identify the learning style.

By using various activity spaces and generic tools a LMS was modelled to reach the vision which aims to accelerate the teaching and learning rhythm. Both teachers and learners have personal spaces to create forums. It focuses on making the user, regardless his/her roles, more active by enabling customize his/her office, creating various activity spaces, aggregate, copy and share resources in activity space. It also can create managing online training systems such as MOOCs. The LMS was focused on user activities. Creating and organizing activity spaces, proposing various types of activities, creating forums, blogs, and managing interaction. It also consists with course, quizzes, forums, instant messenger, and blogs [7].

The research [8] proposing a cross-platform learning management system based on cloud technologies and mobile client applications indicates, simultaneous access to the large number of users, universal enough for the educational services in both higher education and companies, material data, tests, answers were stored in the server, administrator has the ability to add users, teachers can add resources and students can perform many of the educational features as the significant features which are very common in both organizational as well as open source LMSs. The researchers use biometric solutions to secure the user biometric data. To make an innovative IT-ecosystem it will be great to use AI.

The research [9] was conducted in 3 states as analysis, implementation of technical guidance and evaluation of activities. Analysis was conducted via a google form to identify the types of software needed by the participants. Most important step was the technical guidance which

carried out for 4 days with 32 lesson hours. This was conducted by using interactive video conference tools and the activeness in the video conferences became a separate motivation to the resource persons and ended up with a high attendance rate. using technical guidance to avoid the technical barriers that students face during the online learning can improve the participant rate rather than focusing on interactivity. As the research describes the evaluation was carried out by utilizing the online attendance data and survey on the 1 of preference for the guidance material which reached 98.5% of positive responses.

Hanna fin and Pack approach model used to develop ref. [10] LMS-based E-Learning System. Development model was divided as requirement assessment, design phase, and development and implementation. The LMS that was developed tested among both smaller and larger groups to gather user's response and therefore, researchers were able to measure the level of usability of their LMS. This phase also can help to increase the level of quality. During the development developers used to arrange menu bars and virtual displays. This also equipped the LMS with discussion and video conference menu bar to actively monitor the students during the learning process.

Ref. [11] investigate the issues of LMS evaluation through the User Experience and practice. It also proposing a model which help to make alternative evaluation of LMS platforms. Lack of mobile features dated appearance and user experience, difficulty of use, poor reporting features, poor customer support and inability to adapt to changing needs are the problems that are currently exist with the LMSs. Poor usability, poor visual design, and lack of responsive design are the design issues that affect customer experience. Contemporary trends of LMS such as Cloud - based LMSs which decrease the cost of ownership, Personal Learning Environment which integrate web 2.0 services which enables several functionalities related to social networks, and the LMSs which engage new approaches such as gamification characteristics or APIs that support incorporation of game mechanics.

course management which focuses on time delivery on a relevant course, social connectivity by replicating social environment via online forums, live chats, and video conferences, Assessments, tracking progress, communication tools, security privacy, ubiquitous access are the old features of the LMSs. In the future the teaching methods become more student focus and it will convert the LMS into an administrative tool. Increased number of uses of mobile devices, improvements of storage and bandwidth promotes the LMSs with new technologies. cloud-like functionalities that discussed before, adaptive learning technologies which enables course designers to design tasks and materials to individual learner requirements, micro learning with LMSs connected devices are the common technologies in these days [12].

The paper ref. [13] proposed to combine both collaborative and uncollaborated biometrics modalities to track a log which is based on face tracking, face verification and collaborative biometric recognition. This research solving the authentication problem in e-learning. If the system unable to identify the user in each period, it will use collaborative verification with fingerprints or voice to confirm whether the user is unauthorized. The system developed using C++ programming language and the image processing library OpenCV. BioAPI-compliant face Biometric Service Provider provides face verification, identification services. BioAPI-compliant voice Biometric Service Provider provides voice-based identification and verification. BioAPI-compliant fingerprint Biometric Access Provider provides fingerprint-based confirmation and identification. Specifically face recognition part is based upon extraction of local Gabor responses at each of the nodes from a 102 rectangular grid over covered on the face recognition.

Cloud technology connects users to services to store, retrieve, manipulate data via the internet. Most of the LMS based on cloud computing and they can provide variety of learning tools to the learners. WizIQ which was establish in 2007, Decebo, Litmos, TalentLMS are some of them. Lower start-up cost, Enhanced data security, Improved accessibility, Faster deployment, more storage are the common benefits that can be occur using cloud based LMSs [14]. But for the research area that this paper is going to discuss, using a cloud based LMS may be a cost consuming task. Cloud hosting for single system will be expensive, due to cost of the talent needed, of migration, and of cloud operations.

The system that this research is going to focus on is merging the aspects of both m-learning and e-learning. Therefore, [20] learners will learn on time, access the LMSs via both wireless networks and computer networks, immediate information via mobile learning environment, and sense the learner's environment become significant aspects. students claim difficulties in understanding course materials is a significant observation that claimed by the survey that conducted by this research.

### C. Technologies Used in learning style Selection

[16]Research proposed a method to predict learning style based on pattern recognition technique. Architecture of the learning style prediction model describes that sample learners should complete both index of learning style questionnaire and PIJ benchmark. Information that gathered are using to implement supervised training model. Mutual similarity pattern recognition used to identify the learning style of each user.

Three stairs should be taken. Assemble multidimensional space using pretested learning style preference patterns and assemble mutual similarity patterns depend on their learning data which familiar with same learning subject. finally compares the mutual similarity

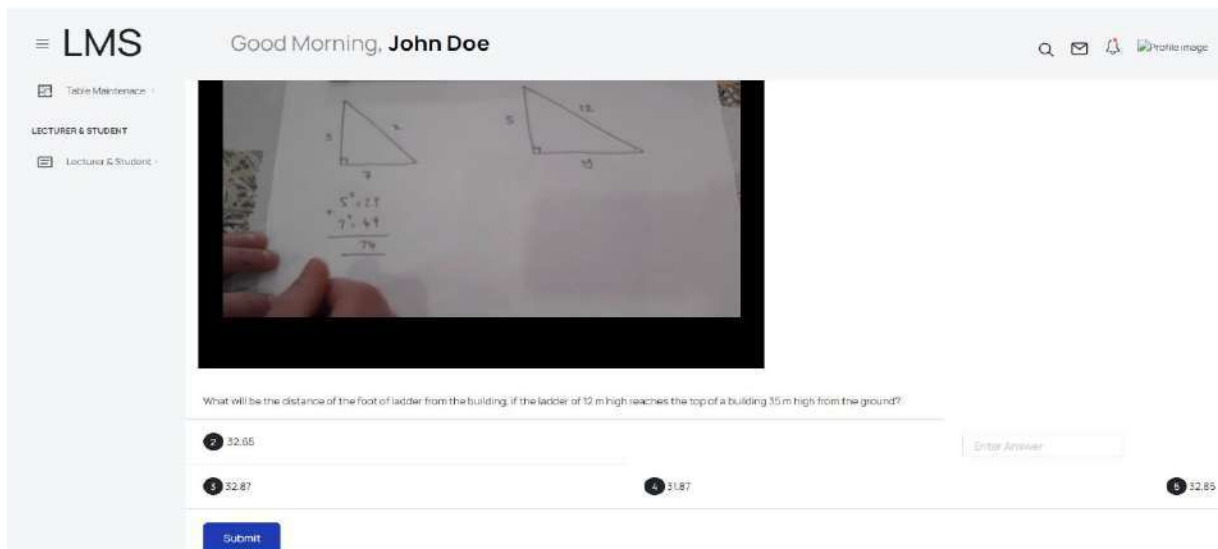


Figure 1. First quiz contains a theorem that elaborate using graphical content. After elaboration, learner should participate on a quiz to obtain marks

pattern with pretested learning style patterns to identify the essential learning style proportions.

learning style preference patterns will have constructed through using normalized learning style data. Active, Sensing, Global, Visual, and Inductive learning styles were considered when Constructing Mutual Similarity Patterns. Aim of identifying essential learning style proportion is to transform multi label classification problem into a single-label classification problem.

This research [17] describes an learning style identification system based on Fuzzy logic. Felder Silverman learning style model used for the learning style classification.

Fuzzy inputs were considered as Felder Silverman Learning Styles Models, Learner's Web Interface Information, Media Wiki E-Learning Server Contents, Student Profile information (domain of interest, educational background, and professional career) for the Fuzzy Inference Engine. Web interface information were gathered as number of mouse movement in the y-axis, ratio of document length to the time spent on a page, ratio of images area to document length and scroll distance, and number of visits to a document. rule base contained 30 fuzzy rules for the purpose of advocating and arranging best e-learning materials based on discovery of learning styles.

[18] Content Based Filtering, Collaborative filtering, and Hybrid Filtering was considered as recommendation techniques. Content based filtering is a primitive method. These recommend system tasks with accounts of learners that they created at the beginning. These personal accounts contain rates for each learning object that is given by therner. This recommendation operation narrows down into three stairs: item representation, profile learning and recommendation generation.

In collaborative filtering algorithm, Target learner preferences considered and compared with ratings included in existing learners' database. Then the learners who have similar preferences found and recommendation made to them for Learning Objects.

Hybrid filtering necessitating two or more recommendation techniques. Previously discussed recommendation techniques used to make person gained recommendations.

Web log files of each learner is considered that contain the etiquette while using the system and contribution in course related tools. To extract learning style Access web logs of each learner, pre-process weblog files, create learning style model, Build tree using decision tree classifier, predict learning style model were taken as major steps[19].

[20]print, aural, interactive, visual, hap tic, kinesthetic and olfactory are the learning styles considered in this research paper. All of these learning styles explains that learners use different media to obtain how the learning material get delivered. Proposed recommend system is based on e learning material ontology. This system contains learning module and a recommender module. Researchers integrate university, corporate, government, payment gateway and bank. These parts used to build new ecosystem in e-learning task. sponsorship, user tracking, payment processors, reporting and applying were used as functional services. The system is based on logic based approach called APARELL.

### 3. Methodology

This research paper express the Learning style prediction based on two examination results. Each examination is a quiz which include five multiple choice objective response questions. At first time which the student accesses the learning management system will get the chance to attempt

to the two quizzes. First quiz contains a theorem that elaborate using graphical content. After elaboration, learner should participate on a quiz to obtain marks. Second quiz contains a theorem that elaborate using textual content. After elaboration, learner should participate on quiz to obtain marks. Marks of the two quizzes will be evaluated and then the probability of being a visual learner will predict via fuzzy logic system.

Fuzzy logic concept emerged in 20th century and then begin to applied on many other fields. Predicting learning style is the one of the best field that using fuzzy logic.

#### A. Fuzzy Inputs

Fuzzification of exam results was carried out using input variables and their membership functions of fuzzy sets. Each student contains two quiz results, both of which form input variables of the fuzzy logic system. Each quiz results set (input variables) has five triangle membership functions.

Table 1 . Each quiz results set (input variables) has five triangle membership functions

Linguistic expression	Symbol	Interval
Very Low	VL	0,0,25
Low	L	0,25,50
Average	A	25,50,75
High	H	50,75,100
Very High	VH	75,100,100

#### B. Fuzzy outputs

The output variable, which is being visual learner value, is entitled “Result” and has five membership functions. For reasons of convenience within the application, a value range between 0 and 1 was chosen.

Table 2. Being visual learner value also contains five intervals

Linguistic expression	Symbol	Interval
Not Visual Learner	N	0,0,0.25
Unsuccessful Visual Learner	U	0,0.25,0.5
Average Visual Learner	A	0.25,0.5,0.75
Successful Visual Learner	S	0.5,0.75,1
Top Visual Learner	T	0.75,1,1

#### C. Fuzzy Rules

To generate fuzzy output, this research paper considered results of two quizzes. They named as Quiz1 and Quiz2.

1. If Quiz1 is VL and Quiz2 is VL then Result is U
2. If Quiz1 is VL and Quiz2 is L, then Result is U
3. If Quiz1 is VL and Quiz2 is A Then Result is A
4. If Quiz1 is VL and Quiz2 is H, then Result is N
5. If Quiz1 is VL and Quiz2 is VH then Result is N
6. If Quiz1 is L and Quiz2 is VL then Result is U
7. If Quiz1 is L and Quiz2 is L Then Result is A
8. If Quiz1 is L and Quiz2 is A Then Result is A
9. If Quiz1 is L and Quiz2 is H, then Result is N
10. If Quiz1 is L and Quiz2 is VH then Result is N
11. If Quiz1 is A and Quiz2 is VL then Result is S
12. If Quiz1 is A and Quiz2 is L, then Result is S
13. If Quiz1 is A and Quiz2 is A Then Result is A
14. If Quiz1 is A and Quiz2 is H, then Result is U
15. If Quiz1 is A and Quiz2 is VH then Result is N
16. If Quiz1 is H and Quiz2 is VL then Result is T
17. If Quiz1 is H and Quiz2 is L, then Result is S
18. If Quiz1 is H and Quiz2 is A Then Result is S
19. If Quiz1 is H and Quiz2 is H, then Result is A
20. If Quiz1 is H and Quiz2 is VH then Result is U
21. If Quiz1 is VH and Quiz2 is VL then Result is T
22. If Quiz1 is VH and Quiz2 is L, then Result is T
23. If Quiz1 is VH and Quiz2 is A Then Result is S
24. If Quiz1 is VH and Quiz2 is H, then Result is A
25. If Quiz1 is VH and Quiz2 is VH then Result is A

#### D. Membership Functions and Results

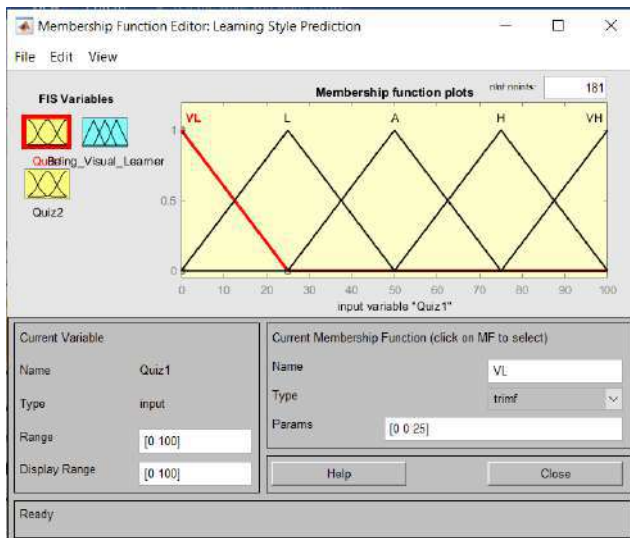


Figure 2. Membership function of Quiz1

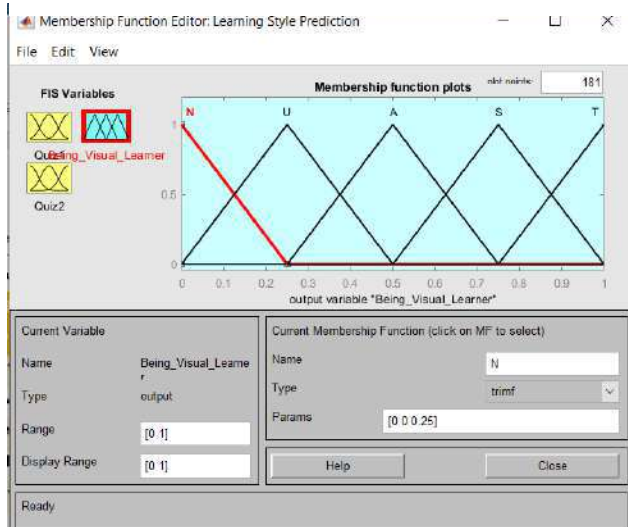


Figure 4. Membership function of being visual learner level

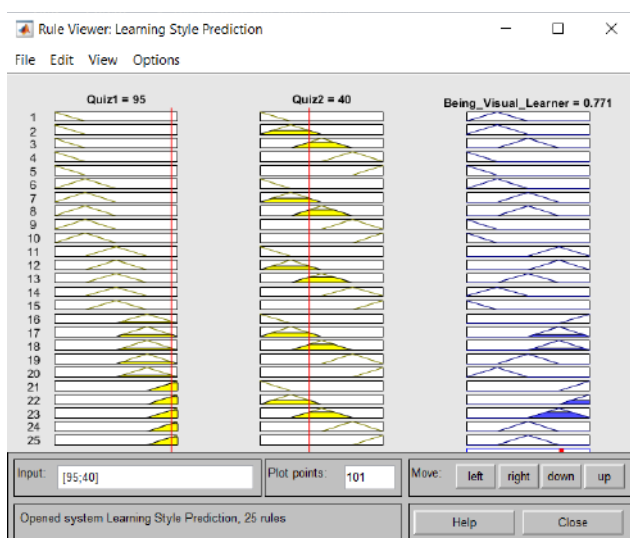


Figure 3. Random input and output

#### 4. Discussion

The end product of this research is to boost up the learning style selection by allowing students to participate in two

Table 3. Random inputs and corresponding outputs

No	Quiz1	Quiz 2	Performance value
1	40	65	0.333
2	20	35	0.433
3	50	65	0.355
4	10	20	0.355
5	45	65	0.348
6	34	60	0.374
7	48	55	0.438
8	56	90	0.291
9	74	70	0.546
10	45	50	0.5

separate quizzes the first time that student logs into the system. Lecturers commonly prepare lecture notes by using advanced books and teach them in traditional classrooms. When it moves to remote learning most of the lecturers were unable to return feedback about the enlighten methods that use for the learning material creation and therefore, it makes low-performance levels of the students. Asking students to interact with learning style selection quizzes at first most entry to the system help to categorize students as either visual or reading. As for future work some trials of the learning style selection feature will be tested. This refers to the process of analyzing the survey results from students. A group of students will be selected out of a University and each student can select their learning style. Each student will be evaluated by a test regarding the learning style that they have selected. Learning style selection, make it easier to create, modify and develop more efficient curriculum and educational programs. This also encourages lecturers to motivate their students to gain professional knowledge by using their learning styles. This also influences overall academic performance. This also removes the barriers such as physical, mental, emotional, cultural, or social elements that obstruct a student from achieving their learning goals.

#### 5. Conclusion

Therefore, the understandability of a student depends on their learning style. Sometimes reading a learning material, repeatedly, asking questions, taking good notes, and using visual demonstrators can impact each student from a different perspective. visual, auditory, reading and writing, and kinesthetic are the main four learning styles. This research summarizes each learning style into two major learning styles by considering their attributes and similarities. Visual learners and Reading based learners are the major two categories that may help lecturers when preparing their lecture notes for the students.



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