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Design and Development of a Learning Style Identification Application for JPTK Students using the K-Nearest Neighbor

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***Abstract*— Learning styles are crucial for all students, as the chosen learning style can greatly assist them in learning. The data source for this research originates from questionnaire results distributed to JPTK (Department of Civil Engineering and Vocational Education) students of the 2019-2021 cohorts, which were used to assess the effectiveness of a learning style product on the students' JPTK website. This study employs the K-Nearest Neighbor approach, which utilizes the principle of nearest neighbors to categorize students' learning styles based on provided features. The data used in this research is derived from the website that students use to input information about their preferred learning styles. Various elements, including visual, auditory, and kinesthetic preferences, are present in the questionnaire on the website. Subsequently, the data is processed and fed into a Python K Nearest Neighbor model to predict students' learning styles and nearest neighbors. The evaluation results indicate that the developed classification model achieves a reasonably high accuracy level of 93%, making it a useful tool for effectively and efficiently identifying students' learning styles. It is hoped that implementing this learning style classification model will benefit the field of education. By understanding students' learning styles, educators can create more tailored lesson plans, enhance learning outcomes, and reduce the likelihood of knowledge loss.**

***Index Terms*— K-Nearest Neighbor; VAK Learning Style; Website**

I. INTRODUCTION

As commonly known, in Indonesia, numerous higher education institutions are attended by a considerable number of students. However, each student naturally possesses diverse learning preferences. No student has an identical learning approach to others, thus learning styles often remain an aspect that hasn't fully received optimal attention, both from educators and learners. Learning style itself comprehends the quickest and easiest way for students to comprehend, absorb, and process information, enabling it to be stored in memory for an extended period.

Learning style is a student's ability to adapt specific learning strategies through active exploration and experimentation. Consequently, students eventually develop a learning approach that suits their learning needs. Person's learning style is how they absorb and process new and challenging information [1]. Meanwhile, [2] define learning style as an individual's chosen way of utilizing their abilities according to their learning style. Learning style is the method each person possesses to absorb, organize, and manage the information they acquire. The appropriate learning style is the key to students' success.

Experts have utilized various methods to differentiate various learning styles. Canfield created the Canfield Learning Style Inventory (LSI). The use of psychometric instruments and the Kolb Learning Style model in the form of the LSI (Learning Style Inventory) is necessary to measure human mental aspects and identify learning style tendencies to achieve comfort in classroom learning. Howard Gardner developed a broader new learning style that describes preferences for multiple intelligences. This is called the Inventory of Memletics Style Learning or Memletics Style Learning. In Memletics learning, students are divided into seven groups: visual, verbal, aural, logical, physical, social, and solitary [3].

Learning modalities: visual, auditory, and kinesthetic. Mar'ah stated that, based on their sensory preferences, visual learners learn from visuals; auditory learners learn from sound; and kinesthetic learners learn from movement, action, and touch [4].

However, most learning processes assume uniformity among all children, meaning teachers often disregard their students' unique learning styles. Consequently, some students with different learning styles than their teachers may struggle to grasp the material and ultimately face difficulties in mastering it [5].

Moreover, with the advancement of technology nowadays, numerous innovations have simplified many tasks. For instance, the technological Development accessed through web browsers over networks like the Internet or Intranet is known as web-based applications [6]. Currently, with the expanding internet, researchers can create sample surveys and online surveys using websites sent via email and social

media platforms (such as WhatsApp, Facebook, Instagram, and Twitter) [7]. Thus, it can be said that web-based surveys help reduce excessive paper usage.

A website, or a collection of interconnected web pages, sometimes contains images, videos, or other files. All internet users can access websites by typing their domain or Unified Resource Locator (URL), which can be accessed by typing its address [8].

The K-Nearest Neighbor (KNN) algorithm utilizes training data from nearby objects to classify them. The training data is transformed into a higher-dimensional space, where each dimension represents data characteristics. As a result, the K-Nearest Neighbor method, used through web-based applications, will be implemented by researchers in this study. This K-Nearest Neighbor method is typically employed to classify and identify objects, as demonstrated by [9].

Based on the many opinions above, determining a fast and accurate learning style with the help of current technology is feasible. Therefore, this research aims to design an application for identifying students' learning styles using the K-Nearest Neighbor learning method.

II. Research Method

Previous research has indicated that the K-Nearest Neighbor (KNN) Algorithm employs nearest training data for classification. This data is projected into multiple dimensions with features in each dimension. KNN is a promising method for data mining classification [10].

The KNN algorithm is straightforward; it measures the distance between the query instance and the training data to determine the KNN. The training data is represented in a high-dimensional space, depicting data characteristics. The training data is classified and grouped within this space. For instance, points in this space are assigned a class label C if the most frequent K nearest neighbors' classification is class C. Euclidean Distance is used to compute the distance between an object and its environment, whether near or far.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad (1)$$

It is important to employ various methods to comprehend information [11]. The VAK modality (Visual, Auditory, Kinesthetic) is popular for learning, creating comfortable and effective learning experiences [12]. [13] states that learning can be dominant in one style or a combination, such as visual and auditory, auditory and kinesthetic, or other combinations.

A. Visual

The visual learning style involves using images and real-life object experiences to comprehend a concept. Individuals with a visual learning style prefer reading maps, diagrams, or paying attention to visual presentations to understand information.

B. Auditory

The auditory learning style involves using sound and music to comprehend a concept. Individuals with an auditory learning style prefer learning through group discussions, listening to lectures, or taking notes on what they hear to understand information.

C. Kinestetic

Kinesthetic learning involves the use of physical experiences to comprehend a concept. Individuals with a kinesthetic style prefer learning through hands-on practice or trying things themselves to understand information.

Research and Development (R&D) is a technique to create and test product effectiveness [14]. R&D involves design, experimentation, and revisions to meet quality standards (Amile and Reesnes). This method develops products and evaluates their utility [15]. SDLC (Systems Development Life Cycle) is the process of designing, building, and delivering business information systems. The Waterfall method, an older SDLC method, follows steps such as analysis, design, coding, testing, and maintenance (Waterfall).

Disproportionate stratified random sampling is suitable for a heterogeneous population with non-proportional stratification. This method divides the population into groups or strata. Factors like age, city, gender, religion, education, and income can form these strata. In this study, 20 strata will be used for students majoring in Computer Engineering, Civil Engineering, and Mechanical Engineering.

Data will be collected through a website distributed via WhatsApp groups to students from three majors at Universitas Sebelas Maret: Computer and Computer Engineering Education, Civil Engineering Education, and Mechanical Engineering Education from various batches.

The number of questions used is thirty, each containing multiple questions describing the most suitable learning style for participants. These questions will be presented in a closed-ended format with three answer choices.

III. Result

The Campus V of the Faculty of Teacher Training and Educational Sciences, Department of Computer Science and Computer Engineering, Universitas Sebelas Maret, is located at Jalan A. Yani No. 200A, Makam Haji, Kartasura, Sukoharjo. The author defines the scope of the research to encompass the entire campus of the Department of Teacher Training and Education at Universitas Sebelas Maret, where there are study programs in Computer Science and Computer Engineering Education, Civil Engineering Education, and Mechanical Engineering Education. This limitation aims to achieve the expected outcomes of the research.

The Disproportionate Stratified Random Sampling method is used to select research respondents. This

means that sample data from the population is collected randomly without considering population strata. 67 students from the Department of Teacher Training and Education from various academic years are chosen as respondents or participants. The identities of the research respondents cannot be traced; however, they can be identified based on their study programs and years of study.

The primary data in this research is obtained through responses from students of the Department of Teacher Training and Education at Universitas Sebelas Maret based on statements presented on the K-Nearest Neighbor Quiz website. The statements amount to 30 items, grouped into a class called Visual Auditory Kinesthetic (VAK). Each question has 3 answer choices that the research subjects are required to answer. The levels for each type are divided into 3 categories: Visual, Auditory, and Kinesthetic.

TABLE I. RESULTS OF ANALYSIS OF JPTK STUDENTS

Types of Learning Styles	Amount	Percentage (%)
Visual	22	33%
Auditory	15	22%
Kinesthetic	30	45%
Total	67	100%

The data description of the learning process dimension indicates a tendency towards kinesthetic learning style. Research subjects with a preference for Visual learning are mostly found in the light category, accounting for 33%. Following this, the auditory level is 22%, and the strongest preference, kinesthetic, is 45%.

The distribution of data for Computer Science and Computer Engineering Education students.The summarized results of the learning style type percentages in Computer Science and Computer Engineering Education are presented in Table 2.

TABLE II. DISTRIBUTION RESULTS OF COMPUTER AND INFORMATION ENGINEERING EDUCATION DATA

Types of Learning Styles	Amount	Percentage (%)
Visual	10	48%
Auditory	5	24%
Kinesthetic	6	28%
Total	21	100%

The data description of Computer Science and Computer Engineering Education indicates a tendency towards the Auditory learning style. Among the research subjects, the highest percentage is observed in the Visual learning style at 48%, followed by the Kinesthetic level at 28%, while the Auditory level is at 24%.

The distribution of data for Mechanical Engineering Education students. The summarized results of the learning style type percentages in Machine Engineering Education are presented in Table 3.

TABLE III. DISTRIBUTION RESULTS OF MECHANICAL ENGINEERING EDUCATION DATA

Types of Learning Styles	Amount	Percentage (%)
Visual	4	17%
Auditory	6	26%
Kinesthetic	13	57%
Total	23	100%

The data description of Mechanical Engineering Education indicates a tendency towards the Kinesthetic learning style. Among the research subjects, the highest percentage is observed in the Kinesthetic learning style at 57%, followed by the Auditory level at 26%, while the Visual level is at 17%.

The distribution of data for Civil Engineering Education students. The summarized results of the learning style type percentages in Civil Engineering Education are presented in Table 4.

TABLE IV. DISTRIBUTION RESULTS OF BUILDING ENGINEERING EDUCATION DATA

Types of Learning Styles	Amount	Percentage (%)
Visual	8	35%
Auditory	4	17%
Kinesthetic	11	48%
Total	23	100%

The data description of Building Engineering Education shows a tendency towards the Kinesthetic learning style. The research subjects mostly exhibit the Kinesthetic learning style at 48%, the Visual style at 35%, and the Audio style at 17%.

Software Design

A. Landing Page

The front page of the website http://dioquiz.netlify.app contains the application's name, Learning Style Identification. It includes inputs such as Full Name, Email, Student ID (NIM), and Program of Study from the respondents. Above the homepage, there is also a logo and the website's name.

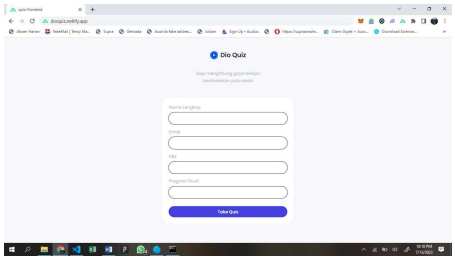

Fig 1. Screenshot on Landing Page

B. *Question Page*

The question page of the website contains questions that respondents will answer. This website has 30 questions about the personality of respondents in the field of Civil Engineering and Planning which will later serve as a reference to determine the appropriate learning style based on respondent's answers. Each question has 3 answer choices, each categorized as Visual, Audio, and Kinesthetic. As for the initial design of the website interface.

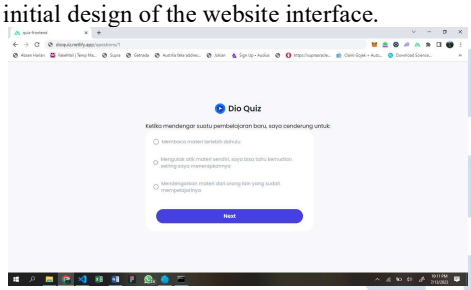

Fig 2. Screenshot on Question Page

C. *Page Result*

The results page contains the outcomes of the 30 respondents' questions. Later, the answer results will be processed by Python's K-Nearest Neighbors algorithm within the website to determine whether the respondent falls into the Visual, Audio, or Kinesthetic learning style. The answers will be matched with existing training data. Subsequently, on the results page, the nearest neighbors to the respondent's answers will be displayed along with the final result and the suitable profession for the respondent.

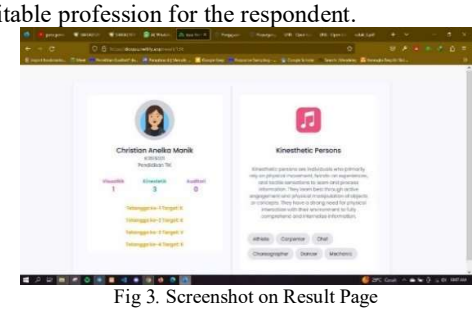

Fig 3. Screenshot on Result Page

D. *Python K-Nearest Neighbour*

The website includes a Python program to process the available data results. The data results will be processed using the K-nearest neighbors machine learning algorithm, and the outcome will display the nearest neighbors according to K=11, which is utilized in this current research. The selection of K=11 is based on considerations of the highest accuracy and the class being used. Here, the best values for K are 9, 10, 11, and 12, considering the appropriateness with the 3-class variable. Therefore, the value K=11 is chosen. The results of the calculations are as follows:

TABLE V. DISTRIBUTION AND ACCURACY OF K

Neighbors	Accuracy
9	62.27%
10	62.27%
11	67.4%
12	60.4%
13	60.4%

Accuracy is obtained by entering existing data into the Python program, where the program will later process and produce results like the table above. For the confusion matrix values, the precision values for Visual are 0.56, Auditory 0.73, and Kinesthetic 0.80. The recall values for Visual are 0.62, Auditory 0.65, and Kinesthetic 0.80. The f1-score values for Visual are 0.59, Auditory is 0.69, and Kinesthetic has a value of 0.87.

IV. DISCUSSION

Applying learning styles among students in the Department of Civil Engineering and Vocational Education (JPTK) at Universitas Sebelas Maret has been implemented through a Visual Audio Kinesthetic learning style website containing 30 questions. In this website, respondents answer questions with responses that align most closely with their preferences. Subsequently, respondents are provided with an answer indicating the most suitable learning style. The results also include the four nearest neighbors in terms of learning styles, in line with the utilized machine learning method, K-Nearest Neighbors, which seeks outcomes by employing its neighbors.

Based on data analysis and discussions conducted in the previous chapter on Information Engineering Education, it can be concluded that most students in the Information Engineering and Computer Education stream have a visual learning style. Out of 21 respondents from a heterogeneous group, 10 students exhibit a visual learning style, 5 students an auditory learning style, and 6 students a kinesthetic learning style. From a diverse cohort of 23 respondents, 8 students display a visual style, 4 students an auditory style, and 11 students a kinesthetic style, leading to the conclusion that most students in Building Engineering have a kinesthetic learning style. Similarly, in Mechanical Engineering Education, out of 23 respondents from varying batches, 4 students demonstrate a visual style, 6 students an auditory style, and 13 students a kinesthetic style, thus indicating a predominant kinesthetic learning style.

Learning generally takes place as students consciously or unconsciously absorb information. When students understand their learning styles and utilize preferred learning methods, the learning process becomes smoother, resulting in better learning outcomes. Each student's learning style is distinct due to their uniqueness [16].

Having comprehended the learning styles of students in the Department of Civil Engineering and Vocational Education (JPTK) at Universitas Sebelas Maret (UNS), this research delves into several critical aspects that warrant attention. This study seeks to explore the following information: millennials' ability to self-regulate and manage others, the role of teachers in creating a conducive learning environment for students, and discussions on research findings that offer guidance. The research also focuses on information regarding suitable learning models aligned with students' learning styles.

V. CONCLUSIONS

The results indicate 67 students from three Department of Civil Engineering and Vocational Education (JPTK) programs at Universitas Sebelas Maret (UNS). The sample was obtained using a proportional stratified sampling method, by the population's heterogeneity. Data management employed the K Nearest Neighbors method with K=11, yielding good results (67% reliability). This suggests that the learning style variable is strong and reliable, reinforcing its influence on students, as the JPTK UNS students display excellent scores.

K-Nearest Neighbors was implemented on students in the Department of Vocational Education at Universitas Sebelas Maret through the website http://dioquiz.netlify.app. This website consists of questions with three answer options (visual, auditory, kinesthetic). Respondents answered 30 questions to determine their corresponding learning style. The answers were processed using the Python programming and the K-Nearest Neighbors algorithm. Respondent data was compared with training data within Python to determine the learning style outcomes.

Out of the 67 respondents, most JPTK UNS students exhibit a kinesthetic learning style, with 22 students being visual learners, 15 auditory learners, and 30 kinesthetic learners. This impacts the students' ability to move and act independently. Professors can guide them directly through demonstrations or practice, as kinesthetic learners are sensitive to bodily expressions.

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