

# CHAPTER I

## INTRODUCTION

### 1.1. Background

The development of digital technology has brought significant changes to the field of education, particularly in the implementation of online learning (e-learning) systems. In Indonesia, the use of digital platforms such as Learning Management Systems (LMS) has become increasingly widespread to support teaching and learning activities. However, amidst this digital transformation, teachers continue to face major challenges related to time efficiency and administrative workload. Various educational studies and reports indicate that administrative tasks, including lesson planning, learning documentation, reporting, and school document management, consume a substantial portion of teachers' working hours. Consequently, this reduces the time available for designing innovative learning strategies that focus on students' individual learning needs. Furthermore, learning systems implemented in most schools still follow a one-size-fits-all approach, where all students receive the same instructional materials without considering differences in their learning styles. In reality, each student possesses unique learning characteristics, such as visual, auditory, or kinesthetic preferences, which influence how they process and understand information. Previous studies have shown that the alignment between learning styles and instructional delivery methods significantly affects the effectiveness of e-learning. Unfortunately, most adaptive e-learning systems in Indonesia remain limited to providing standardized learning materials and have not yet been capable of generating truly personalized instructional content [1].

On the other hand, the implementation of Learning Management Systems (LMS) generates a substantial amount of student behavioral data. Through activity logs such as login frequency, material access duration, participation in discussion forums, and assessment results, valuable insights into students' learning patterns can be obtained. These data can be utilized to objectively understand students' learning preferences and characteristics. However, in practice, most teachers have not fully utilized this information. Current approaches to identifying learning styles

are still largely manual, relying on questionnaires and classroom observations, which are often inefficient and may not accurately reflect students' actual behavior within digital learning environments. Based on these conditions, there is a need for a learning system that does not solely depend on teachers' subjective perceptions but is capable of automatically analyzing student behavioral data to identify learning style patterns. One approach that is well suited to this objective is the Agglomerative Hierarchical Clustering (AHC) algorithm. AHC is an unsupervised learning method that groups data according to similarity levels through a hierarchical merging process, resulting in a structure that can be visualized using a dendrogram. The primary advantages of AHC include its ability to discover natural patterns in data without requiring the number of clusters to be predefined and its flexibility in employing various linkage methods, such as Single Linkage, Complete Linkage, Average Linkage, and Ward's Linkage, to accommodate different dataset characteristics. Previous research entitled "*Application of Agglomerative Hierarchical Clustering for Determining Factors Causing Incomplete Mathematics Learning Outcomes*" demonstrated that AHC is effective in clustering complex educational data and producing clusters that are easily interpretable by teachers [2]. Similar findings were reported in "*Data Mining for Student Major Selection Using the Agglomerative Hierarchical Clustering Method*", where AHC successfully grouped students based on academic and non-academic characteristics with a high degree of similarity [3]. Furthermore, the study "*Linkage Comparison in Agglomerative Hierarchical Clustering for Clustering Students' Knowledge of First Aid*" showed that the choice of linkage method significantly influences clustering quality, making AHC a suitable approach for analyzing complex and multidimensional student learning behavior data obtained from LMS platforms [4].

This research was conducted at SMK Telkom Sidoarjo, a vocational high school that has extensively implemented LMS-based learning through the myLMS Telkom Schools platform. The school accommodates a large number of students with diverse learning styles and digital activity patterns, making it an ideal environment for data-driven learning analytics research. Through the implementation of the Agglomerative Hierarchical Clustering algorithm, this study aims to group students based on their learning behavior patterns within the LMS

and subsequently identify the dominant learning style of each cluster. The clustering results will serve as the foundation for developing an adaptive learning system capable of automatically generating instructional materials according to students' learning characteristics, supported by generative artificial intelligence technologies such as the ChatGPT API. Therefore, this research is expected to address the existing research gap between the vast potential of student behavioral data generated by LMS platforms and the practical implementation of adaptive learning systems in schools. By utilizing the Agglomerative Hierarchical Clustering approach, the proposed learning system is expected to adapt automatically to students' characteristics, assist teachers in developing instructional materials more efficiently, and enhance the effectiveness and personalization of the learning process within digital educational environments such as SMK Telkom Sidoarjo.

## **1.2. Problem Statement**

Based on the background research described above, the problems addressed in this study can be formulated as follows:

1. How can student activity data from the Learning Management System (myLMS Telkom Schools) be utilized to identify students' learning patterns and characteristics?
2. How can the Agglomerative Hierarchical Clustering (AHC) method be applied to group students based on their learning activities?
3. How can the clustering results be used to identify the dominant learning style tendencies of each student group?
4. How can an adaptive learning system be designed to automatically customize learning materials and assignments based on the clustering results?

## **1.3. Objectives**

Based on the research problems that have been formulated, the objectives of this study are as follows:

1. To analyze student learning patterns using activity data from myLMS Telkom Schools.
2. To develop an adaptive learning system that automatically adjusts learning content based on student characteristics.

3. To enhance learning effectiveness through a personalized learning approach.
4. To create a data-driven learning model by integrating learning analytics, machine learning, and artificial intelligence (AI).

#### **1.4. Research Benefits**

##### **1.4.1. Theoretical Benefits**

This study is expected to contribute to the literature on data-driven learning, particularly in the use of LMS activity data to analyze students' learning patterns and styles. It may also serve as a reference for future research involving learning analytics, machine learning, and artificial intelligence.

##### **1.4.2. For Teachers**

This study can assist teachers in reducing administrative workload, especially in preparing instructional materials, allowing them to focus more on teaching and student development.

##### **1.4.3. For Students**

This study can provide a more personalized learning experience by adapting learning materials to students' characteristics, thereby improving engagement and understanding.

##### **1.4.4. For Schools**

This study can support the implementation of digital learning and optimize the utilization of existing Learning Management Systems (LMS).

##### **1.4.5. For Future Research**

This study can serve as a foundation for the development of more advanced adaptive learning systems and AI-based personalized learning approaches.