

CHAPTER - 1

INTRODUCTION

1.1 Education – An Overview

The process of education is crucial to human development. Education involves the complete progression of human learning, comprising knowledge transmission, skill development, and the acquisition of diverse aptitudes. An alternative understanding of education is the action, practice, or implementation of discipline to enhance the intellect or foster the process of character formation. It is considered to influence or condition the social behavior of the learner.

Education in a specific domain empowers individuals to cogitate, feel, and behave in a manner that fosters their achievements and elevates their happiness and that of their community. Education also stimulates the growth of an individual's character, ideas, and social skills, preparing them for life's experiences. Education yields considerable benefits, enlightening a person's mind and intellect, consequently granting them a distinguished status in their local community and wherever they reside. An excellent education can lead to a successful career, a high social status, and increased self-assurance, among other advantages.

Education is the discipline that deals with how things are taught and learned. The student will almost certainly have a tutor during the educational process, however the student can educate themselves and become knowledgeable without the assistance of a tutor. There are two categories of education: formal and informal. Formal education refers to instruction that takes place in a classroom and is given to students by any kind of educational institution with the assistance of a trainer or tutor. On the other hand, informal education is a broad term that refers to learning that occurs outside of a traditional classroom. The wise, reverent, and spontaneous process of learning

is known as informal education. It functions by continuously enhancing, exploring, and interacting with the learner's experience.

Equal access to high-quality education is a fundamental human right. Education has a wide range of effects on society, from improving living standards to fostering the growth of gifted people with the capacity to transform society. Development on a personal, societal, and global level is accelerated by education.

1.2 Quality of the Education

A top-notch education prioritizes the comprehensive development of every student, encompassing their social, psychological, intellectual, physical, and cognitive growth, irrespective of gender, color, culture, economic background, or geographical location. Such a high-quality education equips all students with the necessary skills to establish sustainability, advance tranquil and democratic communities, and nurture individual well-being. The specific education results may vary depending on the context, but after completing the foundational education phase, there must be attainable levels of literacy, proficiency, essential scientific knowledge, and life abilities, include health consciousness and disease prevention. Throughout this journey, empowering teachers and other education stakeholders remains critical.

The majority of definitions regarding quality in education stem from two core principles. Firstly, it asserts that the primary explicit objective of all educational establishments is the cognitive growth of students. Secondly, it emphasizes education's role in fostering the growth of inventive and emotional abilities, civic values, and attitudes. The quality of education impacts children's learning capacity and the extent to which their education results in various personal, social, and developmental benefits. It underscores the significance of effective pedagogy. The curriculum is understood by the teaching and learning procedure, which also governs what occurs in the classroom and, consequently, influences the level of learning results.

A high-quality education delivers the results for people, communities, and societies to succeed. Furthermore, educational institutions can collaborate, seamlessly integrate, and leverage different services from different sectors aimed at enhancing their students' academic progress. Three core principles serve as the bedrock for high-quality education: ensuring access to competent educators, offering top-notch instructional materials and professional growth, and establishing supportive and safe learning environments. Table 1.1 shows the elements of education quality.

Table 1. 1 Components of Education Quality

Elements	Quality Indicators
Learners	The students' fine health and nourishment, initial encounters in psychological growth, consistent presence, and parental encouragement for academics.
Learning Environment	Physical components (such as classroom size, school infrastructure, etc.), psychological components (such as a secure environment, instructors' conduct, discipline procedures, absence of aggression, etc.), and service rendering (e.g., healthcare services).
Content	The uniqueness of indigenous and national material, the focus on literacy, numeracy, and life abilities, and the learner-oriented and benchmark-based curriculum.
Processes	Teachers' competency, support for student-centered learning, participation-based teaching strategies, teachers' working circumstances, and

	other indicators, as well as supervision and assistance, are all indicators that relate to teachers and teaching.
Outcomes	Reading fluency, self-assurance, life skills, health, and parentally desired student outcomes.

Developing a person's competences, habits, skills, beliefs, and knowledge is called learning. These qualities are taught or acquired through experience in children. Psychological and physiological explanations are used to explain the learning process. Three significant models can be used to characterize the learning process. These theories are constructivism, cognitive, and behaviorism.

An observable change in behavior during the learning process is highlighted by behaviorism. Children's conduct is influenced by various environmental influences, which are crucial. Cognitive theories focus on the internal mental organization of the knowledge that shapes children's behaviors. By internal mental organizing, information is processed, and knowledge is acquired. Constructivism, the last paradigm, sees learning as adding new concepts and ideas to previously acquired information and experiences.

Numerous teaching philosophies exist, and they all subtly influence how people learn. The moralistic approach, or "teaching as a transmission" where students are seen as passive recipients of knowledge communicated, primarily involves lecturing and is often teacher-centered and content-oriented. In addition, teaching may be understood as a process that builds on what students already know and takes a learner-centered approach to help students acquire knowledge and understand (i.e. teaching as facilitation). Finally, another

strategy focuses on improving students' cognitive abilities, awareness, and control of thinking and learning ".

An exceptional educator exerts a favorable impact on students' learning and development through a combination of subject matter proficiency, mastery of a wide array of pedagogical techniques, and strong communication/interpersonal abilities. The best teachers are dedicated to their subjects, constantly improving their knowledge, and introspecting about their instructional methods. They impart knowledge of their subject matter and the learning process through effective communication, diagnostic capabilities, understanding of diverse learning styles and cultural influences, comprehension of child development, and the ability to deploy multiple strategies to cater to student requirements. They uphold high standards and assist students in attaining them. They create a setting beneficial to learning and use resources both within and outside the classroom.

1.3 Educational Data Mining

Education involves developing intelligence, abilities, values, attitudes, and behaviors. Categories of education encompass guidance, perusal, storytelling, discussions, and guided learning. Education is predominantly conducted under the guidance of instructors, but learners can also be self-taught. Education can occur in formal or informal settings, and any interaction that significantly shapes one's beliefs, behavior, or actions should be regarded as educational.

Any educational program's main goal is to give students the skills and information they need to move into productive employment within a set time frame. Assessing student knowledge using Data Mining (DM) techniques may reveal useful insights into the learning process. The goal of Educational Data Mining (EDM), a subfield of data mining, is to focus and give solutions to problems in academia [1]. It includes a variety of contextual data that helps us

understand learners and their learning styles better. To analyse educational data and address educational difficulties, EDM uses DM methodologies. EDM collects pertinent, interpretable, valuable, and new information from educational data in a manner similar to previous extraction methods utilising DM [2].

Figure 1.1 depicts data mining steps in educational systems. Teachers may use the knowledge that has been discovered to help students perform better, and the recommendations that have been discovered may be used by students to help them perform better in the areas they are studying. Furthermore, incorporating educational data mining techniques into the educational system can aid in classifying academic records, including student information, learning patterns, activities, and performance in the classroom.

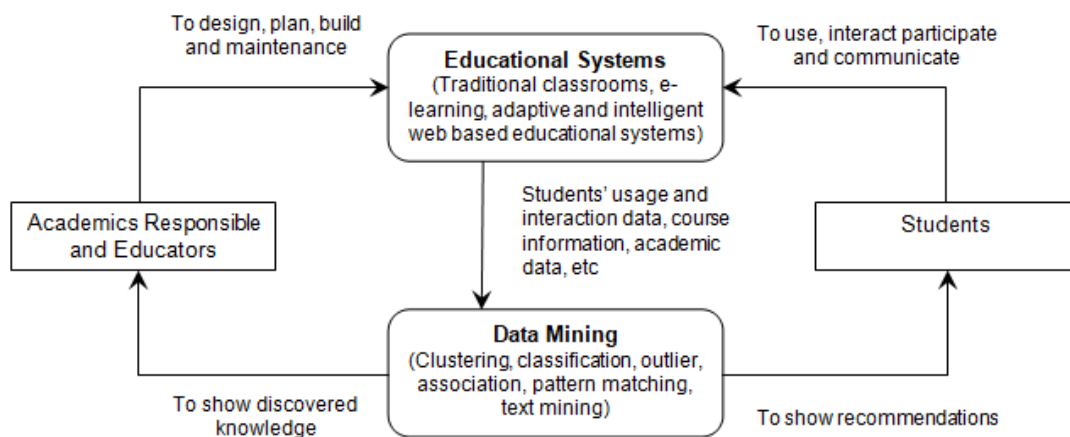


Figure 1. 1 Process of EDM

The objectives pursued by researchers in educational data mining are as follows [3]:

- Predicting students' potential learning behavior involves the establishment of model which incorporate specific details such as the learning experience, enthusiasm, mental processing, and mindsets.
- Discovering or creating domain structures that define learning content and best instructive sequences.

- Examining the effects of various tutorial aids provided by learning software.
- Building up computer models that incorporate student simulations, the learning atmosphere, and the course's approach to improve empirical insights on learning process and the learners.

EDM is described as a new, growing discipline that focuses on investigating and discovering innovative approaches to using data gathered from educational institutions to improve student performance and exploring new tools for this goal [4]. Data gathered from educational organizations utilizing various educational systems is used and analyzed by EDM. The primary objective is to create models that will improve the educational system and increase the efficiency of institutions of higher learning [5].

The three processes of gathering, preserving and analyzing educational data comprise the core elements of EDM models. The methods used to collect educational data, such as the responses to online student quizzes, the activities of educational intelligence systems, and all pertinent information, comprise the first stage. The next phase involves archiving, browsing, and saving instructional data. The final stage involves evaluating educational data using various methods, including machine learning, to fully comprehend the educational data, investigate the relationships between data features, and create a model to obtain a comprehensive quantitative grasp of cognitive processes in general [6].

EDM uses different methods and algorithms for various tasks, including decision trees, association rules, clustering, naive Bayes, support vector machine, neural network, and k-nearest neighbour algorithms [7]. Data mining techniques and functions can be utilized for various purposes, including student success prediction, syllabus arrangement, student enrollment in particular courses, and improving student performance by identifying the

most important variables influencing the pass rate of students [8]. EDM embraces an extensive variety of frameworks, encompassing (but not restricted to) optical information analytics, domain-guided data excavation instruments, knowledge retrieval frameworks, suggestion frameworks, social network analysis frameworks, cognitive psychology and psychometrics.

EDM involves constructing and executing information extraction methodologies that enable the scrutiny of extensive quantities of data from diverse scholarly settings. Academic accomplishment stands out as a pivotal determinant for acceptance into advanced educational establishments. Considering this, it is believed that forecasting the learning procedure and assessing student achievement hold significant goals in EDM [9]. EDM constitutes an ever-evolving domain that concentrates on formulating self-educational and adjustable methodologies to unveil latent correlations or concealed structures in educational data. Furthermore, heterogeneous data contributes to and develops the big data paradigm in the education sector. Hence, certain data mining methodologies are necessary to adaptively glean helpful insights from extensive educational datasets [10].

The utilization exploration for EDM is advancing rapidly due to data mining-linked technologies facilitating the scrutiny of immense quantities of student data to expose helpful patterns of student learning activities. Numerous domains of educational data handling, comprising student retention, dropout prognostication, academic data investigation, and student activities scrutiny, have witnessed the application of data mining methodologies [11]. Moreover, the assessment and prediction of student academic accomplishment have perpetually constituted substantial constituents of EDM.

EDM frameworks can be classified into two categories [12]: illustrative frameworks and anticipatory frameworks. Anticipatory frameworks are predominantly employed for data-driven prognostication, while illustrative

frameworks are employed to illustrate models and act as a reservoir for decision-making. The former is chiefly utilized to evaluate students' scholastic accomplishments and advise teaching managers during decision-making processes. In contrast, the latter is mainly employed to foretell students' academic achievements, diminish the probability of school dropout, and improve students' academic performance.

The four main EDM applications are [13],

Predicting Student Performance: It develops the educational process and enhances student learning to predict academic failure. In addition, it aids those involved in education in their efforts to raise student achievement in the future.

Detecting Undesirable Student Behaviors: The primary goal of this application is to identify unfavourable student behaviors, such as incorrect acts, a lack of motivation, cheating, and poor academic performance.

Grouping students: The intention of categorizing student applications is to organize students into groups or clusters according to diverse attributes of their profiles. It is utilized by various educational stakeholders for various purposes to further the educational process.

Student modelling: This application delineates numerous student attributes, encompassing cognition, capabilities, sentiments, domain expertise, learning methodologies, accomplishments, traits, instructional approach, impacts, and evaluation. The goal is to recognize the student's characteristics and adapt the pedagogical approaches to cater to the students' learning requisites.

EDM focuses on creating novel approaches and strategies for identifying patterns in students' behavior from unprocessed, semi-structured, or structured information resulting from stakeholder interaction in intelligent tutoring systems or other educational software [14]. In addition, the EDM tries

to address issues that develop across various stages of the learning process. Consequently, the principal uses of EDM involve information scrutiny and depiction, aid in decision-making for educators and administrators founded on students' input, automated recommendations, anticipation of students' achievements and triumphs, formulation of user models, identification of students' social connections, and numerous additional applications.

1.4 Bloom's Taxonomy

Bloom's Theory is an extensively employed structure that supports educators in formulating learning aims, evaluating student learning, and crafting instructional resources [15]. Benjamin Bloom, an educational applicable in modern educational environments. The cognitive, emotional, and psychomotor domains are the three learning domains that make up Bloom's Taxonomy.

The cognitive domain of Bloom's Taxonomy comprises six distinct levels remembering, understanding, applying, analyzing, evaluating, and creating arranged in a hierarchical order[16]. The initial level is Remembering, which involves recalling information, such as definitions, facts, or procedures from memory. This level emphasizes rote memorization and demands only rudimentary cognitive processing[17].

The next level understands, which necessitates the learners' comprehension of the significance of the information they have memorized. They should be able to explain the information in their own words, identify key themes and ideas, and provide examples.

The third level is applying, where learners are expected to utilize the information they have memorized and comprehended in novel contexts or situations. This level necessitates learners' application of their knowledge to complete tasks, perform procedures, or solve problems.

The fourth level is Analyzing, which demands that learners break down intricate information into smaller, more manageable components and

understand their connections. Learners should be able to identify patterns, connections, and relationships among the various pieces of information.

At the fifth level, Evaluating, learners must assess the worth or quality of the information they have analyzed. They should be able to evaluate the strengths and weaknesses of arguments, recognize biases, and make informed decisions based on the available information.

The final level, creating, emphasizes learners' use of their knowledge and comprehension to generate original ideas, products, or solutions. This level demands imagination, creativity, and critical thinking skills to produce something innovative and unique.

The lower-order thinking skills of Bloom's Taxonomy are encompassed in the first three levels: Remembering, Understanding, and Applying. These levels necessitate that learners recall, comprehend, and apply knowledge in familiar settings. On the contrary, the upper-level cognitive abilities of Analyzing, Evaluating, and Creating are imperative at the last three stages. These levels require learners to engage in more sophisticated cognitive processes like analysis, evaluation, and synthesis.

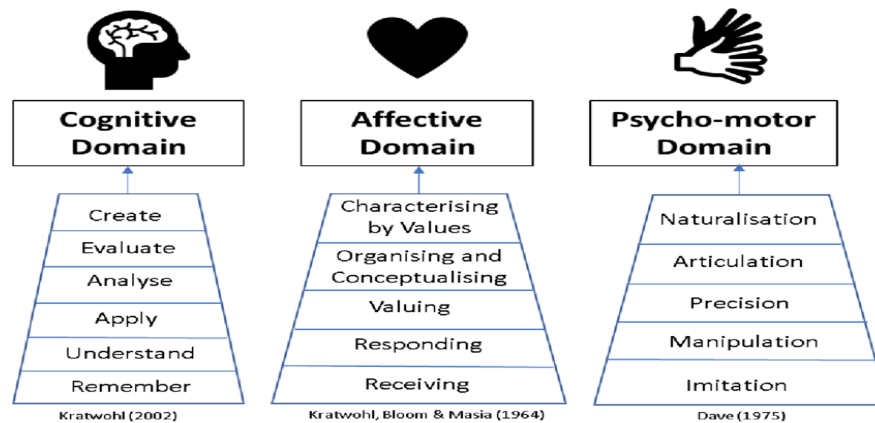


Figure 1.2 Bloom's Cognitive, Affective and Psychomotor Domain

The emotional aspect of learning, encompassing feelings, values, and beliefs, is referred to as the affective domain [18]. It acknowledges that emotions play a crucial role in learning, and students' attitudes and beliefs can influence their motivation, engagement, and success. Therefore, educators

must focus on what pupils know and how they perceive their learning. Each of these categories is given a hierarchy that represents varying learning levels.

The affective domain is classified into five tiers, ranging from simple awareness and acceptance to a more intricate internalization and integration of values. These levels are Receiving, Responding, Valuing, Organizing, and Characterizing [19]. Receiving pertains to the readiness to acknowledge and recognize the information. Responding refers to pupils' willingness to engage and respond to information actively. Valuing relates to the development of a personal interest in the information and the recognition of its significance. Organizing refers to the internalization of values and the organization of these values into a hierarchy. Finally, Characterizing refers to integrating these values into one's self-concept.

On the other hand, the psychomotor domain pertains to physical abilities and skills [20]. It acknowledges that learning entails more than just gaining knowledge or comprehension; it also encompasses developing skills, such as motor skills and coordination, and applying them in practical situations. The psychomotor domain is divided into seven levels, ranging from simple reflex actions to complex movements requiring advanced coordination and control[21]. The stages consist of Awareness, Configuration, Guided Answer, Mechanism, Elaborate Display, Adjustment, and Invention.

By attending to the emotional and physical dimensions of learning, Bloom's Taxonomy provides a more all-encompassing and holistic methodology towards education. Educators can use this taxonomy to create learning objectives that target cognitive abilities and affective and psychomotor skills. It can help ensure that students develop various skills and competencies crucial for success in both academic and real-world settings.

Bloom's Taxonomy provides a systematic and structured approach to learning and teaching. It helps educators develop clear and measurable learning objectives, design effective instructional materials, and assess student learning. It also fosters higher-level and evaluative reasoning competencies

imperative for triumph in the contemporary knowledge-driven economy. The objectives of Bloom's Taxonomy are to provide a framework for developing learning objectives, promote higher-order thinking skills, support the design of effective instructional materials, and assess student learning. By using Bloom's Taxonomy, educators can ensure that their teaching is aligned with the learning objectives, and they can design activities that promote deeper learning.

1.5 Emotional Intelligence

The phrase "emotional intelligence" pertains to the capability, expertise, or self-perceived proficiency to comprehend, assess, and govern one's own feelings, as well as those of others and groups. Individuals with high emotional intelligence possess a profound comprehension of their own emotions and the emotions of others. Consequently, by enhancing their emotional intelligence, individuals can enhance their productivity and success in their professions, as well as the productivity and success of others. The process and outcomes of enhancing emotional intelligence also encompass several elements acknowledged for reducing stress for individuals and organizations, involving conflict management, relationship management, stability, continuity, and harmony. Five overall classifications of emotional intelligence comprise self-understanding, self-control, self-drive, interpersonal awareness, and interpersonal abilities.

These categories span both personal and social competencies [22]. Table 1.2 shows the attributes of emotional intelligence.

Table 1. 2 Emotional Intelligence Attributes

Categories	Attributes
Self-Awareness	<p>Emotional awareness: Identifying one's emotions and how they affect them.</p> <p>Correct self-evaluation: Being aware of one's strengths and restrictions.</p> <p>Self-confidence: Belief in one's inherent value and skills.</p>
Self-Regulation	<p>Self-control: Restraining irrational feelings and impulses.</p> <p>Credibility: Upholding moral principles of honesty and integrity.</p> <p>Consciousness: Accepting accountability for one's performance.</p> <p>Adaptability: The capacity to respond quickly to change.</p> <p>Ingenuity: Feeling comfortable and open-minded towards novel ideas and knowledge.</p>
Self-Motivation	<p>Drive for attainment: Aiming for excellence or improvement.</p> <p>Commitment: Supporting the goals of the team or association.</p> <p>Initiative: The capacity to take benefit of opportunities.</p> <p>Optimism: Perseverance in pursuing goals in the face of challenges and failures.</p>
Social Awareness	<p>Empathy: Perceiving another' thoughts and feelings and actively engaging in their woes.</p> <p>Service orientation: Acknowledging, foreseeing, and fulfilling customer requirements.</p> <p>Assisting in others' development involves recognizing their necessities and fostering their abilities.</p> <p>Capitalizing on diversity: Generating possibilities</p>

	<p>within a varied population.</p> <p>Political consciousness: Identifying the power dynamics and emotional currents within a group.</p>
Social Skills	<p>Influence: Employing compelling tactics that prove effective.</p> <p>Communication: Conveying messages that are convincing and unambiguous.</p> <p>Leadership: Inspiring and guiding teams and individuals.</p> <p>A change catalyst is an individual who initiates or oversees change.</p> <p>Conflict resolution through dialogue and negotiation.</p> <p>Cultivating relationships that fulfill significant purposes.</p> <p>Cooperation and collaboration: Aiding one another in accomplishing shared goals.</p> <p>Teamwork skills: Cultivating group unity in the pursuit of general goals.</p>

The understanding of emotional intelligence can develop some aspects of education. Education and emotional intelligence collaborate to produce utmost contentment and triumph in life [23].

It can be applied to interpersonal relationships: For humans as social organisms, cooperative life and interpersonal relationships are highly valued. Establishing, maintaining, and having good interpersonal relationships depend on possessing emotional intelligence skills. According to research, good relations and emotional intelligence are strongly positively correlated.

It can be applied to the psychological well-being of the person and society: The cornerstone of the educational system lies in the comprehensive growth of one's character. According to research by Mayer and Salovey conducted in

the USA, college students with elevated emotional intelligence report reduced physical symptoms, diminished social concern and sadness, employ more active coping mechanisms, and perceive stresses as less dangerous, resulting in psychological well-being.

It is vital for administration, business, and decision-making procedures that education places emphasis on decision-making and problem-solving abilities. As per numerous researchers, the essence of sound decision-making lies in attaining equilibrium between one's emotions and thoughts. Good feelings and moods appear to aid in decision-making. Individuals who encounter positive feelings regarding themselves are more inclined to employ strategies to expedite decision-making. In addition to enhancing problem-solving abilities, pleasant emotions help people develop better solutions to difficulties.

It oversees the learner's academic success: Academic achievement is the only factor in the educational process. Emotional intelligence may be a modulator of cognitive abilities' effects on academic success. Stress and emotional challenges while studying tend to have a greater impact on individuals with insufficient emotional intelligence. By possessing the ability to be attentive to their thoughts and experience emotions clearly, one can overcome negative mental states that significantly influence students' mental well-being and emotional equilibrium, subsequently affecting academic achievements.

Everyone knows that negotiating is an emotional activity, hence these aids in effective negotiation. Understanding one's and others' emotions and moods can aid in managing stressful situations and enhancing dispute resolution. Emotional intelligence and effective negotiation require active listening skills and the ability to read nonverbal signs to identify and understand emotions.

The capacity to understand, make positive use of, and control one's own and other people's emotions and attitudes is known as emotional intelligence (EI). Emotional intelligence assists students in developing stronger relationships, succeeding, and achieving their career and personal goals. Daniel Goleman, a well-known psychologist, devised a framework of five characteristics that characterize emotional intelligence are Awareness of oneself, discipline, motivation, determination, empathy, and social abilities. It is a likert scale with values that range from "Not at All" to "Rarely" to "Sometimes" to "Often" to "Very Often." Based on the sum, the respondent is classified as high, average, or low.

Here there are types of questionnaires explained for measuring other chosen emotions.

The Positive and Negative Affect Schedule (PANAS) [24] is widely used to assess mood and emotions. This brief scale consists of 20 items, with 10 gauging positive affect (for example excitement or inspiration) and the remaining 10 gauging negative affect (for example distress, scared). Participants rate each item on a five-point Likert scale, ranging from one, indicating extremely slight or no affect, to five, signifying an extreme intensity of the experienced emotions during a specific period. An individual is classified as positive or negative based on the emotion that received the highest score.

Self-esteem is the belief in one's abilities or values. A person with great self-esteem has a good chance of success. However, success in life and high self-esteem are mutually exclusive. Rosenberg formulated a scale comprising 10 items, known as the Rosenberg Self-Esteem Scale, to evaluate positive and negative perspectives concerning one [25]. The respondents rate each question on a 4-point Likert scale; range from powerfully agreed to disagree. Based on the response score, the individual is classified as having high, average, or low self-esteem.

The Self-Determination Scale (SDS) [26] was devised to evaluate variations among individuals based on their self-governing approach. It is based on considering each person's unique personality, which reflects (1) becoming more conscious of their emotions and intelligence of personality and (2) having a sense of agency over their activities. The SDS is a concise scale with ten items, subdivided into two sets of five items each. The initial subscale is self-awareness, while the second subscale pertains to perceived choice in one's behaviors. A total SDS score can be generated by combining the subscales or using each independently.

Personality culminates in an individual's emotional, cognitive, and behavioral changes. Affectivity is fundamentally influenced by personality. The Eysenck Personality Inventory is used to determine a student's personality. The Eysenck Personality Questionnaire (EPQ)[27] is a survey used to evaluate a person's personality characteristics. It was created by psychologists Sybil B. G. Eysenck and Hans Jürgen Eysenck. There are 100 Yes/No questions on the Eysenck Personality Inventory. The question asked each respondent to choose one response from each group that best summarized their feelings throughout the previous week. The participants are classified as extroverted, neurotic, or psychotic based on their replies to 100 items used to compute their score.

Emotions of joy, satisfaction, contentment, and fulfilment characterize a state of emotional well-being known as emotional happiness. The Oxford Happiness Questionnaire[28], which has 29 multiple-choice items, is used to quantify it. Each item has four options designed to represent incremental steps between two satisfaction levels, low and high. The respondents were instructed to choose one statement from each group that best summarised their feelings over the previous week. The participants are classified as Happy, Moderately Happy, and Unhappy based on how each participant responded to the 29 items that made up the score.

Self-efficacy is the conviction that one can carry out a task or accomplish a goal. It encompasses an individual's confidence in managing their behavior, exerting influence on their environment, and sustaining motivation in the pursuit of their objective. The GSE Measure [29] is a psychological instrument comprising 10 items, designed to assess people's optimism and their ability to handle diverse challenging situations in life. Based on their overall scores, the students are categorized into high and low groups.

1.6 Types of Questionnaires

The questionnaires can be categorized into two types: Open-ended and closed-ended questionnaires.

Open-ended queries permit participants to reply in free-text format and articulate their complete knowledge, sentiments, and understanding. It denotes that the response to this inquiry is not limited to a few options. Qualitative market research depends significantly on open-ended questions. A query with an open-ended reply enables the respondent to reply based on their data and skill. The respondent's comprehensive and detailed insights offer the possibility for further conversation and refinement. An Open-Ended query presents chances for the investigator and the respondent to study.

Figure 1.3 illustrates a few instances of open-ended questionnaires.

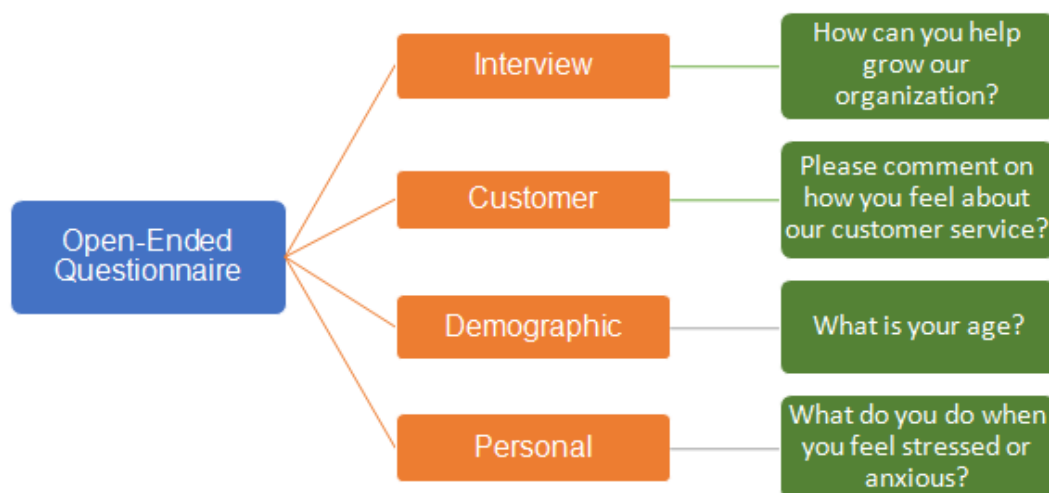


Figure 1.3 Open-Ended Questionnaires Categories

The unstructured questionnaire offers numerous advantages, but analyzing and arranging the data into reports can be challenging. An excessive number of queries could straightforwardly impact the response rate. Additionally, the open-ended questionnaire might yield unrelated data.

A survey acts as a research instrument comprising inquiries or cues created to amass information from participants. Two different kinds of questionnaires exist: structured and unstructured. Structured questionnaires collect numeric data and are utilized to assess or validate pre-established accuracy. These questionnaires are meticulously crafted and engineered to amass precise data.

Additionally, it initiates a systematic inquiry, contributes data, verifies previously collected data, and assists in refuting any prior notions. Qualitative questionnaires, also known as unstructured surveys, are utilized to collect non-quantifiable data. For instance, when exploring data to either validate or challenge a hypothesis, researchers employ qualitative questionnaires. These questionnaires have limited structure and include just a few branching questions, giving respondents the freedom to express their thoughts. The open-ended nature of the questions is meant to elicit specific replies from respondents. However, this research centers around structured quantitative questionnaires, which are commonly referred to as closed-ended questionnaires.

Closed-ended queries necessitate respondents to select from a restricted assortment of pre-defined responses, such as "yes," "no," or multiple-choice options. Closed-ended questions are often utilized to collect statistical information from the respondents. They could get a variety of forms, but all are characterized by providing specific options for the respondents to choose from. Figure 1.4 illustrates the various types of closed-ended questions.

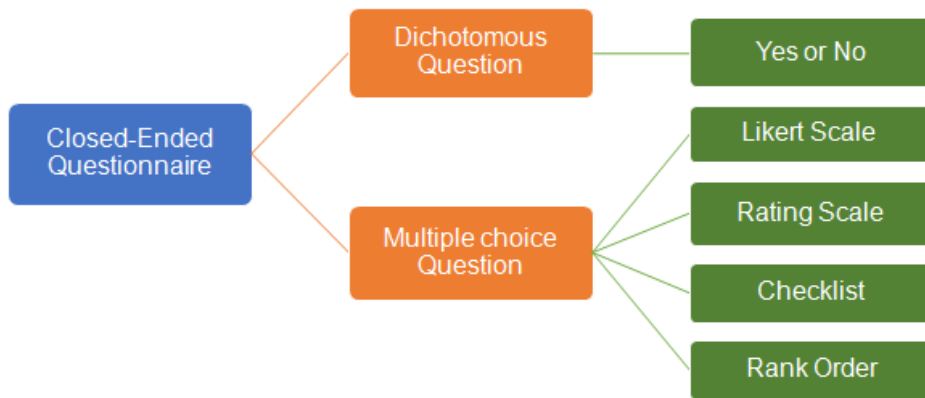


Figure 1.4 Varieties of Closed-Ended Queries

This research work uses closed-ended questionnaires.

1.7 Machine Learning in Education

Machine learning falls under the umbrella of artificial intelligence, concentrating on crafting algorithms that empower computers to learn from data without requiring explicit programming [30]. It has numerous applications in various industries, including education. Although machine learning is not widely implemented in education, it's potential to transform learning and teaching experience is significant.

One of the primary benefits of machine learning is its capacity to rapidly and accurately process and analyze vast volumes of data. Consequently, it becomes an ideal instrument for educators to discern patterns and trends in student performance data. Through data analysis, machine learning algorithms can discover students at risk of lagging or requiring additional assistance to reach their utmost potential.

Machine learning can also help educators personalize learning experiences for each student based on their specific needs and learning preferences. By analyzing data from student assessments, educators can gain insights into each student's learning style, strengths, and weaknesses. It permits educators to customize their teaching methodologies and resources to align with the

distinctive requirements of each student. Furthermore, machine learning algorithms can also aid educators in devising efficient interventions and teaching approaches grounded in the analysis of student data. For example, educators can identify specific areas where students are struggling and provide targeted interventions to address these areas. As a result, educators can help prevent students from falling behind by intervening early and improving overall student outcomes.

Another advantage of machine learning in education is its ability to personalize learning experiences. By analyzing student data, machine learning algorithms can create personalized learning paths tailored to each student's needs, interests, and abilities. Consequently, it could assist learners study efficiently and effectively and help educators provide more targeted support. For example, a machine learning algorithm could recommend specific learning resources to students based on their interests and learning style or provide immediate feedback on their progress.

Machine learning can also help improve the efficiency and effectiveness of education. By automating certain tasks, such as grading and assessment, educators can save time and focus on more important tasks, such as teaching and supporting students. Machine learning can also help identify areas where curriculum and instruction can be improved by analyzing student data and identifying areas where students struggle or excel. It can help educators make data-driven decisions and improve the overall quality of education.

Another advantage of machine learning in education is its ability to provide real-time feedback to students. Traditional feedback methods, such as assessments and grading, can be time-consuming and may not provide immediate feedback to students. Nevertheless, machine learning algorithms can examine student data in real-time and offer immediate feedback on their performance. Consequently, it can aid students in comprehension. Furthermore, real-time feedback can assist educators in recognizing areas

where students might necessitate supplementary support and intervene early to enhance student outcomes.

On the whole, machine learning holds the potential to transform education by enhancing the efficiency and efficacy of teaching, delivering personalized learning experiences, and discovering students at risk of falling behind. As the field evolves and more data becomes available, machine learning will likely become an increasingly important educational tool.

1.8 Sentiment Analysis in Education

Sentiment analysis (SA) is a technique that focuses on determining sentiment polarity and direction towards a specific entity, which could be a person, a concept, or an endeavour. The objective of sentiment analysis is to ascertain citizen's viewpoints, detect the sentiments they state, and subsequently classify them as favourable, unfavourable, or neutral.

Document level [31], sentence level [32], and aspect level [33] are the three divisions of SA. Document-level SA makes an effort to categorise opinion documents as having a favourable or unfavourable point of view or attitude. The entire book serves as a straightforward informational unit (concerning a single subject). The goal of sentence-level SA is to group the emotions that are communicated in each sentence. Identifying the statement's subjectivity or objectivity is the first step. If the sentence is subjective, sentence-level SA will evaluate whether it represents favourable or unfavourable opinions. Finally, aspect-level SA is concerned with categorising thoughts on certain entity attributes. The entities and their different aspects need to be defined first.. As a result, many points of view will be expressed on various aspects of the same entity.

Sentiment analysis has found extensive application in diverse contexts, encompassing customer reviews of products [32], the financial industry [34], sales prediction [35], tweet data [36], and sarcasm detection [37]. In the realm

of learning, sentiment analysis has achieved increasing prominence. In contrast to the aforementioned segments of societal and business networks, which focus on individual users, sentiment analysis research in the education domain encompasses multiple perspectives; include teachers, students, decision-makers, and organization. By evaluating learners' approaches and behaviors concerning course, platform, organization, and instructors, sentiment analysis is chiefly employed to enhance teaching, managing, and assessment.

Rajput et al. [38] suggested utilising sentiment analysis to evaluate teachers based on feedback provided by students at the end of a course. In order to use a Knime's text processing capabilities for sentiment analysis of student input, a workflow was developed. This approach promotes classifying comments as good, negative, or neutral using a sentiment score.

By integrating machine learning and lexicon-based approaches, Nasim et al. [39] suggest analysing the emotions represented in student responses. The textual feedback, which is typically given at the end of the course, offers helpful insight into the general quality of the instruction and makes recommendations for improving certain teaching methods.

Aung and Myo's [40] comprehensive lexicon-based analysis of students' textual replies aims to determine instructional performance levels. To establish word polarity as a point of linguistic reference, they develop a vocabulary of English emotive expressions.

Sentiment Analysis finds utility in numerous applications. A few of these applications are enumerated below:

Business Based on how customers view the product, choices on demand and distribution should be made. The business can analyse these comments to determine how well its service is performing. Decisions about market expansion can be made based on the real-time sentiments available

Politics Controversial political topics discussed in online forums. The impact of public figures, whether positive or negative, can be determined by looking at what people post on social media.

Recommender System When clients are enthusiastic about a product or service, it suggests that they are experiencing pleasant emotions. These things may obtain high recommendations from potential consumers if users consider the scores or emotions. Opinion analysis is also important in the recommender system.

Summarization Reading all opinions about a specific institution and then making judgments is a time-consuming task for readers. Sentiment analysis (SA) should provide a concise overview of each organization's overall opinions within a given time frame.

Government intelligence To identify its reason, the growth in aggressive behavior might be tracked. People's feelings can be evaluated in order to design policy. This can help in assessing people's attitudes towards each conflict analysed using sentiment analysis (SA).

Education Student feedback is used to assess student behaviors and emotions. To ensure that students understand the lecture's pace and receive support when facing challenges, students tweet at particular points or during certain time slots as directed by the presenter.

1.9 Association Rule Mining in Education

Association rule mining is a data mining approach that reveals associations between variables within extensive datasets [41]. In the field of education, this technique can be applied to examine student performance data and discover patterns and trends that might be challenging to detect using alternative techniques. By analyzing large datasets, association rule mining can identify underlying patterns and relationships between student demographics, learning

styles, and academic performance. It can help educators better understand student behavior and performance and use this knowledge to develop effective interventions.

One of the primary benefits of association rule mining lies in its capacity to uncover connections between variables that might not be readily evident. For example, by analyzing student performance data, association rule mining can identify relationships between specific teaching strategies and student performance or between certain student characteristics and academic success. This information can help educators develop personalized learning experiences tailored to each student's needs, abilities, and interests.

Association rule mining can also help educators identify areas for improvement in curriculum and instruction. By analyzing student performance data, educators can identify areas where students struggle or excel and use this information to adjust teaching strategies and curricula accordingly. For example, suppose association rule mining identifies a relationship between poor performance in a specific subject and a lack of engagement with the material. In that case, educators can use this information to develop new teaching strategies that increase student engagement.

Another advantage of association rule mining is its ability to help educators design effective interventions. Through the examination of vast datasets, association rule mining can pinpoint students who are susceptible to lagging behind or could advantage from additional assistance. It enables educators to create targeted interferences that address particular areas of requirement and enhance student results.

Association rule mining can be a cost-effective way to identify areas of improvement in education. By analyzing existing student performance data, educators can gain insights that can inform their decision-making without incurring additional costs for collecting new data. In addition, it can help

schools and districts optimize their resources and prioritize interventions based on data-driven insights.

Association rule mining can also predict future student performance [6]. By identifying patterns and relationships in historical data, educators can use association rule mining to predict which students are at risk of falling behind, which students are likely to excel, and which students may benefit from additional support. It can help educators proactively address potential challenges and tailor interventions to meet the needs of individual students.

The association rule can be used for student behavior analysis, predicting academic performance. Wang et al. [42] analyze student behavior using association rule mining. For enhancing the existing data association rule mining algorithm, a four-layer data association mining framework is constructed. This framework encompasses data collection, storage, computation, and examination to ease the processing of vast datasets. Moreover, it defines a three-step mining procedure ranging from "data preprocessing" to "discovering association rules" to "attaining pertinent knowledge." A new categorization model for forecasting the outcome of a student's academic subject using logical association rules is presented by Czibula et al. in [43]. The traditional association rules are expanded to indicate different relationships between data attributes.

Overall, association rule mining is a powerful data mining technique that can potentially improve education by identifying patterns and trends in large datasets. By analyzing student performance data, association rule mining can help educators develop personalized learning experiences, identify areas for improvement, and design effective interventions. As data mining continues to evolve, association rule mining will likely become an increasingly important tool in education.

1.10 Types of Recommender System

Recommender systems provide users with personalized service support by monitoring past behavior and forecasting future needs for certain products. To forecast users' preferences for items of interest, recommender systems leverage a range of data sources. The earliest application of recommender systems was in e-commerce to handle the data overload brought on by Web 2.0. Their application swiftly spread to customise online commerce, e-government, e-learning, and internet-based travel. In today's online services like Meetup, Facebook, Netflix, YouTube, and Amazon.com, recommender systems are crucial. In essence, recommender systems are designed to assess a recommendation's utility and value [44]. Figure 1.5 depicts a graphical representation of the recommendation system.

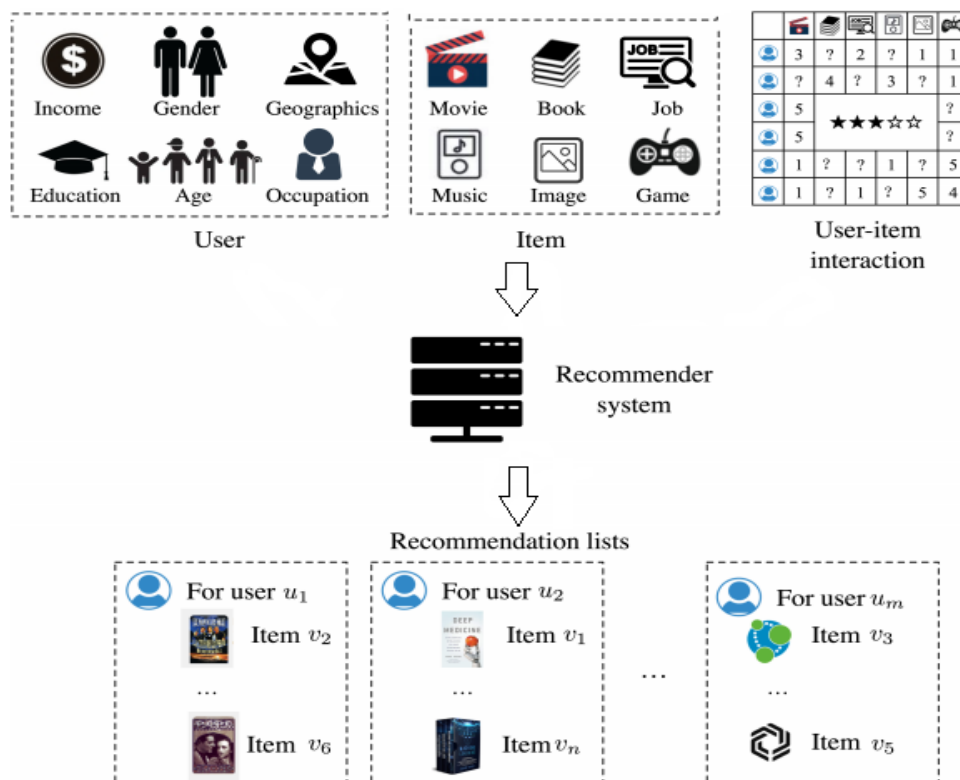


Figure 1.5 Graphical representation of the Recommender system

Significant research has focused on the three main types of recommendation techniques: content-based, collaborative filtering (CF)-based, and knowledge-based techniques. Each of the three categories has unique traits and appropriate application circumstances. Content-based recommendation systems [45] create user profiles based on past activity and suggest products matching those profiles. It is appropriate for promoting stuff like documents or webpages with a lot of content information. The assumption behind CF-based recommendation [46] algorithms is that users who are similar will favour similar goods. Due to the Netflix competition, it has gained widespread usage in different environments. Knowledge-based recommendation [47] employs open knowledge concerning individuals, products, and commercial regulations to outline user interests and give suggestions. It is used in a few multifaceted cases when products like cars, houses, and insurance are not graded or are not commonly purchased. The combination of the three strategies above (hybrid model) [48] is frequently used in real-world recommender systems since each strategy benefits from the strengths of the others to make up for its shortcomings.

1.11 Motivation

Education is a potent change agent that creates prosperous people, wholesome neighborhoods, strong societies, vibrant economies, and a healthy planet. Every society's fundamental building component is education. Every person has a right to high-quality education and opportunities for lifelong learning. Education is a deliberate endeavor with specific objectives, such as data transmission or cultivating abilities and character. Education encompasses many concepts, one of the most renowned is Bloom's Taxonomy. Dr. Benjamin Bloom, an educational psychologist, devised a system in 1956 to classify learning goals into various domains that inspire teachers to adopt a holistic approach to education.

Bloom categorized learning behaviors into three domains: the cognitive domain (involving knowledge or mental abilities), the affective domain (encompassing attitude or emotions), and the psychomotor or physical domain. Bloom emphasizes that a student grows knowledge worthy, emotionally and skillfully during learning. All three domains influence one another. The objective of education is attained when there is the highest development of the individual as a member with knowledge and positive behavior traits that influence their self-growth and societal growth. In order to help the instructor connect the chosen cognitive parameter with the emotional parameters using educational data mining, this study examines the relationship between the cognitive field and the emotional field.

The vast amount of data emerging in the educational sphere is the focus of the research field known as educational data mining. In the following forms of the discovering data as a data set, different processing methodologies are employed to derive an intriguing pattern from it, which can then be used for further analysis and decision-making for the re-modelling of learning patterns, improvement of teaching methods, as well as for the increase in quality of the educational system.

EI is considered the main affective attribute. SE, SD, GSE, EH, PANA and personality are secondary affective attributes used to evaluate the affective domain. This research studies the association between the main attribute, second-level attributes and academic performance, the attribute for assessing the cognitive domain.

A criterion-reference model is a method for determining how well a student has met the course's objective. The evaluation is conducted using predetermined criteria. The findings are relationships between the student's performance and the specified standards. The grade is given according to the criteria the student met concerning the requirements. CGPA is used to assess the student's academic performance. Academic performance is classified

based on Credit Grade Point Average CGPA as Excellent (9 - 9.9), Very Good (8 - 8.9), Good (7 - 7.9), Above Average (6- 6.9), Average (5 - 5.9), and Fail (<5).

1.12 Problem Statement and Research Objective

The wide concept of education includes gaining general knowledge, self-awareness, and skill development. Education is a crucial element for behavior change, even while it is insufficient. As in Bloom's theory, the outcome of education is fulfilled only when the student is groomed in knowledge, Behavior/Emotions and skills. An effective teacher contributes significantly in a student's education.

The following conclusions are drawn from this study, which suggests a framework for predicting student academic success:

- The effects of emotional intelligence on self-esteem, self-determination, emotional wellness, self-efficacy, Positive / negative emotions and personality individually.
- The effect of personality, emotional wellness, self-efficacy, self-determination, self-esteem, and positive/negative emotions on a person's ability to succeed academically.

This technique assists teachers in comprehending their students' lagging affective condition. Teachers can serve as emotional mentors by examining the disparity between the selected affective characteristics, empowering their pupils to acquire strong emotional capacities in order to thrive academically.

The research goal is to develop a model that predicts student academic achievement by connecting affective, cognitive, and academic domain traits. The primary goals of this study are as follows:

- To consider emotional intelligence as a main affective attribute.
- Select Self Esteem, Self Determination, Self Efficacy, Emotional Wellness , Positive/Negative Emotions, and Personality as second-level affective attributes.
- To use closed-ended questionnaires for predicting student affective states chosen for study.
- To create a sentiment analysis model for identifying student affective states by assigning a polarity value for each questionnaire scale.
- To create a mixed numerical and categorical data clustering algorithm.
- To generate proper rules from clustered data by developing a hybrid association rule mining algorithm.
- To create a recommendation system for foreseeing students' academic achievements through mining association rules.

1.13 Research Contribution

The goal of this research is to build a system that allows students to recognise their affective states and predict academic achievement using sentiment analysis and recommended hybrid machine learning techniques. The following are the research's contributions:

- Sentiment analysis is used to discover a student's affective state. The student responses are collected for the respective questionnaire, which is a close-ended questionnaire. A polarity value is allocated to each question in the questionnaire. The affective state scale is identified using sentiment analysis with polarity scores.
- A proficient clustering algorithm, named Reclust, is introduced for datasets containing both numerical and categorical information.

Reclust employs a reclustering and cluster validation approach, constituting a repetitive process that enhances the cluster's quality outcomes. The algorithm iteratively re-clusters incorrectly clustered data and evaluates it using cluster validation techniques.

- Using associative classification, a prediction algorithm is proposed to generate association rules from clustered data.
- A recommendation system is suggested to forecast the student's academic performance with the association rule generated.

The overall workflow representation of the framework is illustrated in Figure 1.6.

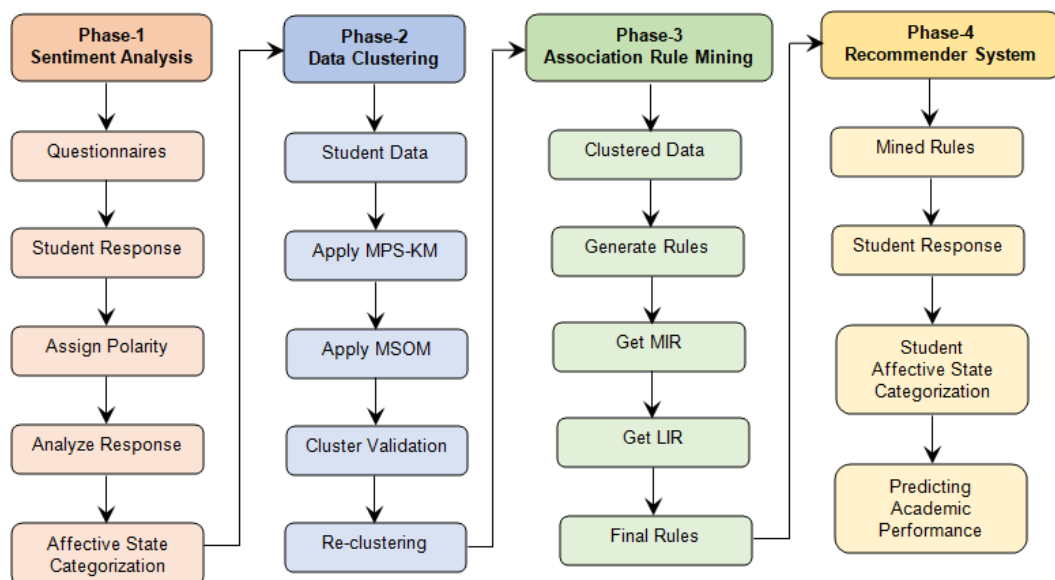


Figure 1. 6 Overall Workflow of the Proposed System

1.14 Thesis Outline

The thesis is structured into 7 chapters. The introduction of the chapter 1 explains the basic concept related to the thesis, including education, educational data mining, emotional intelligence, machine learning, sentiment analysis and association rule mining in education. This chapter further elucidates the problem statement, the aims of the research, and the

contributions made by the study. The remaining chapters are organized as mentioned below.

Chapter 2 provides a literature review pertinent to the thesis. This chapter includes the topics of education data mining, sentiment analysis, association rule, and recommendation. This literature review provided an understanding of various topics' fundamental concepts and different experts' perspectives.

Chapter 3 explains the sentiment analysis technique to identify the affective state. This chapter analyses responses to a closed-ended questionnaire to determine the respective affective level of students using the sentiment analysis technique by assigning polarity scores to the options in the questionnaire. Then, the sum of the polarity-value score is used to identify the students' affective categories.

In Chapter 4, the clustering method developed for datasets containing both numerical and categorical information is introduced. The process begins with the utilization of two clustering techniques, namely Modified Probability and Similarity-based K-Means (MPS-KM) clustering, and Modified-Self-organizing Map (MSOM) for clustering the mixed dataset. Subsequently, re-clustering and cluster validation methods are employed to enhance the accuracy of the cluster results. Through iterative re-clustering and evaluation based on cluster validation, inaccurately clustered data is addressed.

In Chapter 5, a detailed explanation of rule-based classification is provided. This chapter presents an efficient prediction algorithm that leverages rules generated from clustered data through associative classification. The algorithm makes use of two minimum support values to select the MIR and LIR for prediction. By employing the generated rules, this research work predicts the corresponding class and conducts attribute analysis within the rule set based on the predicted class.

In Chapter 6, a hybrid recommender system for anticipating student academic proficiency by assessing the emotional state is detailed. The research utilizes association rule mining to provide recommendations based on behavioral and emotional attributes. Additionally, surveys conducted in real-life settings with questions that have predefined response options, including EIQ, EPI, SDS , GSE, RSE, PANAS, and OHQ are employed in experimental studies.

In the concluding part of Chapter 7, the main discoveries from the research were summarized, and a promising path for future investigations was proposed.