

Review Article

# Investigating Factors Affecting the Learning Process in Higher Education - A Case Study

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**Abstract** - Globalization, Information and Communication Technology (ICT) advances, and the expansion in Higher Education (HE) pose many challenges on HE Institutions (HEIs). Chief among them is gaining a competitive advantage necessary for sustainability, achieving goals and providing a service that satisfies customers (students). Learning is the essential service offered by HEIs, and it involves two other stakeholders in addition to the institutions, namely, students and educators. This study aims to identify the main factors that affect the learning process at HEIs and empirically investigate their effectiveness. Content analysis techniques and exploratory interviews were used in identifying main factors and their associated variables. Data mining was utilized for analysis to discover patterns and extract valuable information. The case study involves students from the College of Computer Science and Information Technology (CSIT) at Sudan University of Science and Technology (SUST). A survey instrument was used to gauge stakeholders' perceptions and expectations of the effect of the predetermined factors. The results showed that many factors have an adverse impact on the learning process and require attention, including transportation, ICT support, and services such as cafeteria and health services, etc. This research contends that identifying and highlighting the effect of factors from the perspective of the main "customers" would yield better students' satisfaction, reduced dropout rates, enhanced HEIs competitiveness and eventually improved learning process.

**Keywords** - Learning process, higher education, ICT, decision-making, data mining, clustering.

## I. INTRODUCTION

Education is defined as a learning process for the individual to attain knowledge. It is an important process for individuals and society since it contributes to the progress and development of societies [1], [2]. No society can advance and become more civilized without education. The culture and values of any society depend on the education of individuals as cultural values are passed on through educational institutions. Generally, the formal educational process is composed of the following stages, kindergarten, primary, middle, secondary and the HE

stage. HEIs deal with the post-secondary level of education, and this includes undergraduate and postgraduate colleges, universities and centres.

Numerous research [3], [4] has shown that the core functions of HEIs are: education, research and contributing to society. In addition, they play a vital role as a supplier to the labour market, as they provide highly qualified human resources. Learning is the most important process in HEIs, and it involves three main stakeholders, students, educators, and institutions.

HEIs currently face a variety of challenges, as the spread of ICT and globalization has unlatched international competition in addition to the local one. Moreover, the surge in the number of students without financial support from governments and the expansion in HEIs both locally and globally. Confronting these challenges requires strategic and tactical planning by HEIs as they must maintain their existing students and stay competitive in recruitment by providing a service that satisfies their customers (students). HEIs must also respond to and stay in line with the continuous changes in the labour market. Focusing on learning and how this service can be provided in a modern, efficient, and satisfactory to students will make HEIs more competitive.

Innovations in ICT have enabled HEIs to better respond to their growing challenges and achieve their objectives. Currently, almost all HEIs utilize ICT in different capacities to support students' operations, HE management, administrative operations, and planning. Many research articles [5], [6] were published in recent years on improving the learning process in HEIs. Similarly, there are several studies on the use of data analysis, including data mining techniques in supporting decision-making at HEIs [7], [8], [9], [10]. This paper combines these two research areas by utilizing data mining techniques to enhance the learning process.

To improve the learning process, first, identification and examination of the factors affecting its success must be carried out. Followed by an investigation of stakeholders' perceptions. From the previous discussion, the following research questions arise: what are the main factors that affect the learning process? How can HEIs improve the



learning process? This study's objective is to identify and evaluate the factors that influence the learning process from the perspective of students. The study focuses on students because they are the main stakeholders, and their satisfaction is the target of HEIs. For this purpose, a survey instrument was administered to CSIT students at SUST in a classroom setting.

In order to deliver a meaningful analysis, data mining clustering techniques were applied to provide further knowledge beyond the data [11], [12]. The aim is to discover structure inside unstructured data, extract meaning from noisy data, discover patterns in apparently random data, and use all this information to better understand trends, patterns, correlations, and ultimately predict students' behaviour.

The paper is organized into five sections beginning with this introduction. The following section presents background information about learning, the learning process, and data mining. The next section outlines the research methodology utilized to identify factors affecting the learning process, create a survey instrument, and the analysis approach. The fourth section presents the survey results and discusses their significance. At the same time, the last section provides a summary of the research and proposes a future direction.

## II. BACKGROUND

Learning is an essential activity and is even more vital for youth because, through its institutions, they prepare for their future roles in the development of their societies and acquisition of success in life [13], [14]. There are many definitions for learning; the Oxford Companion to Philosophy defines it as "the acquisition of a form of knowledge or ability through the use of experience". Another one is that "learning is an activity with the purpose of making a change in behaviour, attitude, habits, knowledge, skill, etc." [15].

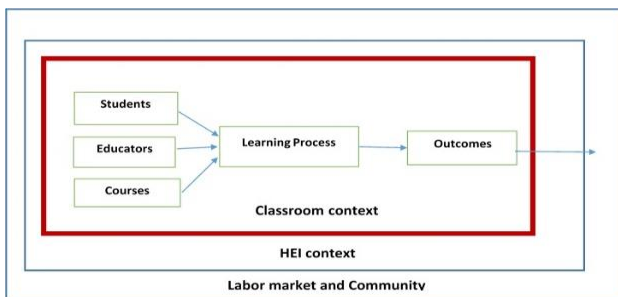


Fig. 1 Learning process

Learning is done through providing and improving the learning process. The learning process is comprised of the interaction between institution, educator, student, environment and courses. The outputs from the learning process are the graduate students and their quality [16], [17]. Fig. 1 gives a general view of the learning process and the interaction between its elements. The practice of learning is done in a classroom context. This could be a physical classroom in traditional face-to-face education or a

virtual classroom in e-learning. The classroom setting affects the ongoing learning process. Classrooms are generally inside the HEI context, where all regulations, policies, environment and facilities provided by the institution affect the learning process. There is a strong bidirectional relation between the labour market and the HEI context, as labour market and community requirements affect the design of curriculum to produce graduates who, in turn, contribute to community and business development. The community is affected by the final output because the development of the community in all aspects such as economic, political, social and cultural depends on the outputs of the learning process.

From the preceding information and discussion, we conclude that the learning process is complex, interconnected and involves many factors and stakeholders. Identifying these factors and how they affect the learning process is an important issue for any improvement. Similarly, stakeholders play a role in the success or failure of the process, with students being the most important one. For two reasons, first, they are at the heart of the process, being the main customers for HEIs. Second, their success is the target and outcome of the whole process as graduates. Therefore, any effort to improve the learning process must take into account the viewpoint of students. This includes investigating their attitude, expectation and perception toward various specific activities and characteristic features of the process, along with socioeconomic factors. The next section presents and explains the factors affecting the learning process in more detail.

Numerous recent research articles have proposed utilizing ICT tools and techniques to assist in HEIs management and planning. For example, using ICT to support the management process [18], to help with decision-making [19], staff development and curriculum design [20], and for general administration (payroll, administration of students' data, etc.) [21]. In this study, the data clustering technique is utilized to analyze the case study survey results. Clustering is an unsupervised learning data mining method that has become an essential component to various organizations due to its significance in decision-making support. Data mining is the process of analyzing data from different perspectives and summarizing it into important information so as to identify hidden patterns from a large data set [22].

Clustering is the process of partitioning a set of data into a set of meaningful groups, called clusters. Clustering algorithms can be used to find natural groupings when there are many causes and no obvious groupings. Clustering relevant data in several clusters makes it easy to analyze. In this study, we explore and analyze the factors that affect the learning process from students views. Thus, partitioning students into groups based on their characteristics and how they assess these factors simplifies data analysis and the understanding of the problem.

The widely used clustering algorithm, K-means, is the one selected for data analysis. It is considered a hard-

clustering algorithm since each object is assigned to one cluster. The k-means algorithm is simple and easy to understand [23].

### III. METHODOLOGY

This section describes the methodology used to realize the research objectives by answering the research questions. It is organized into two phases: In the first phase, content analysis and analytical research procedures are used while performing an extensive review of the literature to identify the factors that affect the learning process. In the second phase, a questionnaire is designed to gauge the effectiveness of the previously identified factors on the process.

#### A. Factors Affecting the Learning Process

In the first phase, we review the literature to explore, identify and analyze in detail the learning process, factors affecting it, and stakeholders involved. Consequently, and as outlined in the previous section, the process of learning is influenced by many factors related to student, family, class, colleagues, educators, courses, teaching methods, technology, HEI policy, regulations, aids and the general environment. These factors can be grouped into six main factor groups or dimensions, namely: environment, student, teaching, academic advising, HEI, and ICT.

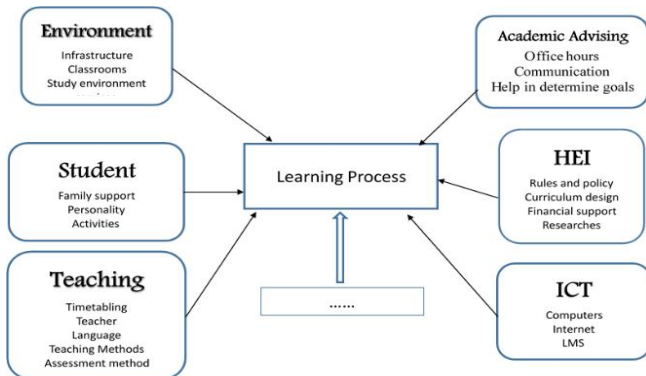


Fig. 2 Factors affecting the learning process

Fig. 2 presents these six dimensions with arrays of their comprising factors or characteristics. These arrays are dynamic and can expand or reduce in size over time.

**a) Environment:** The learning environment refers to the space allocated for classrooms, science labs, open spaces and offices. It also refers to diverse physical locations, contexts and cultures in which students learn [24]. From this definition, we can see that environment is about different physical aspects that affect the learning process inside the classroom, e.g., light, sound, air-conditioning, seats, etc., and outside the classroom. The physical classroom environment is one area that makes an obvious impact on students' success because most of their time is spent there. There is a clear relationship between the physical structure of the classroom and the psychological factors as behaviour and interaction in the classroom [25].

The HEI environment outside the classroom, such as roads, gardens, parking, adjacent buildings, easy

movement, etc., all these things affect the behaviour of students and their achievement and their motivation towards study.

**b) Student:** The student plays an important role in the success of the learning process. There are many student characteristics that influence the process. First is motivation or desire, and this is the driving force behind student learning and success [26]. The second is family environment and support. This is characteristic is reflected in students' relation to their parents, their communication with them, and their family income. Students who live in a stable family environment and find good support do well in their studies. Third, the relationship and communication with colleagues.

**c) Teaching:** This dimension contains five important factors; the first and foremost factor is the educator. The role of an educator at HEIs is more like a facilitator than a teacher, as she/he leads students through the learning process. Educators play an extremely important role in guiding students to achieve their academic goals [25]. One of the basic elements that influence the learning process is educators having solid and up-to-date knowledge and encouraging interaction with students in and out of the classroom. There are technical and personal requirements in the teaching factor, such as appropriate verbal instructions, that can be interpreted as the method of teaching, feedback to students about their progress, good relationship with the student, and attitude towards the subject taught [26].

The second factor in the teaching dimension is teaching aids, and they are those materials that help educators explain better and help students understand. Teaching aids play an important role in the learning process, as they motivate students, clarify the information, and make the classroom alive and active. They are many types of teaching aids such as visual, audio, and audiovisual aids [27].

The third factor is courses, sequence of courses, contents, and curriculum design and if it relates to the labour market. All of these aspects influence the learning process. Courses content should meet students' needs, and their objectives must be clear [17]. Related to contents is how the information is displayed or presented to students; the educator must take into account the different learning styles in the classroom [28]. Learning styles refer to the preferred way an individual processes information and also describe a person's typical mode of thinking, remembering or problem-solving. The basic learning styles are visual, auditory and Kinesthetic [29].

Courses assessment methods enable educators to ensure that students learn what they need to meet course learning objectives. They include strategies, techniques, tools and instruments for collecting information to determine the extent to which students demonstrate the desired learning outcomes. Using multiple assessment methods leads to a complete view of students' achievement.

The fourth factor in this dimension is the teaching method, and this is the method of subject delivery to students. Teaching methods must correspond to students'

characteristics. There are different kinds of teaching methods, including lecture, discussion, question and answer and group work. Choosing the appropriate method leads to increased learning achievement [30]. The last factor in the teaching dimension is the lectures timetable. Timetable setting is an important issue; for example, if the timetable is compressed and does not contain any gaps between lectures, it negatively affects students' comprehension. Students need time between lectures to perform other activities such as eating, drinking, praying, etc. They also need to relax their mind so receiving new information could be easy.

**d) Academic Advice:** Advising is a process in which advisor and advisee enter a dynamic relationship respectful of the student's concerns. Ideally, the advisor serves as an educator and guide in an interactive partnership aimed at enhancing the student's self-awareness and fulfilment [31]. The advising process can help students to identify personal strengths and interests related to their educational and career goals [32]. Academic advising is important because it is a central key to any student's success in college. Advisers monitor students' academic progress, give students the ability to navigate the HEI policies and procedures better, and assist students in their problems. Continuous interactions between students and their academic advisor are important and help in increasing student retention [33], and this plays a vital role in improving the learning process.

**e) HEI:** The HEI itself plays a key role in the learning process by designing curricula related to the labour market and providing the necessary environment for students and educators. HEI must also establish clear and understandable policies and regulations for students offer incentives to superior students while providing financial assistance to poor students. Moreover, HEI develops research projects and reflect their results on the whole process. All of these characteristic factors directly affect the quality and efficiency of the learning process.

**f) ICT:** It is obvious that ICT utilization and its necessary support have a strong influence on all stakeholders of the learning process. They do so in a number of ways, such as facilitating educators' access to information, the preparation of educational materials and the presentation of information to students. ICT provides the possibility of sharing information between educators and students, and students among themselves. It also enables opportunities for discussion and exchange of ideas through the use of academic sites, social media and collaboration work techniques [34]. Furthermore, the availability of adequate numbers of computers, high-speed internet, Wi-Fi, secure data processing and support is extremely important for students and facilitates their learning.

**B. Survey Design**

In the second phase of the research, a survey was designed to capture students' feedback on the identified factors influencing the learning process. The questionnaire consists of two sections; the first is about personal data to illustrate the characteristics of the sample of the study,

including college, department, academic year and gender. The second section is divided into six sub-sections corresponding to the dimensions outlined earlier. These sections consist of 71 questions, with each dimension covering its related factors.

A five-point Likert scale was used to measure student responses to the questionnaire sections as follow: 1 - "strongly disagree", 2 - "disagree", 3- "neutral", 4 - "agree", 5 - "strongly agree"

The WEKA data mining tool was used for analyzing the survey results. WEKA stands for Waikato Environment for Knowledge Analysis, and it is a data mining or machine learning tool [35]. It is an open-source tool that supports different standard data mining tasks such as data preprocessing, classification, clustering, regression, visualization and attribute selection. WEKA is easy to use and has many built-in features that require no programming [36].

**IV. RESULTS AND DISCUSSION**

The participants in this study are students from the CSIT College at SUST. CSIT has four departments, namely, Computer Sciences (CS), Computer and Information Systems (CIS), Computer Systems and Networks (CSN) and Software Engineering (SE).

**Table 1. General Characteristics**

Department	Students	Male	Female
CS	83	36	47
CIS	72	35	37
CSN	79	28	51
SE	113	54	59
Total	347	153	194

As Table I shows, the total number of students who responded to the questionnaire is 347; of those, 153 are male (44%), and 194 are female (56%).

The K-means clustering algorithm utilized for data analysis allows users to select the number of clusters. In this study, after exhaustive testing, we decided to use three clusters (k=3) since they gave clear and understandable results. This implies that all analysis results will be divided into three groups based on respondents' feedback. These groups will be called Cluster0, Cluster1 and Cluster2.

**A. Environment**

**Table 2. Environment Dimension**

Factor	Cluster0	Cluster1	Cluster2
1 HEI infrastructure	2.3	3.3	2.8
2 Transportation	1.6	2.5	1.8



3	Classroom environment	2.2	4.0	3.1
4	Study environment	2.0	3.5	2.9
5	HEI services	1.8	2.9	2.4

Table II show the results of the five Environment factors and the Mean for the three clusters, i.e., cluster0, cluster1 and cluster2. Each cluster represents a group of students, and the Mean is the output from the K-means algorithm. The Mean here represents the weighted average. Since we are using the Likert quintet, the range is 4, and the number of options equals 5, then the weighted average becomes 0.8. Therefore, each option Mean falls in the following range: 1-1.79 "strongly disagree", 1.80-2.59 "disagree", 2.60-3.39 "neutral", 3.40-4.19 "agree", and 4.20-5 "strongly agree". It is clear from Table II that "Transportation" is a problem that faces the majority of students. All students have to commute to and from the SUST campus, and the lack of transportation affects their morning lectures attendance. The results of "HEI services" show that most students are not satisfied with services such as healthcare and cafeteria services.

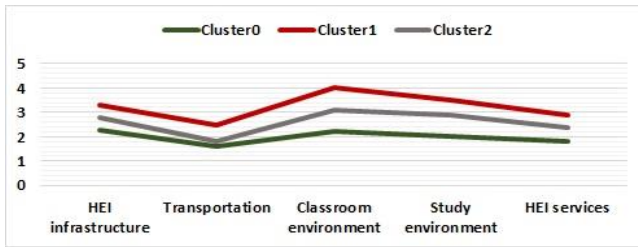


Fig. 3 Environment Dimension

Fig. 3 is a line graph of the Environment dimension results, where the y-axis represents the Mean. From the figure, we can clearly see that students grouped in Cluster0 are not satisfied with the environment factor in general. Cluster1 students are mostly neutral, but they are satisfied with the classroom environment. Cluster2 students are dissatisfied with both transportation and HEI services while they are neutral with other factors.

**B. Student**

Table 3. Student Dimension

Factor	Cluster0	Cluster1	Cluster2
Family support	3.7	4.4	4.1
Personality	2.6	3.8	3.4
Extracurricular	1.7	3.4	1.9

Table III presents the results of the Student dimension. "Family support" explores the student's relation with his/her parents, the ability to communicate with them, and also if the student can pay tuition fees. From Table III results, the general pattern of answers is "agree". This means that most students have good financial and moral support from their families.



Fig. 4 Student Dimension

Fig. 4 is a bar chart representation of the Student dimension, and the y-axis represents the Mean. The second factor, i.e. personality, exposes the students' desire to study, communicate with colleagues, and communicate with people responsible for his/her affairs. From the results in Fig. 4, we can see that some students have problems with this factor. The third factor deals with extracurricular activities such as politics, sports, culture, etc. It addresses the availability of time and infrastructure to practice such activities on the SUST campus. The results in the table and graph clearly demonstrate that SUST needs to put more emphasis on supporting these activities as they positively affect students and learning.

**C. Teaching**

Table 4. Teaching Dimension

Factor	Cluster0	Cluster1	Cluster2
Lectures Timetable	1.4	2.8	1.9
Language barrier	2.3	3.4	2.8
Teaching method	2.3	3.4	2.8
Teaching support	2.8	4.1	3.6
Communication	2	3.5	2.8
Collaborative work	2	3.8	3.2

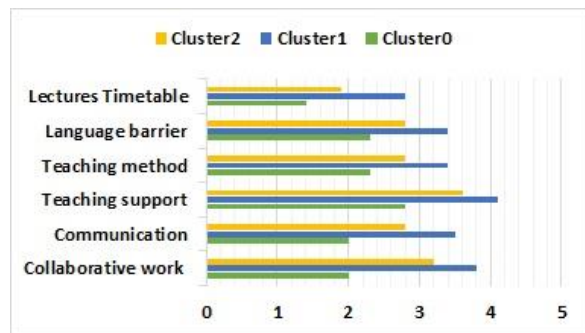


Fig. 5 Teaching Dimension

The result of the analysis of the Teaching dimension and its factors is presented in Table IV and Fig. 5. Generally, most responding students ranked all factors low except the students in Cluster1; they ranked "Teaching support" and "Collaborative work" high. These results reflect the strong dissatisfaction of students with the teaching dimension and have a negative impact on the learning process. Consequently, there is an urgent need for improvements as the teaching factors play a vital role in the

learning process and have a direct relation with students' satisfaction.

**D. Academic Advice**

**Table 5. Academic Advice**

Factor	Cluster0	Cluster1	Cluster2
Office hours	1.2	3.7	2.2
Communication	3.5	3.4	1.7
Help to determine goals	3.2	3.6	1.5

With regard to this dimension, students were asked about the office hours for meeting their advisor, the communication with the advisor, and if they get adequate assistance from her/him to achieve their goals. From the result presented in Table V, there are varying views between dissatisfied and satisfied, and this is due to the evaluation of different advisors. This indicates that there is a difference in performance between academic supervisors.

**E. HEI**

**Table 6. HEI Dimension**

Factor	Cluster0	Cluster1	Cluster2
1 Curriculum design	2.9	2.4	2.0
2 Additional education opportunities	3.9	1.9	1.9
3 Financial support	3.4	3.0	1.9
4 Students' affairs	3.7	3.3	1.9

HEI dimension has four factors, as shown in Table VI. The "Curriculum design" factor addresses the process of course design and the sequencing of courses. From the results in Table VI, the majority of students are not satisfied with this factor since the Mean value is less than 3 in all clusters, meaning that it negatively affects the learning process. The second factor in the table explores if the HEI provides additional education opportunities, such as professional or summer training, internship support, international research projects, etc. This factor, too, has a negative effect on the learning process because students in Cluster1 and Cluster2 are not satisfied. The third factor in this dimension deals with the financial support for students. Here responses vary, as some students see that SUST provides enough support while others disagree. The last factor addresses students' affairs, i.e., do students know where to go if they have a problem or issue, and to whom do they talk. Again, in this factor, there is no agreement. From the discussed results, we conclude that there are some factors in the university HEI dimension that need improvement.

**F. ICT**

**Table 6. ICT Dimension**

Factor	Cluster0	Cluster1	Cluster2
Technical support	4.0	4	2.1
Network and internet Availability	3.6	2.6	2.2
Availability of LMS	3.6	1.8	2.1

From Table VII, most students are satisfied with the first factor, i.e., availability and accessibility of computers and technical support. At the same time, most are not satisfied with the second factor, i.e., internet, network, and Wi-Fi availability; the Mean value is less than 4 in all clusters. This implies that there is a need to provide better internet connectivity with high speed and Wi-Fi connection in order to improve the learning process. The last factor is about the availability of a Learning Management System (LMS), and the majority of students don't know about LMS and have not used it. ICT is an important factor, and there is a relation between ICT and other factors. Supporting and encouraging the use of ICT will lead to improving the learning process.

**V. CONCLUSION**

This paper has investigated the factors that affect the learning process at HEIs. It has identified essential factors and empirically examined the core stakeholders' (students) feedback. A survey instrument was used to collect data from the target group, i.e., CSIT students at SUST. Analysis of the survey results has shown that there are various factors that adversely affect the learning process at SUST. For example, transportation HEI services, including cafeteria and healthcare services, lectures timetable, academic advice, curriculum sequences and ICT support. These factors require further in-depth study, focus and analysis by SUST administrators to explore ways to improve performance and thus enhance the learning process. Furthermore, the research has shown that ICT support is a vital factor, not only because it impacts all stakeholders but also for its influence on other factors as well.

This study has laid the foundation for improving the learning process and achieved the outlined research objective while demonstrating that the use of data analysis tools and techniques is a key component in supporting HEIs administrators and planners in their decision-making. It has also provided the base for further research and extending to other data analysis techniques, case studies, and other related contexts.

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