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The Success of Using Computing Technologies to Improve Learning Outcomes of Students in Higher Education Institutes

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ABSTRACT

This paper presents the importance of Artificial intelligence (AI) in the computing education, which has become an important and powerful aspect of human lives. It is still a field in its beginnings, but as time progresses, we will observe how AI evolves and explores its untapped potential. The rapid development regarding scrutiny of learning outcomes for higher education, establishment and implementation of international standards shows the need of the technology. Many higher education institutes of the world are adopting information and communication technology (ICT) to enhance the Course Learning Outcomes (CLO) of the students based on the revised Bloom Taxonomy that assists the institutions to analyze the outcomes of students in planning the course and techniques to improve and enhance the performance of students. This research paper analysis the importance of blooms in integration of computing technologies and smart learning environment and provides the encouraging results when analyzed by using supervised machine learning methods during the COVID-19 pandemic situation. In this research, we have designed an ICT based framework to achieve the learning outcomes of the students in computing subjects. It is worth mentioning that the proposed educational model reports the promising results of a bout of 83% accuracy. The accuracy of the model is also verified from self-assessment reports of the students.

Keywords: Education; Bloom Taxonomy; Course Learning Outcomes; Online Learning in Higher Education Institutions.

Introduction:

With the continuous advancement and innovation in the ground of higher education, learners are in the state to perceive the knowledge. Due to the uncertain situations during the

COVID-19 pandemic, the prediction of the future education has left many questions in students' minds. However, an efficient technology in the field of education can deliver knowledge to learners rapidly. The lack of technology in the education field has made the learning process difficult to achieve targeted results for both educators and learners. The prevailing tools incorporated in educational systems have encouraging results for the educational system [1]. The vital part in the growth and development of the any state depends upon the higher education, focusing its quality. The results may be not as desired in achieving targets of quality higher education for several reasons[2]. The expeditious growth of technology has framed information societies, a hub where knowledge has been piled up, to provide easy access to information [3]. The norms expounded by the organization of the International Society for Technology in Education (ISTE), involving all participants associated with the educational system to provide access to each as desired by the information society. Under these norms, the Information and Communication Technology (ICT) individuals think as a digital citizen, the learner develops his learning processes, information understanding, and bilateral ties of mutual interest of the field [4]. The skills can be obtained for the student by incorporating ICT in the context of learning impressively [5].

Since last few decades, Artificial Intelligence (AI) flourishing rapidly in the technological domain has been absorbed in every field of interaction in the society. Starting with education problems, AI has extended to other aspects of the society. The AI with suitable guidelines is incorporated in education to boost the results, suggestions with examples showing how AI enhances the efficiency of education with excellence in emerging countries [6]. The queries related to educational problems are responded by using soft computing through data "mined' of interactive learning systems. Huge data is gathered by these systems, which can be utilized by the learner [7]. The different taxonomies are often considered in analyzing the curriculums and education. In designing the learning aims and goals of curriculums, taxonomies are appeared as the mutual language for communicating among learners. The taxonomy was designed by Bloom to assist the learning system. The merits and demerits of the curriculum are also spotted by the taxonomy [8].

With the advancement in the education field, the bloom taxonomy was thought to be insufficient resulting in the revised bloom taxonomy. The objectives of the curriculum are evaluated by bloom's taxonomy during the examination of students [9]. The assessment of learning process achievement is vital to move to analyze the course learning system. The quality and constant progress is important in the learning process, curriculum, aims, goals, and norms in the educational system. The quality of learning outcome and its constant progress are the main features for international recognition as Accreditation Board for Engineering and Technology [10]. A mechanism to analyze the outcome of learning process for graduate students, rating the quality of education as per the necessity of society should be formed [11]. The Covid-19 pandemic is prevailing danger and alarming situation for world as stated by the World Health Organization (WHO). This pandemic of Covid-19 has compelled the social and economic activities in addition, to closing the educational institutions. In order to deal this natural calamity of Covid-19 and resume healthy educational activities the online learning is incorporated in the educational system [12]. The ICT methods provide several ways to deliver quality education to

the students during the COVID-19 pandemic; however, there may be several problems reported by author such as the challenges of the various computing subjects specifically, primary programming ideas, less knowledge about code, language and self-dependence. The author has also marked the different issues related to academic and non-academic of the educational system [13].

Literature Review:

The current scenario of the education system needs renovation. The introduction of the latest techniques and tools has a great impact on enhancing the education system, the gateway to switch over modern learning systems from the traditional learning. The technology in the education system wastes field, however, some issues may be highlighted with electronic equipment concerning with the learning process.

Education has been always a facilitator currently in developing modern learning techniques, with the support of ICT. The prescribed use of these technologies contributes towards achieving the aims and objectives of the most efficient education system for both teachers and students [14]. The ICT usage in the learning process and affecting factors has been the inadequacy of modern tools and equipment. This is considered as the "Infrastructure" factor that affects the role of ICT in education [15]. Fig.1 shows the integration of all the important parts of the ICT required for an efficient students' learning system. The role of AI in the educational system has been not encircled up to teaching and learning. AI has gained importance in policy-making strategies, focusing and capturing educational markets. The main objectives of AI technologies are to develop the educational standards to meet geopolitical policies and frame the business policies in the modern technology market [16], [17] .

The most efficient system is a requirement of time for the solution of complex problems, intelligent system blend of education, technology, and another medium of sources. These smart systems are masters in their field, alter the surroundings, and predict the behaviors. Dealing with computer problems and their solutions, the smart system is drawn incorporating different computer technologies and branches of soft computing. Modern progress towards soft computing is constructive, for conventional computing parity, designing models, and compound computer problems. Soft computing involving different techniques like neural networks, genetic algorithms and fuzzy logic. Nowadays, soft computing technology is used well in social society, industrial and commercial projects. These models act as the human mind [18]. The rapid advancements in the mobile and smart based techniques have revamped the learning scenario into the smart learning domain. This process of transformation has clear impact on the both teaching and learning methods. In order to produce a framework for learning system which focus on performance of student in learning atmosphere, different trends of learners' direction provide solid mode for the teachers customize the student learning. The authors have designed model of self-automated smart learning domain named as meta-cognitive smart learning environment model (MSLEM) [19].

There is a great importance of machine learning technologies to analyze and predict the learning outcomes of the students in the online learning system [20]. The authors in this study have spotted the satisfaction level of the learner with Google hangout, LMS (Moodle) and Google classroom for the online lectures, course guidance and evaluation during the Covid-19

pandemic. This research also advised for online learning with more incorporation of the professional seminars with field tutoring courses[21]. The learning outcomes of the curriculum establish the basis for understanding the teaching. The objectives-learning outcomes for a reliable education program should be strong-minded and approved out as well-defined [22]. The role of taxonomy's objectives is essential in the composition of curriculum and drawing of aims and objectives of learning outcomes. Many intellectual associated with this field had considered this model for learning attainment for primary level education to higher levels concepts [23]. The successful results of students in the central examination will boost the quality of education in the country. Moreover, educationists will take these results in evaluating learning outcomes and, will help design the curriculum [24]. This excerpt provides a thought-provoking avenue for the educational institutes to pledge questions in their curriculum planning process, teaching and learning applications in their organizations. Fig.1shows the situations that present the consideration of how the structure and framework of learning may delay a student and the challenges a highly motivated student has to face. It will assist practitioners to analyse whether learning can be improved when given a free zone or in structured models. In Fig.2, learning is taking place the traditional way whereby a hierarchy is to be followed stepwise and it may appear inflexible and progress focused [25].

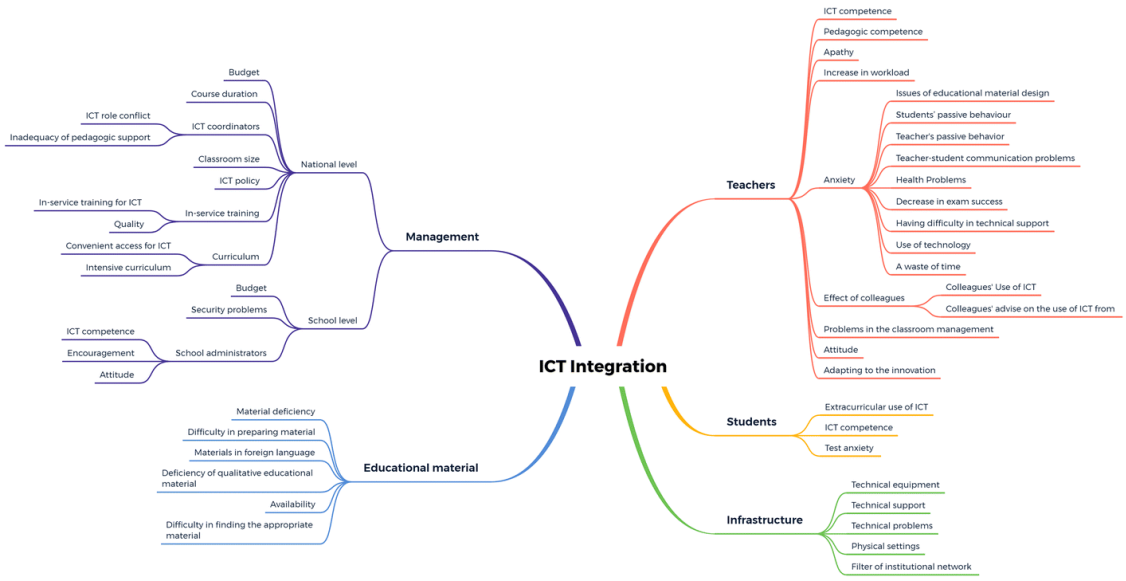


Fig. 1: ICT Integration in Education

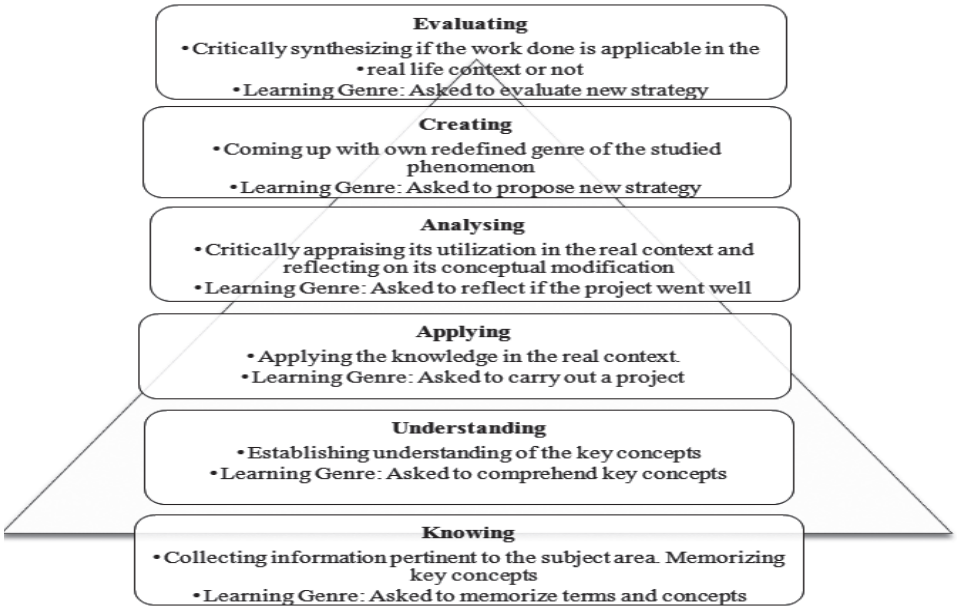


Fig. 2: Student Learning Motivations

For the graduates of the computing discipline, the most demanding skill is programming. As there are various fields for computer graduates, the need for professional skills in the core computing subjects is necessary. To follow the curriculum monitored across the world, CLOs are essential; moreover, many researchers have examined the CLOs of basic programming languages [26]. It was started with a brainstorming session that identified major stakeholders of the program and institutional vision and departmental mission. The contribution of this paper is to apply the blooms level to all core computing subjects in a smart learning environment. Furthermore, with the introduction of new technologies in education, the student records, sharing and storage strategies, the main concern are security and privacy issues [27]. In higher education institutes various authors have proposed cloud-based security for virtual and online learning scenarios [28].

Fig.3 shows the process of Program Learning Objectives (PLO) and its improvement techniques by using continuous quality improvements.

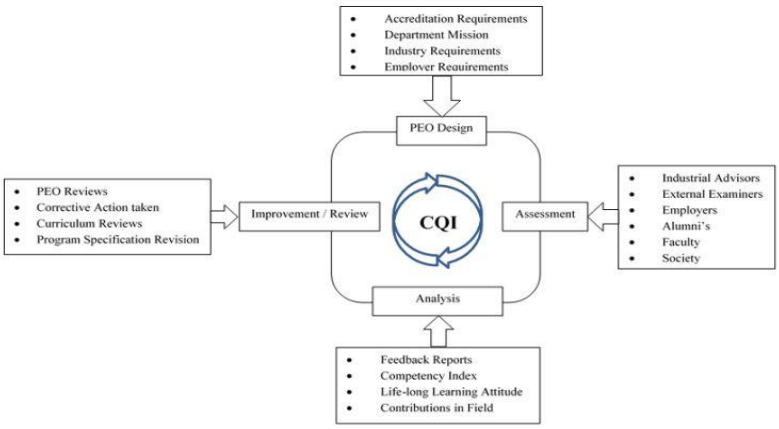


Fig. 3: Process of PLO development and improvement

Methodology:

Fig.4 shows the proposed methodology followed for this research work. The data for this research was collected from the students learning in an online environment. The following steps were followed to achieve the learning outcomes of the students in the computing discipline. MATLAB is used in this study as it gives best results in the development of ANFIS system [29], [30].

Smart Learning/ICT: The results of the sessional, midterm and final exams were collected from the examination department of different universities, where the lectures were delivered in an ICT and online learning environment.

***Bloom's Level*:** The CLO's for the core computing subjects is design conferring to the stages of revised bloom taxonomy.

ANFIS: In the ANFIS system, we have selected some training and testing data for evaluating the results of the students from the collected data. This prediction system will help to predict the Grade Average Point (GPA) of the student.

***CLO Interpretation*:** From the results obtained from the students, we have measured the achievement of course learning outcomes. The achievement of the learning outcomes is based on the GPA of the student. Fig.5 shows the achievement mechanism of CLO evaluation.

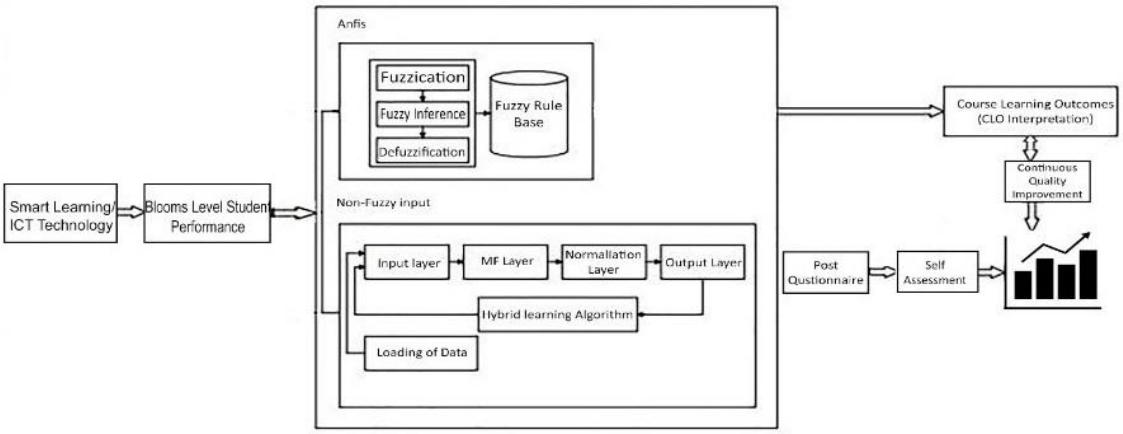


Fig. 4: Research Methodology

The classroom activities, midterm and final exams paper were designed to achieve the learning outcomes of the students. After the evaluation of the learning outcomes of the students, GPA has been measured. The extent of CLO was in progress by mapping the results of courses into different bloom levels. This step was done when the curriculum was designed. Based

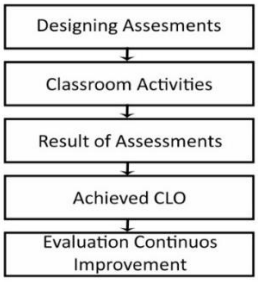


Fig. 5: Achievement mechanism of CLO

on the bloom taxonomy and subject study materials, lectures designed the CLO and the suitable assessment method. Based on the initial design, the lecturers then do the teaching-learning activities for 14 weeks lecture plus 2 weeks' mid-term and final exam. The assessments collected then are processed for CLO and GPA calculation, and evaluation and continuous improvement of course and curriculum. The simple scheme of this process is presented in Fig.5. The various parameters designed for the CLOs are illustrated in Table I.

***Continuous Quality Improvement (CQI*)**: If we are unable to achieve the outcomes of the students then the process of continuous quality improvement helps to figure out the learning outcomes of the students.

***Post Questionnaire*:** To validate the results, a post questionnaire was designed to check the satisfaction level of the students and compared the results of the exam with the response of the questionnaire.

***Graph of Result*:** The results of the achieved CLO and self-assessment are represented in different evaluations.

Table I: Course Learning Items

Code	Course Learning Outcome (CLOs)	Level
CLO-1	How much you can recall the basic concepts learned in DSA subject through smart classrooms.	C1
CLO-2	How much you are satisfied to get the understanding of analysis of algorithms using mathematics in the context of time and space complexity using the smart system.	C2
CLO-3	Basic operations of both data structure types applied on particular data (linear-nonlinear)	C3
CLO-4	Up to what extent you can perform DSA basic operations on both data structures using particular data	C4
CLO-5	How much do you understand the various types of algorithms and their run-time complexities.	C5
CLO-6	How much you are confident to find the appropriate data structure for a given problem and proposed appropriate data structure for a given problem and proposed appropriate solution to solve the particular problem	C6
CLO-7	To what extent do you have (recall) information regarding the internet and intranet.	C 1
CLO-8	Distinguish different types of networks.	C 2
CLO-9	Differentiate between protocols usage	C 3
CLO-10	You can prepare the solutions for the shortest path for the network.	C 4
CLO-11	Develop Analyzes data flow on the network and the concept of network security.	C 5

CLO-12	Develop a network project in a multidisciplinary environment.	C 6
CLO-13	Easily recall the basic concepts of the AI world.	C1
CLO-14	Level of understanding of Agent technologies.	C2
CLO-15	Identify their solutions using AI.	C3
CLO-16	Development of smart systems and their real-life different applications	C4
CLO-17	Development of decision support system	C5
CLO-18	Evaluation of a problem and its characteristics according to time and space complexity.	C6
CLO-19	Able to describe basic concepts and definitions of a database environment.	C1
CLO-20	Illustrates the concepts of transactions, concurrency and recovery techniques in database.	C2
CLO-21	Apply normalization techniques for the given database application.	C3
CLO-22	Outline and design DBMS system which satisfied relational theory and provide business queries, business forms and business reports.	C4
CLO-23	Interprets theoretical information in any language (.net and SQL server)	C5
CLO-24	How much you can use database query languages.	C6

Results and Discussion

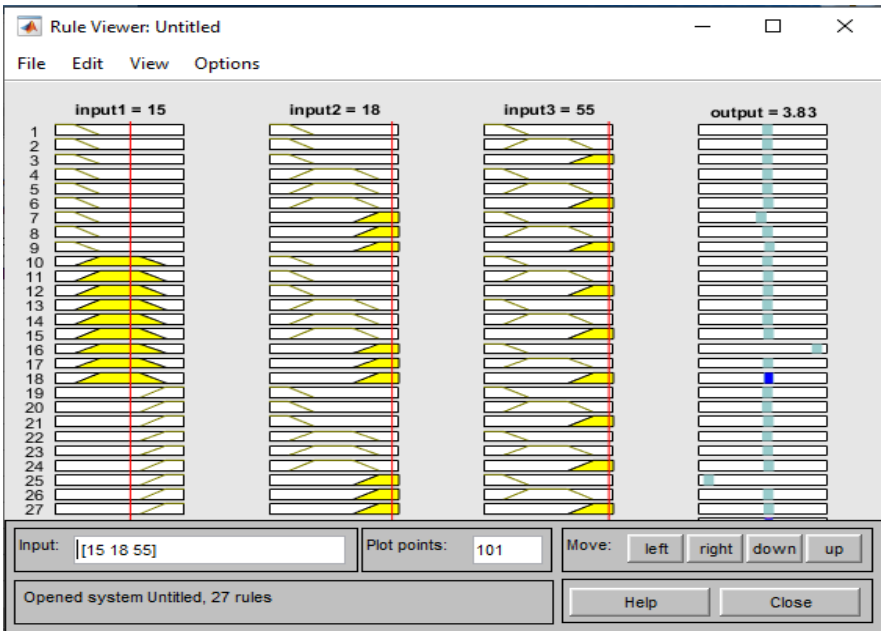
In this paper, a smart learning model was designed with a data sample collected for 300 students. From the samples, 75% of data was utilized for the training and secondhand 25% of the data was for testing purpose. The achievement of the CLO was done by the parameters of the sessional, midterm and final exams results of the students. From these parameters, the GPA is measured using ANFIS system. CLOs have been measured in online environment using smart tools. With the help of these parameters, it have been checked that either the student has achieved CLO for the specified subject or not. The criteria for the achieved CLO was termed as >2 GPA of the student for that particular subject. If the GPA of a students is <= 2, the model shows that the student has not achieved the desired result and needs CQI. To appraise the enactment of the model, the core computing subjects have been selected in this research study. The results of different subjects are prepared for this research work. Some of the results obtained are shown in Fig.6. The data in Fig.6 shows the response of the smart learning system which has been developed to predict the performance of the students. The first three variables are the input and the last variable is the output of the student which is the total GPA. The data of 300 students have been used here for database and data structure subjects. Using these input values, the result of the manual system was 4 GPA, while the proposed predicting system gave the result of 3.83 GPA.

Fig. 6: Response of ANFIS

After evaluation, the ranges of GPA and bloom are discussed in Table II. These ranges of the GPA will help to categorize the achievement of the CLOs.

Table II: GPA Ranges of Bloom levels

Bloom level	**Ranges**
Not Achieved	0-2
Partially Achieved	2.01-2.99
Mostly Achieved	3.0-3.5
Fully Achieved	3.51-4



After designing the criteria here, we evaluated the achievement of CLO of database subject as shown in Table II. According to the GPA achieved by the students, the bloom levels show the achievement of the CLOs.

The results in Fig.7 indicate that most of students have achieved the learning outcomes in database subject in a smart learning environment. In this COVID-19 pandemic, online classes help as a connecting bridge of learning. The cognitive domain contributed overall 83% of the

total CLOs achieved. Continuous quality improvement appeals a procedure for course learning level assessment for each course offered. To confirm the accomplishment of an acceptable course level by an instructor, the selected course learning level was examined by mapping assessment questions to Bloom's taxonomy. After measuring the CLO levels, the CQI is used to identify the CLO's where students have not performed well.

Fig.7: Achievement of CLOs with respect to bloom levels

The CLO's in which students were unable to achieve or not performing well, the suggestions are provided on how to improve those students by knowing either the poor management or personal issues of student.

Table III: Students achievement on the database subject

Student	Sessional	Mid term	Final exam	Over all GPA	CLO Achieved/Not Achieved	Achieve Bloom levels
1	19	17	54	4	Fully Achieved	C1,C2,C3,C4,C5,C6
2	15	05	11	0	Not Achieved	
3	17	17	50	3.75	Fully Achieved	C1,C2,C3,C4,C5,C6
4	20	16	52	4	Fully Achieved	C1,C2,C3,C4,C5,C6
5	17	16	50	3.75	Fully Achieved	C1,C2,C3,C4,C5,C6
6	16	11	46	3	Mostly Achieved	C1,C2,C3,C4
7	17	16	48	3.5	Mostly Achieved	C1,C2,C3,C4
8	19	19	56	4	Fully Achieved	C1,C2,C3,C4,C5,C6
9	17	17	50	3.75	Fully Achieved	C1,C2,C3,C4,C5,C6
10	16	14	50	3.5	Mostly Achieved	C1,C2,C3,C4
11	15	15	48	3.5	Mostly Achieved	C1,C2,C3,C4
12	20	17	52	4	Fully Achieved	C1,C2,C3,C4,C5,C6
13	17	17	50	3.75	Fully Achieved	C1,C2,C3,C4,C5,C6
14	15	16	48	3.5	Mostly Achieved	C1,C2,C3,C4
15	16	07	6	0	Not Achieved	
16	16	15	44	3	Mostly Achieved	C1,C2,C3,C4
17	13	10	26	0	Not Achieved	
18	15	11	43	2.5	Partially Achieved	C1,C2
19	15	12	36	2	Partially Achieved	C1,C2

The date in table III shows the complete representation of the system. In which with the help of students marks in different activities are mapped with the achievement of the bloom's levels. This table also highlights the achievement of course learning outcomes of database subject.

Fig.8 shows the response of the self-assessment of the students. Most students have shown their agreement towards the online learning environment with smart tools. For the self-assessment, a questionnaire was designed and evaluated with the help of 5 steps Likert scale.

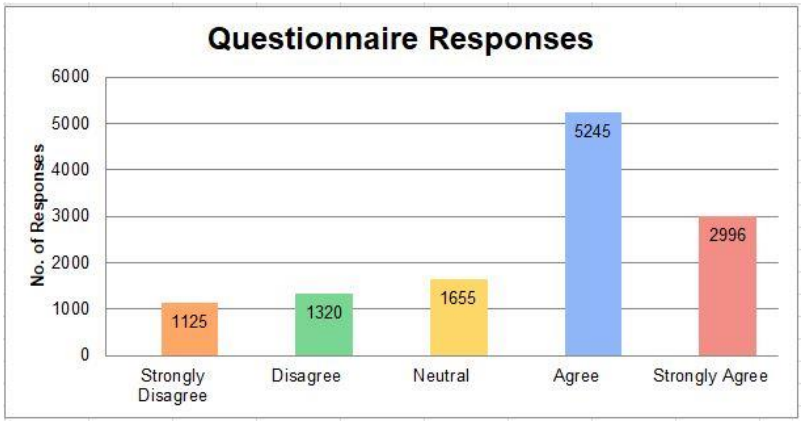


Fig.8: Response of students for a smart learning environment

Table IV: Statistical Analysis

MEAN	3.890941
MEDIAN	4
MODE	4
STANDARD DEVIATION	0.60

The data in Table IV states the agreement of the students towards the online learning environment using ICT tools. As median and mode are 4, this shows the students are satisfied in the smart learning environment.

Conclusion

Education has always very constructive part to enforce AI in the workplace in the future. The vacuum of AI expertise can be filled by only adopting and enhancing the use of technologies for learning. The efforts are to be taken to reconsider the methods of teaching, the content of courses according to AI capabilities. These AI competencies are expounded by many countries, and have been included in their educational systems keeping in view the expertise to point out the problems and their solutions by using AI methods. The problem faced by higher education institutions is to check and evaluate students' performance as per the designed syllabus. The Outcome-based education (OBE) model is a parameter and essential part of learning outcomes in engineering institutions. The research participants in this study have achieved their CLO of core computing subjects under the umbrella of blooms levels in the smart learning environments and ICT technology. In this pandemic situation if the student does not move towards online learning, a massive loss in the field of education has to bear. The successful results show that the impact of bloom's taxonomy is esteemed when used in the smart learning environment. The achievement average is 83%. After measuring the learning outcomes with the help of the GPA calculated from ANFIS system, the process of continuous quality improvements highlights some learning outcomes which are not achieved by the students due to poor computing skills. We also authenticate the results with the post questionnaire. The statistical analysis was performed

on the questionnaire responses and provided a mean, mode, median and standard deviation of 3.89, 4, 4 and 0.60 respectively. This shows the accuracy and the agreement of students in online learning environment. The results show it is successful in the developing a bridge between students and their education. In future the security, privacy and cyber laws will be considered and security precautions will be used to secure the system from unauthorized access. Moreover, more computing subjects will be included to measure the performance of the model more accurately.

Author's Contribution: Saima. Conceived the idea; Nisa, Designed the model and Asghar., did the acquisition of data; Akhtar and Shamshad., Executed model, data analysis or analysis and interpretation of data and wrote the basic draft; Ibrahim, Asadullah and Khuda, Did the language and grammatical edits or Critical revision.

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