A Machine Learning-Based Sustainable University Field Training Framework

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The proposed sustainable University Field Training (SUNFIT) is an educational data mining framework based on the pedagogical strategies of preparing, conducting, and assessing computing students' skills in courses involving practical industry engagement.

Keywords: machine learning ; computing programs ; data management

1. Introduction

With the exponential increase in the number of public and private universities offering different computing programs, it is becoming an important factor and a long-term dream worldwide to recognize universities as world leaders in delivering computing major students with excellent communication skills in higher education [1]. Moreover, a university degree is often measured based on the output of a university or college's young graduates over the years who have successfully taken on different market positions post-graduation. Problem solving in the real world is at the core of many theories and models in higher education [2]. Hence, the development of outstanding students with real-life IT experience has become the primary focus of the vision and mission of computing colleges around the globe. To achieve this goal, field training programs providing students with practical experience outside the classroom are becoming part of the core courses.

The Accreditation Board for Engineering and Technology (ABET) is an accrediting body recognized worldwide as a global leader, ensuring quality and innovations are well established and maintained in the fields of applied science, computer engineering, and information technology education [3]. To maintain educational standards at the highest levels, as highlighted by [4], colleges and departments with computing programs worldwide have recently begun to embrace ABET international accreditation along with national accreditation standards such as the National Commission for Academic Accreditation and Assessment [5], as well as departmental policies aimed at fulfilling the department's mission statement and the overall vision of the university. Unfortunately, the immensity of setting proper evaluation criteria and guidelines of best practices and cooperation among faculties, students, as well as industry staff without Information and Communication Technology (ICT) platforms is a daunting and time-consuming process [6][7]. In some of the core CS courses, for instance, "system analysis and design", apart from technical concepts, graduating students also need to be evaluated on soft skills including verbal and written communication skills to ensure that students are professionally and ethically developed as necessary for their lifelong careers, based on accreditation ontologies [8] and Blooms knowledge Taxonomy frameworks [9]. Identifying gaps between teaching practices at the faculty levels and improving student critical communication skills could ensure that the curriculum is delivered efficiently, accurately evaluated through rubrics, and continuously improved in line with the education standards and best practices [10]. Students do not achieve higher-order thinking skills and competency skills to the expected level in a traditional classroom setup for all learners, thus it is essential to motivate students with new pedagogy techniques and thereby improve learners' performance [11]. As highlighted in [12], there is little evidence now of a breakthrough in the application of 'modern' Artificial Intelligence (AI) specifically towards teaching and learning, in higher education, except for perhaps learning analytics. However, the mining process of student assessment data structures is a significant task, with the aim to acquire crucial fact-finding information that is not otherwise available, or that would require time-consuming and expensive manual procedures [13].

2. A Machine Learning-Based Sustainable University Field Training Framework

Ref. [14] proposed machine learning algorithms using Weka data mining software to measure and monitor students' academic progress. The proposed study is primarily aimed at identifying weaker students and notifying instructors.

However, the research fails to identify how to measure the criteria-based evaluation and how to integrate practical industry experience along with academic studies. The research also does not consider sets of courses that students undertake during each academic year, which are an important factor in students' gradual progress. Ref. [15] proposed a data mining-based approach on ABET criteria to discover relationships between program educational objectives (PEOs) and SOs in engineering programs. The study employed the Apriori algorithm to extract association rules and for decision making. Unfortunately, the study does not consider the core of ABET, i.e., the continuous improvement strategy. In addition, the study only considers at the SOs level and does not consider deep learning at the rubrics level, which is critical in measuring students' performance in different skill sets.

Ref. [16] proposed the integration of the agile Scrum Framework and Cooperative Learning guidance in response to the needs of ABET accreditation into one of the computer information systems (CIS) semi-capstone courses "systems analysis and design" to encourage collaboration, communication, and problem-solving skills while learning system analysis and method concepts. The research proposed two approaches, including "overlapped" and "delayed" methodology including theory-based applied learning best practices, context-based learning, modernized teaching methods, project-based learning in teams, and providing students with formative feedback. The research-recommended improved advice for CIS students could provide them with the ability to obtain input regarding their preliminary analysis before moving on to design and implementation aspects. Nevertheless, the methodology does not address how agile scrum framework implementation could affect the learning experience for CIS students both inside and outside the classroom. In addition, the analysis of data from the students' appraisal against best practices and metrics of performance has not even been discussed.

Ref. [11] proposed a model that incorporates Visual, Auditory, Read, and Kinesthetic (VARK) learning styles in a flipped classroom to improve students' higher order thinking skills. The research work was focused on developing a framework to successfully leverage the ABET learning outcomes and competencies in a systematic way when designing, delivering, or revising an undergraduate and postgraduate syllabus. The approach involved using Information and Communication Technology (ICT) cloud computing tools for education. The research recommended measuring competency skills such as communication skills using Mind-Mapping activity to determine higher-order thinking skills using the flipped classrooms. The outcomes of this research through the flipped classroom strategy enhanced student performance and proved to be a positive learning strategy for engineering courses. Fuzzy logic was used to analyze the performance of learners using MATLAB. However, it would have been interesting to see how in-class and out-class components could be experimented based on students' cognitive levels as suggested by [9].

Ref. [17] proposed a Course and Student Management System (CSMS) to address the course assessment matrix and help achieve department objectives on ABET requirements including teamwork, ethics, lifelong learning, oral, and communication skills. The research focused on facilitating means to assess courses based on course learning outcomes, student evaluation, and student tracking to fulfill ABET criteria. The research also aimed at helping faculties in identifying courses and student outcomes that need attention. However, the proposed CSMS was not a panacea towards the identification of students' performance data on communication skills and other practical skills without ABET assessment and improvement indicators. A deeper educational data mining is needed to analyze the breadth and depth of various forms of assessments and the evaluation of results for course continuous improvement process. Ref. [18] proposed Problem Based Learning (PBL) as a best methodology for students learning one of the CIS semi-capstone courses "system analysis and design", which has diverse areas of concepts from project management skills to communication, design, and implementation expertise. The research recommended that PBL could enhance learning soft skills including communication and teamwork and could be retained as part of lifelong learning. The outcomes of the research included students' positive feedback on changing five lectures to PBL-based classes and suggested incorporating PBL as a way forward and as part of fulfilling ABET criteria. The research recommended giving proper training to faculty members to use PBL effectively and transfer knowledge in their core courses. However, the proposed model does not involve any course measurement data collection strategy, which is critical for ABET for evidence. In addition, the PBL approach alone could be challenging and might not be suitable for courses where communication skills are measured by internal and external faculties such as in field-training cooperative programs while gaining practical industry experience as part of course curricula. Studies conducted in [19][20][21][22][23][24][25] are evident that field training cooperative courses are the pillars of professional programs especially in engineering, computer science and information technology curricula. Moreover, the role of IT as instructional technology, pedagogy and library information system has been instrumental.

Authors in [26] proposed a modern approach to smart education systems by developing a cloud-based collaborative filtering recommendation system using SVM and machine learning. The research aims to improve students' learning efficiency, especially in cloud teaching by the classification and collection of the necessary knowledge for students. Another purpose of the presented algorithm was to increase the engagement between teachers and students in courses

involving document writing and processing. A group of experiences has been conducted in this research, concluding the improvement cloud computing can make in classroom environments. Authors in [27] proposed a sustainable quality assurance framework for outcome-based education (OBE) at the higher education level. Since higher education plays an important role in the life-long learning and other factors of a graduate, the authors suggested a set of guidelines and best practices to foster sustainable quality education; it was mainly based on their experience and the lessons learned from three programs accredited by the ABET. Stakeholders' (such as students, faculty, alumni, and industry partners) engagement was one the prominent guidelines in this regard. Saeed et al. [28] investigated sustainable program assessment practices under the umbrella of ABET and the National Center for Academic Accreditation and Evaluation (NCAAA); ABET is an international body and NCAAA is a local accreditation body in Saudi Arabia. The study contrasts in terms of sustainable program assessment practices by taking the case study of a computer information system program. In continuation to this, the authors further studied the importance and role of academic accreditation in sustainable quality education that instill due skills among the program graduates [29].

In [30], an algorithm for predicting classified training quality was introduced with the objective of the assessment and enhancement of active learning methods for English major students. The presented algorithm uses SVM in combination with the Grey Wolf Optimizer (GWO) to generate a prediction model for classified training quality in English majors. The experimental results of this algorithm have shown superiority in comparison to previously proposed algorithms in terms of computational speed and prediction performance. In [31], authors proposed the Apriori algorithm as an educational data mining approach to investigate the best teaching and learning practices to enhance the overall learning environment at the higher education level. The study encompasses several aspects of students' interests such as preferred learning hours, days of the week, and their preferences towards various learning equipment. The study revealed quite interesting patterns of students' interests to enhance the overall teaching and learning environment at the higher education level. In [32], the authors have investigated the role of various data mining algorithms on the student success prediction at the secondary school. The algorithm includes Naïve Bayes, J48, and Random forests where Naïve Bayes outperformed the other algorithms. The data include the student educational outcomes along with human factors.

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