Volume 39 Number 1 2023 ISSN 0949-149X

Contents

Contributions in: Generic Competences, Attrition, Graduate Students, COVID-19, Motivation, Stress, Systems Thinking, First Year Students, Creativity, Sustainability, Risk Estimation, Design Education, STEAM, Cross-Cultural Comparison, Coaching, Interdisciplinarity, PBL, Student Persistence, Abstract Thinking, Academic Dishonesty, Assessment, Asynchronous Online Discussions, Attitudes, Senior Projects, e-Learning, Team Work, Computer Simulation, Particle Dynamics, Electronic Circuits, Analog Circuits, Fuzzy Numbers

Current higher education is based on a competence development approach including generic competences for the integral development of students. Degrees have been designed based on this paradigm centered on lifelong learning, self-regulated learning strategies and active methodologies in which the student is the core of the formative process, aiming at contributing to develop the key competence learning to learn. In the present paper, strategies for generic competences development and evaluation are discussed in the context of engineering and technical courses and degrees. Challenges in competence assessment as well as alignment of formative assessment, methodologies and learning outcomes are discussed based on a series of experiences. Experience evidence that competence development requires designing activities oriented towards competence development, in which learning outcomes and assessment procedures are clearly defined. The alignment of these three elements is the key for competence development since succeeding in a course by achieving the defined learning outcomes implies succeeding in the acquisition of the generic competences planned. Through the paper it is also discussed that competence evaluation is a challenge for university teachers, for which they will need to be formed and trained, and provided with institutional support.

Keywords: generic competences; transversal competencies; active methodologies; competence evaluation; engineering; technical courses

Available attrition statistics for graduate engineering students do not adequately inform current attrition research because they focus on degree completion rather than attrition or early departure; aggregate science, technology, engineering, and mathematics (STEM) students; and reflect out-of-date data. While recently some work has begun to explore doctoral attrition qualitatively, the purpose of this study is to describe current trends in graduate engineering students' consideration of departure from their programs of study by capturing current numerical data specific to engineering about students' recent attrition considerations. This is important because, since the last studies were conducted, higher education systems have experienced a global pandemic, economic downturn, and sociopolitical turmoil in the United States. Graduate students (n = 2204) in the U.S. completed a survey. The sample includes master's (n = 535) and doctorate (n = 1646) degree-seeking students from 27 engineering disciplines and includes U.S. domestic and international populations. A majority of students considered leaving their degree program in the month before they took the survey: nearly 70% of Ph.D. and 39% of master's students, while 31% of Ph.D. and 16% of master's students seriously considered leaving their program without their degree. Descriptive statistics provide early departure considerations by engineering discipline, gender identity, race/ethnicity, nationality, and year in program by degree sought. Comparisons between groups are presented for gender, nationality, and career stage. It is essential to have an updated and discipline-specific benchmark of attrition considerations for continued engineering education research purposes, for mentorship, and for administrative purposes. Early departure from graduate school remains a threat to innovation and broadening participation in engineering and the professoriate.

Keywords: graduate student; attrition; PhD; Master's; demographics

When COVID-19 struck, engineering schools responded to unique issues, including interrupted capstone projects, cooperative education, and study abroad. Students became a focus. This led to a funded study to investigate the pandemic's impact on engineering students' academic motivation, educational valuation, learning, and perceived stress, which were connected through a conceptual model. Approximately seven months after the onset, a large sample of undergraduate engineering students at a public U.S. university (n = 1,140) responded to a survey (41.6% response), followed by focus groups. Jones' MUSIC Model of Academic Motivation and the Perceived Stress Scale (PSS-10) were key components of the conceptual model. Seventy-eight percent (78%) said their motivation was less versus before remote instruction. Two dimensions of the MUSIC Model were only at the middle point of the measurement scale – *interest* and *empowerment*. Students scored higher on the PSS-10 (M = 22.2) seven months into the pandemic compared to other groups beforehand. Medium negative correlations were found between the MUSIC dimensions and the PSS-10 score, suggesting decreased motivation accompanied by increased stress. *Remote coursework* was the most-frequent de-motivator, and the valued college experience cited most was *Campus-based instruction*. The most-frequent stressor was *Academic*. In all focus groups, low or decreased motivation was mentioned. This research informs Higher Education about undergraduates' motivation and stress, in particular during COVID-19 and contributes to use of the MUSIC Model and PSS-10 with engineering students. Awareness of motivation and stress experienced during COVID is crucial for responding to future crises.

Keywords: COVID-19; pandemic; engineering education; stress; motivation; valuation

Among the numerous aspects of everyday life affected by the COVID-19 pandemic, education stands out as one of those deeply impacted. In this context within university settings, the ICT senior project courses were no exception either. This study presents the recommendations for a hybrid curriculum based on the online implementation of a senior project course in the ICT departments of an engineering faculty. The data were collected to better understand the impact of this re-structured course on 99 undergraduate IT students and their projects during three semesters, and later analyzed qualitatively and quantitatively to obtain some insights. The results indicate that, during the pandemic, the students adapted their senior project studies to the related restrictions by changing certain aspects related to the project, improving their teamwork, and increasing the level of communication. However, they also reported certain problems related to their overall psychology as well as social interactions. In light of the pandemic effect on the software industry towards remote working environments, further suggestions are provided to eliminate the drawbacks of remote working reported by the students and to equip them with the necessary skills. The resulting recommendations could be used by other higher-education institutions and be further adjusted for application in other disciplines.

Keywords: ICT senior/graduation project course; COVID-19 pandemic; virtual meetings; hybrid curriculum

Various models of evaluating eLearning system success have been identified in the past and the need for *effective* evaluation of eLearning systems has been highlighted during the COVID-19 pandemic. The purpose of the present work is to elicit how both academic staff and students (the evaluators) view the performance of eLearning attributes when being taught using an eLearning system. The attributes are ranked using a multi-criteria evaluation algorithm called the Fuzzy Technique for Order Preference by Similarity to the Ideal Solution (Fuzzy TOPSIS). Here, using linguistic-response expert questionnaires, a set of eLearning system attributes and a set of eLearning system criteria are evaluated. The Fuzzy TOPSIS algorithm yields weightings for each of the attributes which can then be ranked to arrive at the optimal solution in terms of how well they contributed to the success of the current eLearning system. IT service quality is found to rank highest, followed by technical system quality, information quality and finally the consideration of different learning styles. Large agreement is seen between academic staff and student evaluators, with minor disagreement between students of two different disciplines. As regards practical implications, it is shown from the rankings that the eLearning system must be re-organized and consideration of different learning styles must be improved. The Fuzzy TOPSIS method has been found to be a reliable and economic evaluation approach of eLearning systems, since it does not require large numbers of evaluators and provides a ranking of attributes which translate directly into priorities for improvement.

Keywords: eLearning; eLearning system; TOPSIS; multi-criteria evaluation; fuzzy numbers

We present the design, operation, and analysis of an online introductory-level analog electric circuits course. The course is an adaptation of a sophomore-level onsite course taught in its current form at the University of Maryland, College Park for a decade and has both a traditional lecture component and an active-learning laboratory component. We compare the expectations, attitudes, and performance of the students whose lab sections were online to those students who took the traditional onsite lab. The study was preformed across four sessions from the summer of 2020 through the summer of 2021 with a total of 111 students. The summer classes were 100% online, but the fall and spring semesters had a mix of onsite and online lab sections. A total of 34 students took the onsite version of the lab leaving 77 students in the online lab sections. Twenty-six percent of the students were female, Hispanic, or African American. The percentage of students passing the course was 88% both for the full cohort and for the underserved population. The percentage of online students passing the course was 92%. Student surveys probed the students' expectations, level of satisfaction, and self-efficacy and focus groups were conducted to help validate survey results. While onsite lab students had higher expectations and were more satisfied with their lab experience, the two cohorts reported similar feelings of self-efficacy. The post-course analyses helped to improve the online course from one semester to the next, but the quality of the interaction with the instructors and teaching assistants was found to have a significant impact on the students' responses.

Keywords: analog circuits; online education; laboratory; higher education

Many studies seek to understand teamwork skill development, and teamwork is a core concept in engineering education. Whether teamwork skills are effectively developed in the classroom or whether additional training is needed, however, is not always clear. This study seeks to answer this question by examining the understanding and implementation of teamwork skills by two groups of engineering master's degree students. The first group is defined as Returners, individuals who spent five or more years in industry before returning to university to obtain a master's degree. The second group is defined as Direct Pathway students, who spent less than five years between degrees. Several comments in the data collected in a study comparing Returners and Direct Pathway students indicated a potential difference in how the two groups work in teams. Thus, this work sought to determine whether work experience has an impact on how teamwork skills are developed. A survey was completed by approximately 300 engineering master's degree students at multiple universities throughout the United States, and 41 students were interviewed. Fixed choice survey questions asked participants to rank their confidence in various team- and group-related activities. Free-response questions and interviews were used for further insight on teamwork skills and knowledge. Returners were more confident in their skills for every teamwork-related activity. Returners were also more likely to use the word "team" in survey responses, as opposed to Direct Pathway students who largely used "group." Interviews showed that group work is common in academia, whereas teamwork is a central concept of engineering in industry. Academic institutions should develop programs that better prepare students for teamwork in industry. Current programs focus primarily on group work, rather than teamwork. Significant differences exist in terminology used to describe multi-person collaboration depending on work experience levels and the collaborative context.

Keywords: team; teamwork; group; academia; engineering; industry