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Contents

Contributions in: Blended Classroom, Research Methods, Industry 4.0, Internship, Engineering Design, Design Thinking, Critical Thinking, Self-Evaluation, Mathematical Modeling, Cultural Impact, Leadership, Behavioral Factors, Entrepreneurship, Cooperative Education, Academic Outcomes, PBL, Dropout Rates, Writing Attitudes, Perception of Engineering, Gamification

Ahmad Ibrahim	1	Editorial
Donald R. Webster, Robert S. Kadel and Wendy C. Newstetter	2–17	What Do We Gain by a Blended Classroom? A Comparative Study of Student Performance and Perceptions in a Fluid Mechanics Course

We conducted a study of student performance in and perceptions of a blended classroom delivery of a 3rd-year-level fluid mechanics course. In the blended classroom pedagogy, students watch short on-line videos before class, participate in interactive in-class problem solving (in pairs), and complete individualized on-line quizzes weekly. The hypothesis is that when the cognitive load attendant on fluid mechanics problems is significant, an interactive learning environment yields greater learning outcomes than the traditional modeling-and-mimicry approach. We analyze this claim in the context of the complexity, ill-structuredness, and cognitive load inherent in navigating fluid mechanics problems. Comparisons are made among traditional and blended classroom deliveries by the same experienced instructor via student surveys and direct assessment of student performance. The results reveal dramatic improvement in student engagement, perceptions, and achievement in the blended classroom pedagogy. Significant differences are found in final course total and the withdrawal/fail/passing (WFD) rate. Further, a regression model explains a strong amount of variation in final course total and the coefficients suggest that the blended classroom pedagogy adds approximately 4–5 points on a 100-point scale. Student surveys reveal significantly greater enthusiasm, stimulation, self-perception of how-much-learned, perception of the value of the course activities, and the overall effectiveness of the course and instructor in the blended classroom. The combined use of the lecture videos, the interactive exercises in-class, and online quizzes provided an opportunity for students to manage their cognitive load while learning the subject of fluid mechanics.

Keywords: instructional change; blended learning; collaborative learning; problem based learning; teaching evaluations

M. Jean Mohammadi-Aragh and Rachel L. Kajfez	18–39	Ten Years of First-Year Engineering Literature (2005–2014): A Systematic Literature Review of Four Engineering Education Journals
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First-Year Engineering (FYE) education, while arguably established, is changing within a field that is evolving. To ensure that research is informing FYE change, there is a need for an overview of existing FYE research, which both summarizes what is known and provides direction for future research. The purpose of the review is to answer (1) What is the general landscape of FYE literature? and (2) What FYE practices are recommended or supported by the literature? Four journals were used as the source of articles. Through a three-step process, we identified 156 articles that focused on FYE that were included in the analysis. Of these, 73 were identified as research articles and both their methods and findings were explored in the study. FYE literature spans both innovative practice and research, and covers a wide-range of topics, such as *Design, Pedagogy & Learning Theories*, and *Skills*. Though, numerous studies document individual FYE programs, courses, or projects, many findings were limited to evaluating the activity in isolation. We did not find substantial literature examining the impact of FYE program design (e.g., matriculation decisions, course focus) on achieving engineering program outcomes. Future FYE research should more fully consider the theory and research designs used to promote generalizability and transferability of study findings beyond a single FYE experience or university.

Keywords: systematic review; first year; evidence-based practice; research methods

Caroline Bautista-Moncada, Joselito F. Buhangin and Norbert Q. Angalan	40–47	Review of Industry 4.0 Competencies and Virtual Learning Environment in Engineering Education
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Universities all over the world are considering the utilization of virtual learning environments (VLEs) in engineering education to meet the demands of Industry 4.0 for future employment. A systematic review was conducted to display the current state-of-knowledge in strengthening educational competencies, tackling the challenges of Industry 4.0. This article was designed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses and the Joanna Briggs Institute Method for Systematic Review. Articles published from 2004 to 2019 were sought from six electronic databases: *SCOPUS*, *Science Direct*, *Emerald Insight*, *Ebscohost*, *ERIC*, and *IEEE*. All papers were critically appraised, and quality assessment was performed. Eight studies were selected for potential eligibility. Data were extracted and synthesized using a narrative juxtaposition to provide a consolidated, comprehensive, and summarized evidence. Compared with physical or other types of online learning, the review recognizes the effectiveness of VLEs in enhancing knowledge and cross-functional skills needed for real-world industry settings. Therefore, it is paramount that engineering education courses required to be integrated with VLE targeting the development of competencies towards Industry 4.0.

Keywords: virtual learning environment; Industry 4.0; competency; engineering education

Maria da Glória Diniz de Almeida, Fernando Augusto Silva Marins, Andreia Maria Pedro Salgado, Rita de Cássia da Silveira Marconcini Bittar, José Glênio Medeiros de Barros, Antonio Henriques de Araújo Junior, Nilo Antonio de Souza Sampaio, Bernardo Bastos da Fonseca, Gessica Naira Diniz Baronto and Andresa Deoclidia Soares Côrtes	48–65	Industrial Internship Mentoring Model for Industrial Engineering Education in Public Universities
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This article aims to present an industrial internship mentoring model for undergraduate industrial engineering education in public universities. The study proposed that the constructs of “mentoring” and “industrial engineering education” can be combined in

order to develop a model for teaching. Its reliability has been confirmed by Cronbach's α coefficient test, whereas the statistical hypothesis test has confirmed the validity of the model according to the opinion of 52 pairs of mentors and mentees participating in this applied research with a qualitative methodological approach using a combination of case study and survey. Regarding results, 85% of mentees stated that the model had made a significant positive difference during their internship period, while mentors confirmed that 98% of mentees developed industrial engineering skills and abilities. Thus, the model relies on a detailed procedure about the content that should be assessed in each phase. Its major contribution lies in its pioneering role in developing an industrial internship mentoring model for industrial engineering education and in bringing universities and industries closer together during internship periods.

Keywords: mentoring program; industrial engineering teaching; internship; professional education.

Do-Yong Park and Dae Hwan Bae

66–83 Engineering Education in Cambodia: Investigating Undergraduate Engineering Students' Understanding of the Engineering Design Process

The purpose of this study was to investigate the scope and depth of the engineering design process understood by Cambodian engineering students. An activity involving the building of a mobile phone battery charger system was designed and implemented for the study. Ten undergraduate engineering students participated, and data were collected from focus group interviews, photocopies of protocols and initial products, and observation notes throughout a three-week long project. Data were analyzed by coding and finding patterns and themes in major storylines focusing on the engineering design process. The results were fourfold: (a) Cambodian undergraduate engineering students expanded their understanding of engineering design benefits from an individual to a national level; (b) students felt they were not adequately prepared in mathematics and science in high school; (c) the learning environment, that is, the problem-based context, and the culture of the Cambodian classroom influenced students' learning in engineering design; and (d) students also recognized the iterative nature of the engineering design process and associated challenges to overcome. Thus, experiencing engineering design in a practical, engineering problem-based context helped strengthen their career goal of becoming engineers. The implications for engineering education in Cambodia are discussed in the paper.

Keywords: engineering design process; engineering education; STEM education; problem solving; mobile phone charger; Cambodia

Veronika Šuligoj, Roman Žavbi and Stanislav Avsec

84–95 Interdisciplinary Critical and Design Thinking

Despite the importance of design thinking, there has been little research on interdisciplinary augmentation and the clear articulation of cognitive domain effects is still missing. The present study explores students' perceptions of and experiences in critical thinking and students' creative design ability in different study disciplines and explores correlations between students' attitudes and beliefs towards critical thinking and their design thinking ability. A sample of 268 students aged 21–23 years was collected. The students' majors include preservice technology and engineering teachers' education, chemical engineering, electrical and computer engineering, and mechanical engineering. For all subjects, critical thinking and design thinking are considered important interdisciplinary capabilities. Our findings suggest that the students' critical thinking might markedly affect their creative design ability. The ways in which each discipline is taught can be transferred across different knowledge and skill domains. We found that the most creative designers are mechanical engineering students, especially in terms of the originality and usefulness of design, while their divergent thinking ability might be improved with methods used in technology and engineering teacher education. Electrical and computer engineering students can benefit when interdisciplinary methods for improving understanding are applied as evidenced by the chemical and mechanical engineering curriculum. We also suggest that female students, who dominate in divergent thinking and critical thinking, might improve team learning and decision-making where transferable skills can be enhanced along with pedagogical content knowledge. These findings have implications for interdisciplinary innovation learning and creative design assessment.

Keywords: critical thinking, design thinking, interdisciplinarity, creative design ability, correlation analysis

Muhammad Khalid Shaikh and Kamran Ahsan

96–100 Psychographic Self-Evaluation Questionnaire for Forming Self-Managing Computer Engineering Capstone Teams

A Psychographic self-evaluation questionnaire is designed for assisting students in building teams for Software Engineering capstone projects. The questionnaire consists of 128 questions that are formed around the team building criteria that the author had proposed as part of his doctoral research. The items of the questionnaire are answered on a Likert type scale with varying number of choices. One hundred Computer Engineering students had participated in this research. The responses of the students on the questionnaire were recorded in specially developed software named *Psychographd*; the software had the capability to group the students into teams on the basis of the similarity of their responses to the questionnaire. After the formation of the groups, the students had worked on their capstone project for 10 months. Afterwards the cohesion among the team members was measured using the modified form of Group Environment Questionnaire. The results had shown that the student teams that were formed using Psychographic self-evaluation questionnaire (and thus the proposed criteria) had high degree of cohesion. The questionnaire together with the software (*Psychographd*) also helps tackle the orphan student problem effectively by guaranteeing at least one team for each student. The questionnaire is a result of a doctoral research. The questionnaire and the software developed on the basis of it are now in use in the department of Computer Science, Federal Urdu University of Arts, Science and Technology Karachi, Pakistan.

Keywords: psychographics; Capstone; computer engineering; team formation

Joseph A. Lyon and Alejandra J. Magana

101–116 A Review of Mathematical Modeling in Engineering Education

Mathematical modeling is both an important tool to professional engineers and instructional method in engineering education. This paper reviews the literature around mathematical modeling activities in the undergraduate engineering classroom. Twenty-seven journal articles were selected through a literature review process based on decided inclusion and exclusion criteria. From there, multiple themes arose surrounding the topics of student strategies to mathematical modeling, instructional implementation of mathematical modeling, and assessment of these activities. The result of the study is a clearer picture of what is most effective in implementation of mathematical modeling methods, as well as the effects of modeling activities on the learning of undergraduate engineering students. In addition, considerations around assessment of mathematical modeling activities are discussed. This study also identifies gaps in the literature that need bridged to obtain a holistic view of mathematical modeling activities and their true utility to the education of our engineering workforce.

Keywords: mathematical modeling; engineering education; undergraduate

Martin Jaeger, Gang Yu and Desmond Adair

117–129 Impact of Cultural Differences among Engineering Managers on Assessing Competencies of Engineering Graduates – A Case Study

Globalization has increased the frequency of interactions between engineers from different cultural backgrounds. The purpose of this study is to identify the perspectives of Arab and Chinese managers of engineers on the relative importance of engineering competencies and the satisfaction with these competencies exhibited by early career engineers in their organizations. Questionnaire based interviews are carried out with 95 Arab managers of engineers and 52 Chinese managers of engineers, all involved with engineering projects in Kuwait. Descriptive and inferential statistics (Wilcoxon and Mann-Whitney U test) have been carried out. The results show that managers from both groups largely agreed on the relative importance of the competencies, with the competencies *knowledge of contextual factors* and *orderly management of self* being considered by Chinese managers to be more important than by Arab managers. Chinese managers were less satisfied with the competencies, *knowledge of contextual factors*, in

depth understanding of specialist knowledge areas and the application of established engineering practice. Arab managers perceived their overall satisfaction of the competencies significantly lower than the importance of these competencies. These findings, and further details presented in this paper, support engineering educators and engineering educational institutions to prepare engineers for cross-cultural work within a globalised world by showing that students need more opportunities to increase awareness and practice ethical conduct and team work, develop their understanding of specialist knowledge areas and accountabilities, and be exposed to cross-cultural project scenarios. For Chinese institutions of engineering education it is recommended to include in their engineering curricula contextual factors of the most relevant contexts overseas, and, to investigate further the low satisfaction of Chinese managers with graduates' level of theory based understanding and conceptual understanding of mathematics.

Keywords: engineering competency; importance; satisfaction; manager; Gulf Cooperation Council; China

Katie L. Garahan, Nicholas A. Clegorne and Denise R. Simmons 130–141 Understanding Leadership Through an Ecological Lens: A Rhetorical Cluster Analysis of the *Civil Engineering Body of Knowledge*

As construction and civil engineering professionals continue to acknowledge the need for leadership development in college graduates, it becomes increasingly essential for professionals, educators, and administrators to develop a clear definition of leadership. To move toward this goal, the present study identifies civil engineering's existing definitions of leadership and examines the underlying assumptions of these definitions by focusing specifically on the American Society of Civil Engineers' *Civil Engineering Body of Knowledge for the 21st Century*. Through this analysis, this study seeks to identify *how* leadership is discussed in civil engineering to understand better the trajectory for the civil engineering field's engagement with leadership. Further, given the industry's expressed desires for a more cohesive workplace ecosystem, recommendations are provided for espousing an eco-leadership approach in civil engineering education and praxis.

Keywords: leadership; ecologies; Civil Engineering Body of Knowledge; rhetorical analysis

Ifeyanyi Benedict Ohanu, Taiwo Olabanji Shodipe, Daniel Uchenna Chukwu and Joseph Ndozianychukwu Chukwuma 142–154 Impact of Behavioural Factors as Related to Available Resources on Entrepreneurial Intentions of Electrical Installation and Maintenance Works Students

This paper investigates behavioural factors as a mediator between resources and entrepreneurial intentions among electrical installation and maintenance works (EIMW) students in technical colleges in Nigeria. The study used different approaches to analyse the data collected and structural equation models were used in the empirical analysis. The study found out that the more access EIMW students have to financial resources and tools and equipment, the more positive their attitude, perceived behavioural control and perceived efficacy but not subjective norms. Also, the more positive the students attitude towards starting a new business, the higher their entrepreneurial intentions. This study stimulates the Technical and Vocational institutions to seek collaboration between institutions and industry to bridge the gap between theory and practice through industrial training. It shows that access to resources stimulates students' behaviours towards entrepreneurial intentions and it is mediated by attitudes, subjective norms, perceived efficacy and perceived behavioural control.

Keywords: entrepreneurial intentions; attitude; perceived behavioural control; perceived efficacy; subjective norms; electrical installation and maintenance works

Rafael Goncalves Bezerra de Araújo, Marcus V. Americano da Costa, Babu Joseph and José Luis Guzmán Sánchez 155–169 Developing Professional and Entrepreneurship Skills of Engineering Students Through Problem-Based Learning: A Case Study in Brazil

Engineering courses are currently experiencing a high dropout rate. At the same time, the industry is changing, following the evolution of big data systems, the internet of things, artificial intelligence and machine learning, and today's engineer therefore needs to develop new skills to achieve success as a professional. The purpose of this article is to present a teaching methodology that is organised in the form of a programme, and is based on a set of active methodologies such as project-based learning and hands-on activities. This program is called ARHTE, and provides a set of pedagogical actions for the elaboration of interdisciplinary activities, with the objective of overcoming the fragmentation of knowledge in engineering and the lack of a relationship with professional practice. In the ARHTE program, the first four semesters of a course involve students working in teams and applying cumulative knowledge to a comprehensive project. The ARHTE program has been applied within numerous engineering programs, including environmental, civil, computer, production, electrical, mechanical, automation and chemical engineering. One of the main universities in the state of Bahia, Brazil, has been using the ARHTE program, with 1,209 students enrolled in the second semester of 2018, and the results are presented in this paper. Evaluation surveys of students revealed that the proposed methodology was effective in terms of enhancing their interest in engineering. This study demonstrates that action that is coordinated among different university departments can result not only in improved learning but also in better preparation for the job market, participation in regional, national and international academic competitions, patent registration and the founding of new technology-based companies (startups). Standardised tests show that a significant improvement in scores was seen after this new learning methodology was introduced. The increased retention rate during the initial periods of the engineering programs is also an indicator of the effectiveness of the proposed methodology.

Keywords: active learning; project based learning; hands-on activities; interdisciplinarity

Joyce B. Main, Beata N. Johnson, Nichole M. Ramirez, Hossein Ebrahiminejad, Matthew W. Ohland and Eckhard A. Groll 170–185 A Case for Disaggregating Engineering Majors in Engineering Education Research: The Relationship between Co-Op Participation and Student Academic Outcomes

Cooperative education (co-op) programs provide students with relevant professional experience while they pursue undergraduate degrees. While previous studies identified various benefits of voluntary co-op participation, many studies tend to aggregate engineering majors in their analyses. This study identifies departmental differences in student participation in co-ops and the associated likelihood of graduation using data from a research-intensive institution in the Midwest U.S. Logit regression models were used to estimate the likelihood of co-op participation and graduation in engineering, and ordinary least squares linear regression models were used to estimate the influence of co-op participation on time-to-graduation. At this institution, women are more likely than men to participate in co-ops in aerospace and industrial engineering. Co-op participation is positively associated with graduation except in industrial engineering. The number of enrolled semesters that co-op extends time-to-graduation varies by engineering major. Disaggregating engineering majors in examining co-op participation and outcomes shows important differences that reflect major-specific contexts. This study highlights the importance of disaggregating majors in examining the effects of academic and career preparation interventions on student outcomes in engineering education.

Keywords: cooperative education programs; academic outcomes; regression analysis; engineering majors; persistence

Stephen C. Scogin, Cindy Alexander, Leslie Gruenler, Catherine M. Mader and Melanie Bartoszek 186–200 Using Authentic Project-Based Learning in a First-Year Lab to Elevate Students' Perceptions of Engineering

Evidence suggests that some undergraduate engineering students drop out after their first year because they do not understand the nuances of the profession. Recommendations to alleviate this challenge include developing first-year experiences that provide more authentic contexts and emphasize the social benefits of engineering. The current study investigated a first-year undergraduate engineering lab module that used project-based learning and authentic customer interactions. Eighty-four students created unique prototypes for customers while recording personal reflections about their experiences. These reflections were analyzed using

inductive qualitative methodology to determine how this experience affected students' perceptions of the field of engineering. Researchers discovered that the central phenomenon characterizing the experience for students was related to a growing awareness of the field of engineering and whether it was a viable career path. The characteristic of the module that most affected students' perceptions was its authenticity. Students' abilities to work in teams and successfully use problem-solving skills were also important factors that affected students' perceptions of the module. After the module, students felt they gained many 21st century skills including collaboration, communication, creativity, and confidence. Furthermore, the experience helped students discern if engineering was a career they wanted to pursue. Although there have been numerous studies about project-based learning and its effects on students' attitudes about academic material, this study provides insights into how a first-year experience can affect students' perceptions of the field of engineering as well as students' identities with the profession.

Keywords: engineering identity; 21st century skills; project-based learning; grounded theory; first-year engineering courses

**Sandra M^a C. Pinheiro, Karla Oliveira-
Esquerre, Márcio A. F. Martins and
Roseline Oliveira** 201–212 Modeling the Quantification of Engineering Students' Academic Performance and its Association to Dropout Rates

The academic performance of most engineering students has been unsatisfactory in math and physics courses. This work proposes the construction of a measurement for evaluating students' academic performance based on grades and numbers of failures, associating this performance measurement to dropout percentages. This performance measurement proposed in this study aims to identify and track students who perform poorly in the initial semesters in order to monitor them during the program. The performances of 1622 students in math and physics courses in the first two years of engineering programs were analyzed. Daytime programs analyzed were: Civil Engineering, Electrical Engineering, Mechanical Engineering, Mining Engineering, Chemical Engineering, and Sanitary and Environmental Engineering. Evening programs were: Production Engineering, Computer Engineering, and Control and Automation Engineering. Descriptive analyses of the data, Spearman correlation tests, Mann-Whitney tests and Poisson regression models were performed. Results obtained showed an association between the proposed performance measurement and the students' entrance and exit forms in the programs. It was found that the majority of students performance below median in mathematics and physics courses. There was an inversely proportional relationship between the performance measurement and dropout levels, and higher risks for dropout in the first two performance quartiles, which are the lowest. The analysis based on the Generalized Linear Model, using Poisson regression, presented consistent and statistically significant estimates of relative risk. These analyses indicate that students with the lowest performances in the Analytical Geometry, Calculus I, Calculus II, and General and Experimental Physics I E courses are twice as likely to drop out of engineering courses when compared to students with higher performances.

Keywords: performance measurement; dropout risk; basic cycle; Poisson regression

Prateek Shekhar and Cheryl Bodnar 213–225 The Mediating Role of University Entrepreneurial Ecosystem on Students' Entrepreneurial Self-Efficacy

The importance of developing entrepreneurial skills in students is increasingly getting recognized in engineering education. Several institutions have initiated informal and formal entrepreneurship education programs to expose undergraduate students to entrepreneurial training and practice. Using a wide range of pedagogical approaches and curricular emphasis, entrepreneurship education programs focus on developing an 'entrepreneurially-minded' workforce in addition to encouraging venture creation. As programs continue to grow, more students will be exposed to entrepreneurship education, which brings with it the opportunity to examine how students at different institutions or entrepreneurial ecosystems may differ in entrepreneurship-related skills and characteristics. In our presented exploratory work, we focus on how students' entrepreneurial self-efficacy differs based upon the entrepreneurial ecosystem within which students are situated. We use Mc Gee's Entrepreneurial Self-Efficacy scale to assess students' confidence in their ability to perform five entrepreneurship-related tasks – searching, planning, marshaling, implementing finance, and implementing people. Our findings note statistically significant differences in entrepreneurial self-efficacy for three of the five entrepreneurial self-efficacy measures (planning, marshaling, and implementing people). The implications of our work for engineering institutions interested in developing programs related to entrepreneurship are discussed.

Keywords: entrepreneurship education; entrepreneurial ecosystem; entrepreneurial self-efficacy

Ellen Zerbe and Catherine G. P. Berdanier 226–240 Writing Attitudes and Career Trajectories of Domestic and International Students in the United States

Graduate engineering students are rarely taught to write in formal disciplinary coursework, but it is an essential skill required for success in industry and academic careers. This study builds on existing work exploring doctoral writing practices, processes, and attitudes, expanding it into the disciplinary context of engineering. Engineering traditionally offers few opportunities for students to practice or develop academic writing in coursework, despite the fact that most academic milestones for graduate students are based on writing. Grounded in Academic Literacies Theory, this paper seeks to determine how engineering graduate students' writing attitudes affect their career trajectories. This study surveyed N = 621 engineering graduate students at ten research-intensive universities in the United States using several previously established scales. These data were analyzed using Pearson correlations and Welch's t-test methods to answer the research questions. Results indicate that while most students consider writing to be a knowledge-transforming activity, they overwhelmingly struggle with procrastination, perfectionism, and low-writing self-efficacy. Further, strong writing attitudes are linked statistically with the likelihood to pursue a broader set of future careers after graduate school, indicating that writing may be an invisible mediator for broadening participation in all sectors of engineering.

Keywords: engineering graduate students; writing; writing attitudes; career trajectories

**Feng-Kuang Chiang, Li Li, Rui heng Cai
and Shan Wang** 241–255 Investigation of Elementary-School Students' Perception of Engineering using Drawing Analysis

Science, technology, engineering, and mathematics (STEM) education has become a popular academic model in recent years. Engineering education has been emphasized in the Next Generation of Science Standards (NGSS). A lack of career guidance has become a common problem in engineering education. Hence, it is pertinent to investigate how students understand the career in engineering so that their interests and abilities can be developed strategically. In this study, a drawing analysis method was adopted to investigate students' perceptions of engineering in an elementary school in Beijing. A *Draw an Engineer Test* (DAET) was conducted to 512 students from 15 classes in grades two to six. Our findings reveal that many students held a narrow view of a career in engineering. For example, younger students typically believed that engineers work in construction sites, whereas older students typically regarded engineers as designers or technicians. There were significant differences in the perception of engineering among students in different grades and different gender. We also found that experiences in life and social networks, but not teaching in school, were most frequently used channels for students to understand engineering.

Keywords: Draw an Engineer Test (DAET); elementary school; engineering impressions; graphic analysis

**Ahmed Alzaghoul, Edmundo Tovar,
Angel A. Rodriguez Sevillano and
Miguel A. Barcala** 256–266 Comparison Between Video-class and LEGO Serious Slay Learning Strategies for the Students of Engineering Discipline

The knowledge exchange in higher education is growing day by day demanding more advanced methods of teaching rather than the old methods. This paper presents an approach that tracks and measures changes in learner's behavior, based on two main learning strategies: video – class and LEGO serious play. The objective of the work is to address the question; Does the change of

the learner behavior affect the quality of engineering education?. During this research work, an online task for the purpose of enhancing the process of learning, based on LEGO[®] SERIOUS PLAY[®] methodology, as an innovative technique to explore and support the changing in the learner behavior while solving the designed task. During the planned experiment we used gamified education material that has resulted in capturing the quality criteria by following the behavioral level of the Kirkpatrick Model. A comparison was performed with a class based on learning through video presentations and a class based on “LEGO[®] SERIOUS PLAY[®]” to learn the designed task. The total number of participants was 26 in 1st experiment and 18 in the 2nd experiment, a total of 44 participants. The results have shown that the “LEGO[®] SERIOUS PLAY[®]” class was more oriented into the creative part of the knowledge acquirement. However, the “video-class” was limited to the content of the video and to the video’s visuals design. From the obtained results, the goal has been achieved by measuring the changing of the learner behavior, in the same context, these behavior changes and the learning processes have been measured and improved.

Keywords: behavior; Kirkpatrick Evaluation Model; LEGO[®] SERIOUS PLAY[®]; open educational resources; quality model; gamification