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Enhancing undergraduate engineering education quality through using computer-aided design software

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Abstract

The computer-aided design software has been developed as a support aid for improving the creativity and the ability of students to understand the concept of the practice courses. Therefore, the study reviewed previous scientific studies associated with computer-aided learning (CAL) to identify the importance of CAL in supporting engineering education learning. Additionally, this study aimed to develop a vision for the future of education through the use of an effective technological means to reduce as much effort and time as possible in engineering departments. The results demonstrated that the use of CAL in engineering courses improved the quality of education and increased the ability of the student to solve complex engineering problems. Consequently, the authors recommend that the institute should conduct training courses for instructors in CAL/design/programme and their role in supporting engineering learning.

Keywords: Computer-aided learning, education learning, engineering department, institute, problem-solving skills.

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1. Introduction

During the last quarter of the last century, the world was facing challenges due to the rapid developments in various fields, including the education field. The development in education and technological fields is caused by the technology devices entering the education field and becoming one of the cornerstones in education.

Today, education is one of the top priorities in the world. The technological revolution is considered an essential key to improve student skills and competencies that are accomplished in accepting challenges and facing them successfully. To face the huge explosion of knowledge and technical breakthrough, it becomes necessary for institutions to reconsider the use of teaching aids and new techniques to improve the scientific output.

Moreover, in recent years, interest in the student's creativity has been increased in the educational area. The student's creativity has become an educational necessity to improve education quality and support future student's success (Castillo-Vergara, Galleguillos, Cuello, Alvarez-Marin & Acuna-Opazo 2018; Mullet, Willerson, Lamb & Kettler, 2016). In the meantime, creativity can be made through engaging, motivating and inspiring activities (Hall et al., 2018). Also, according to Zhou (2017), student's creativity depends on education strategies and learning methodologies.

Furthermore, scientific researchers have supported that the need to develop educational curricula and employ technology in the education field is required to improve the quality of education. Additionally, scientific studies show the importance of using new techniques/methods and their role in the success of the educational process and improving the skills of the students. When talking about modern educational techniques, the concept of educational technologies in the education field should be identified. Educational techniques are tools that help to transfer knowledge, information and different skills from person to another to increase the skills and abilities of the student.

Therefore, the objective of this study is to show the importance of using teaching aids and modern technologies in increasing the skills and abilities of the student, particularly who is studying in the engineering department. Also, the importance of this study is one of the urgent needs to develop teaching methods through reviewing the previous scientific studies that addressed the impact of using computers/technology in the educational learning aspect in developing problem-solving skills and quality of the education. More precisely, the study is concerned with the use of information technology in achieving some educational objectives at higher education levels.

2. Educational innovation

Invention is to create or develop a novel idea that helps to do the job in a new way. The three major steps of innovation are (1) an idea, (2) its implementation and (3) the outcome that results from the execution of the idea and produces a change (Serdyukov, 2017). In general, the definition of creativity is varied from inventing, developing relationships and bringing about new and distinct ideas (Ceserani and Greatwood, 2001). Innovation can be applied as a new methodological approach, teaching technique or instructional tool in the education field (Serdyukov, 2017). Therefore, creativity and innovation are now essential skills that will enable students to meet the challenges of the future and the demands of the growing labour market.

Educational innovation involves all stakeholders, such as student, learner, teacher and researcher, and requires active involvement and support (Filho et al., 2018). For the learner, studying cognitive processes, identifying and developing abilities, skills and competencies should be considered during the investigation. Teaching style, motivation, skills, competencies, self-assessment, self-efficacy, creativity, responsibility, autonomy to teach, the capacity to innovate, freedom from administrative pressure, best conditions of work and public sustenance are important factors to increase and improve the quality of teaching (Serdyukov, 2017).

Besides, academic environment, materials and conditions for achieving excellence of the learning outcomes for the student are expected to be provided by educational institutions. In the literature, several studies have been conducted to improve the teaching quality and to raise the level of creativity for the student. For instance, Hassan, Martinez, Dominguez, Perles, and Albaladejo (2004) presented the experience of teaching industrial computer engineering with a new educational innovation project in electronic engineering at the Polytechnic University of Valencia, Valencia, Spain, based on the quantitative results and students' and faculty staff's opinion. The result of the surveys showed that the opinion of the students indicated a positive impression on the new methodology because students acquired more practical abilities to undertake future industry challenges and real engineering problems. Sakthivel and Raju (2006) developed an instrument to measure the quality of higher engineering education. The instrument was designed with 112 operating items and these items were derived based on several quality implementation indicators proposed in the qualitative literature. The authors concluded that the proposed instruments can be successfully used by the engineering institutions to improve education quality. Cristina et al. (2012) studied how the instructors and engineering students see the equality issue by using the interview method. The result showed that the education quality depends on the performance of the teacher, according to the student's opinion. Santhanam and Codner (2012) outlined a project that aimed at improving undergraduate engineering education quality in an Australian university, through a development programme for teaching assistants. The results showed that there is a significant increase in the performance of students with learning support of teaching assistants.

3. Effect of technology on the quality of education

In recent years, scientific researchers have been examining the impact of technology, such as a computer, on the level of student performance and students' creativity because problem-solving skills are a significantly important issue that faces students with different educational levels in academic or real life. Nowadays, successful students can be used in various intellectual skills to solve the problems of new attitudes facing them, which is the main goal for the institutes. Therefore, several studies are aimed to find modern scientific methods that can improve the ability and increase the level of creativity of the students to solve any problem in academic life or the real world. Coller and Scott (2009) evaluated the impact of the video game-based course on the students' academic achievement at Northern Illinois University. The authors concluded that the student became more interested, engaged and invested in learning the material and the quality of education was improved. Also, the game-based course is considered a deeper learning method compared to the traditional methods (lecture/textbook-based numerical methods courses). Robertson and Radcliffe (2009) investigated the influence of the CAD tools on the creative problem-solving process. The results indicated that CAD tools improved the creativity level and skills of the users. Gillich, Frunzaverde, Gillich and Amariei (2010) presented how virtual instruments could be used as educational tools for engineering education. The authors concluded that virtual instruments raised the skills of the students, which is supported by theoretical explanations and could improve the quality of educations. Liu and Ren (2010) introduced a new educational method called assignment project that aimed to improve the skills of the student to solve complex problems. The authors concluded that the method is an effective tool for increasing the skills of the students. Ibrahim (2011) used MATLAB simulation as a tool to improve the teaching and learning effectiveness in the field of electrical and electronic engineering by comparing the simulated results with experimental results. The results demonstrated that engineering simulation tools can be useful in teaching the working principles of various engineering instruments. Hsfner, Hafner, and Ovtcharova (2013) proposed a teaching methodology for a practical course in virtual reality for different engineering education levels, which aimed to develop the skills of the student at the Karlsruhe Institute of Technology. The results indicated that students have the opportunity to learn from their mistakes for a better, professional and real life. Steif, Eicholtz and Kara (2014) described a technology that can improve student learning to solve a complex engineering problem by using computer tutors. The typical truss problem was given as an example to measure the efficiency,

which involves the maximum number of unsolved variables at any instant. The result demonstrated that the efficiency of the student's skill is increased and improves the ability of the student to solve a complex problem. Naukkarinen and Sainio (2018) presented the virtual laboratory concept as an educational design and experiment for engineering in the Chemical Engineering Department at the Lappeenranta University of Technology. The authors found that the virtual laboratory concept is an efficient method for supporting the students' ability to execute the various subtasks in reactor design in a professional manner. Kassem, Faraj, and Camur (2018) discussed how computer-aided design programmes, such as SolidWork Flow Simulation, improve the skills of the student to understand the concept of the fluid dynamic course in the Mechanical Engineering Department, Near East University. The results indicated that the SolidWork Flow Simulation tool improved the student skills and raised the ability of the student to understand the real world. Kassem, Camur, and Alhuoti (2019) investigated the effect of the Mat lab software on the students' academic achievement in the Mechanical Engineering Department at Near East University. The authors found that MATLAB software improved the performance of the students to understand the course compared to the traditional method. Iriondo, Montero, Sevillano, and Socoro (2019) designed a videogame that aimed to engage and develop the experience of the engineering students at La Salle – Universitat Ramon Lull – by working in groups, and the estimation of the multi-subject learning experience was made based on the principles of constructionism. The results indicated that the proposed methodology increased the students' engagement and success in students' rates. Chowdhury, Alam and Mustary (2019) proposed a new methodology called a three-step teaching and learning approach (real laboratory demonstration video clip, conduction of a real laboratory experiment and a computer simulation/modelling) to enhance the mechanical and automotive engineering student learning outcomes. The results showed that the proposed method helped the students to achieve the desired learning outcomes in a relatively difficult subject in a mechanical engineering programme.

4. Computer-aided and engineering education

Currently, most of the educational institutions tend to integrate computer-aided engineering (computer-aided design programmes/software, visual laboratory, visual studio, etc.) in education to enhance the student skills and increase the ability of the student to face real engineering problems in the real world. The benefits of using these tools in education are implemented by many difficult experiments through simulation programmes, which help students to understand the concept of the course through practical programmes. Besides, educational games have proved to be very effective in helping the physically and mentally handicapped. Generally, it is concluded that computer-aided engineering is characterised by the improvement of students' abilities. Moreover, these tools help to increase the quality of engineering education. Using the computer, the student can build prototype models and test all the factors that can affect the design before producing the product. Also, they have led to an extreme increase in student's creativity, skills and efficiency of creating new things that solve complex engineering problems.

Based on previous sections, it is found that computer-aided engineering can enhance the quality of education in all engineering fields. Therefore, this section aims to discuss the most important software that can help to raise the ability of engineering students, particularly mechanical, energy and environmental engineering students. Also, several studies have been examining the impact of the computer-aided engineering tools on the quality of engineering education (Brenner, Shacham & Cutlip, 2005; Dementiev, Burulko & Suvorkova, 2015; Hamade, Artail & Jaber, 2007; Jaakma & Kiviluoma, 2019; Kassem et al., 2018, 2019; Komulainen, Enemark-Rasmussen, Sin, Fletcher & Cameron, 2012; Miller & Bures, 2015; Nylund, Valjus, Toivonen, Lanz & Nieminen, 2019; Ye, Peng, Chen & Cai 2004).

4.1. AutoCAD

AutoCAD is a computer-aided drawing and design software that supports the creation of two and three-dimensional drawings. AutoCAD was developed and marketed by Autodesk. AutoCAD has become the most popular design software in the world. AutoCAD is a general use design programme in many fields, used by engineers from different disciplines to create drawings and engineering designs used by project managers, in addition to many professions and industries.

4.2. Solid Work

Solid Works is a computer-aided design software that supports the creation of three-dimensional drawings. This software runs under the Microsoft Windows environment developed by Dassault Systèmes Solid Works Corp. Solid Works is easy to model, animate and test the model, etc. It is a perfect software that will help the user to create and invent an engineering design.

4.3. MATLAB

MATLAB (Matrix-Laboratory) is a pioneering programme in mathematical engineering and mathematical applications. MATLAB allows mathematical manipulation of matrices, by graphing mathematical functions, by implementing various algorithms and creating graphical user interfaces. The programme is used by many other applications and utilities such as Simulinks. Simulink is called block sets that apply physical or mathematical theories to the model to give a simulation of the proposed model in case the model is subject to these physical or mathematical theories in real life.

4.4. Computational fluid dynamics (CFD)

CFD is a computer-aided design software that is applied as a tool for generating fluid flow following its physical properties. It is a branch of fluid mechanics that uses numerical analysis and data structures to analyse and solve problems that involve fluid flows. It is a perfect software that will help the user to see how the model can be influenced by environmental conditions, such as wind, temperature, etc.

4.5. Open-source simulation software

Simulation software is a powerful and important tool because it provides an alternative method to model a real phenomenon with a set of mathematical formulas. It is widely used to design or propose a model, analyse the physical or environmental variables and solve the problem. A large number of academicians in many different fields have used simulation software in their studies.

5. Conclusion and recommendations

The result of previous scientific studies indicated that there is a positive relationship between computer learning and the development of problem-solving skills, where the method of teaching computer is an excellent method in terms of its effectiveness in the development of problem-solving skills over the traditional way of teaching. Moreover, according to previous scientific research studies, this study has identified the effectiveness of computer education and draws attention to its importance because of its success in the development of skills to solve problems among learners and is limited the effort of the teacher and the time required for the educational process. This study proved that using a computer-aided approach improved the quality of engineering education compared to the traditional method. In light of the results reached in this study, the overarching recommendations are as follows:

- Computer-aided design software should be used in the engineering education courses, especially for practical courses, such as fluid mechanics, heat transfer, thermodynamic, environmental science and chemistry, water engineering design, environmental impact assessment, etc. to enhance the student skills and increase the creativity level of the student to undertake future industry challenges and real problems in life.
- The simulation tools should be used in engineering education to develop problem-solving skills of students and reduce the time required for the educational process.
- Conducting training courses for engineering instructors in computer-aided learning/design software and their role in supporting engineering learning. It is also recommended to carry out studies to be applied in engineering departments to compare the effect of the new method and traditional method on the performance of the engineering students.

References

Balan, L., Yuen, T. & Mehrtash, M. (2019). Problem-based learning strategy for CAD software using free-choice and open-ended group projects. *Procedia Manufacturing, 32*, 339–347.

Baloi, F., Bucatariu, I., & Iovan, M. (2015). Using specific or general software tools in power engineering education. *Procedia - Social and Behavioral Sciences, 191*, 2787–2791.

Brenner, A., Shacham, M. & Cutlip, M. B. (2005). Applications of mathematical software packages for modeling and simulations in environmental engineering education. *Environmental Modelling and Software, 20*(10), 1307–1313.

Castillo-Vergara, M., Galleguillos, N. B., Cuello, L. J., Alvarez-Marin, A. & Acuna-Opazo, C. (2018). Does socioeconomic status influence student creativity? *Thinking Skills and Creativity, 29*, 142–152.

Chowdhury, H., Alam, F. & Mustary, I. (2019). Development of an innovative technique for teaching and learning of laboratory experiments for engineering courses. *Energy Procedia, 160*, 806–811.

Coller, B. & Scott, M. (2009). Effectiveness of using a video game to teach a course in mechanical engineering. *Computers and Education, 53*(3), 900–912.

Dementiev, Y., Burulko, L. & Suvorkova, E. (2015). Pedagogical aspects of applied software packages and computer technologies use in student's education. *Procedia- Social and Behavioral Sciences, 206*, 289–294.

Gillich, G. -R., Frunzaverde, D., Gillich, N. & Amariei, D. (2010). The use of virtual instruments in engineering education. *Procedia - Social and Behavioral Sciences, 2*(2), 3806–3810.

Hamade, R., Artail, H. & Jaber, M. (2007). Evaluating the learning process of mechanical CAD students. *Computers and Education, 49*(3), 640–661.

Hassan, H., Martinez, J.-M., Dominguez, C., Perles, A. & Albaladejo, J. (2004). Innovative methodology to improve the quality of electronic engineering formation through teaching industrial computer engineering. *IEEE Transactions on Education, 47*(4), 446–452.

Hsfner, P., Hafner, V. & Ovtcharova, J. (2013). Teaching methodology for virtual reality practical course in engineering education. *Procedia Computer Science, 25*, 251–260.

Ibrahim, D. (2011). Engineering simulation with MATLAB: improving teaching and learning effectiveness. *Procedia Computer Science, 3*, 853–858.

Iriondo, I., Montero, J. A., Sevillano, X. & Socoro, J. C. (2019). Developing a videogame for learning signal processing and project management using project-oriented learning in ICT engineering degrees. *Computers in Human Behavior, 99*, 381–395.

Jaakma, K. & Kiviluoma, P. (2019). Auto-assessment tools for mechanical computer-aided design education. *Heliyon, 5*(10), e02622.

Kassem, Y., Camur, H. & Alhuoti, S. M. (2019). MATLAB simulator can support student learning for fluid mechanics courses in the Mechanical Engineering Department. *International Journal of Engineering Research and Technology*, *12*(7), 1020–1032.

Kassem, Y., Faraj, R. A. & Camur, H. (2018). Mechanical engineering with Solid Work flow simulation improving and supporting undergraduate student learning in mechanical engineering courses: fluid dynamic course. *New Trends and Issues Proceedings on Humanities and Social Sciences, 5*(4), 45–51.

Komulainen, T. M., Enemark-Rasmussen, R., Sin, G., Fletcher, J. P. & Cameron, D. (2012). Experiences on dynamic simulation software in chemical engineering education. *Education for Chemical Engineers, 7*(4), e153–62.

Liu, G. & Ren, Y. (2010). An *assignment project-based approach for engineering education*. The 2010 IEEE International Conference on Information and Automation.

Mesquita, A. & Sarmento, A. (2011). *Technology for creativity and innovation tools, techniques and applications*. Hershey, PA: Information Science Reference.

Miller, A. & Bures, M. (2015). New approach to industrial engineering education with the help of interactive tools. *Procedia - Social and Behavioral Sciences, 174*, 3413–3419.

Mishra, P. & Henriksen, D. (2018). *Creativity, technology & education: exploring their convergence*. Cham, Switzerland: Springer.

Mullet, D. R., Willerson, A., Lamb, K. N. & Kettler, T. (2016). Examining teacher perceptions of creativity: a systematic review of the literature. *Thinking Skills and Creativity, 21*, 9–30.

Naukkarinen, J. & Sainio, T. (2018). Supporting student learning of chemical reaction engineering using a socially scaffolded virtual laboratory concept. *Education for Chemical Engineers, 22*, 61–68.

Nylund, H., Valjus, V., Toivonen, V., Lanz, M. & Nieminen, H. (2019). The virtual FMS – an engineering education environment. *Procedia Manufacturing, 31*, 251–257.

Oliveira, C. G., Oliveira, P. C. & Costa, N. (2012). Students' and teachers' perspectives about quality of engineering education in Portugal. *European Journal of Engineering Education, 37*(1), 49–57.

Robertson, B. & Radcliffe, D. (2009). Impact of CAD tools on creative problem solving in engineering design. *Computer-Aided Design, 41*(3), 136–146.

Sakthivel, P. B. & Raju, R. (2006). An instrument for measuring engineering education quality from students perspective. *Quality Management Journal, 13*(3), 23–34.

Santhanam, E. & Codner, G. (2012). Enhancing undergraduate engineering education quality through teaching assistants (tutors/demonstrators). *Australasian Journal of Engineering Education, 18*(1), 15–24.

Steif, P. S., Eicholtz, M. & Kara, L. B. (2014). Computer tutors can reduce student errors and promote solution efficiency for complex engineering problems. *Journal of Visual Languages and Computing, 25*(6), 1021–1029.

Ye, X., Peng, W., Chen, Z. & Cai, Y. (2004). Today's students, tomorrow's engineers: an industrial perspective on CAD education. *Computer-Aided Design, 36*(14), 1451–1460.

Zhou, C. (2017). *Handbook of research on creative problem-solving skill development in higher education*. Hershey, PA: IGI Global.