Journal of Positive Psychology & Wellbeing
2023, Vol. 7, No. 2, 28 – 35

http://journalppw.com
ISSN 2587-0130

Information and Communication Technologies (ICT) Applied to Civil Engineering Teaching

Gallardo Amaya Romel Jesus[1], Gustavo Guerrero Gómez[2], Nelson Javier Cely Calixto[3]

[1]*Universidad Francisco de Paula Santander Seccional Ocaña, Colombia*
https://orcid.org/0000-0002-4740-4841
[2]*Universidad Francisco de Paula Santander Seccional Ocaña, Colombia*
https://orcid.org/0000-0002-4316-7113
[3]*Universidad Francisco de Paula Santander Cúcuta, Colombia*
https://orcid.org/0000-0002-2083-6978

ABSTRACT

The pandemic era transformed the reality of everyone in the world and especially the way we interact, education is one of the areas that was most affected by this global calamity, the acquisition of knowledge in a classroom became from a computer at home, so the strategies of teachers to transmit in the best way their teachings had to be restructured. The necessary adaptations for continuous training are made thanks to information and communication technology tools (ICT), primarily through tools such as Google Meet and Skype. As a result of the above and the new lived reality, people around the world have learned to improve Emergency Distance Education (DEE). This study will reveal the main applications and software of ICT in civil engineering and related professional higher education, describe and mention their characteristics and impact on the quality of education.

INTRODUCTION

The evolution of Information Technology tools has been accelerated in recent years, fortunately the applications and technologies that emerged with this progress have been perfectly coupled to engineering, leading almost at the same pace the technological transition. However, it is necessary to adapt the teaching, i.e., the way in which this knowledge will be transmitted and the tools to be used (Arango-Carrillo et al., 2014).

According to the above, it is a priority to teach teachers in charge of teaching these new technologies, pedagogical strategies, mastery of applications, objectives, advantages, disadvantages and challenges to persuade the student (Martinez-Castro and Gritti-García, 2012). Fortunately, current generations of professionals have been forged in cultures more present with technologies, acquiring an efficient mastery of technological innovations. What precedes for the strengthening of educational institutions is to take advantage of the capacity of students in the handling of technological instruments to include in their curricula the use of ICT tools (Botero and Botero, 2015).

Universities and educational centers in the region of Norte de Santander are no strangers to the incorporation of ICT in their curricula, however, the adoption process is gradual and in less privileged areas very slow, as a result of this situation, this work also seeks to draw the attention of governmental entities to the importance of new pedagogical processes

Literature review

The existing theoretical bases around ICT are varied, complete and arduously studied. The following is a description of the positions of multiple authors on the current teaching of these technologies.

The author Ramirez, (2009) developed a more efficient methodology for teaching in the area of

instrumental design at the Universidad de Oriente (Venezuela), demonstrating the extensive applicability of ICT and contributing to university pedagogy. D'Paola Puche mentions the importance of the inclusion of virtual reality and BIM (Building Information Modeling) in the teaching of civil and construction professionals.

Other authors such as Rodriguez, Avila and Chourio, (2010), affirm that the b-learning methodology applied to the learning of mathematics had excellent results in the acceptance by students, stimulating their interest through teacher support and practical work.

Similarly, Santoyo (2021), demonstrated the autonomy acquired by the student using the so-called Virtual Learning Object (VLO), where learning was encouraged by the student himself with the intention of improving his level of quantitative reasoning. Likewise, the authors Morillo, Pérez, Cañas, Aguilar and Díaz, (2017), found great satisfaction in their research on the good adoption of ICT by their students through the use of videos for hydraulic laboratory practices, observing the stimulation of interest and improvement of learning.

It is understandable that technological advances have had a positive impact on the learning process of students, regardless of the subject and its focus.

However, it depends on the author in question and his or her historical and cultural background. Several authors praise information and communication technology (ICT) tools for their ability to connect people and increase efficiency in work and daily life. However, others have expressed concern about the negative impact of ICTs on society, such as the growing dependence on technology and the loss of social and cognitive skills (Carniel and Avila, 2009). It is very relevant to note that these beliefs change over time as technology advances and cultural beliefs change.

In addition, other authors have pointed out the digital divide and how ICTs can exacerbate economic and social inequalities if not adequately addressed (Alarcón et al., 2021). Online privacy and security have also been discussed, as ICTs have given rise to new challenges in these areas. Others have pointed to the impact of ICTs on the economy, such as changing business models and job automation (Gálvez et al., 2021). In general, opinions on ICTs are varied and complex, and it is important to consider different perspectives when assessing their impact on society.

Method

According to the characteristics of this study, this is descriptive research, focused on qualitatively specifying the different perspectives of the authors found in the literature review prior to the documentation of the article. Using the search software Google Academico, DialNet, Scielo and Redalyc, the most current concepts related to information and communication technologies (ICT) in the learning process of civil engineers and related students are registered, and the position of the cited authors is discussed from a scientific point of view.

Results and Discussion

ICT refers to the system of instruments and devices used to collect, store, process, transmit and present information. Some examples of ICT are computers, smart phones, internet, social networks, software, information systems, etc. (Terreros, 2019).

Some ways in which ICT can be applied to civil engineering education include simulations and models of constructive structures, thanks to new technologies that facilitate the three-dimensional design of structures, buildings, bridges, roads, etc (Guerrero, 2020). This helps students to see how the different components of a structure work and how they interact with each other. ICT collaborative learning enables students to collaborate in real time on projects and work together online (Peña and Ancco, 2022). ICT provides those interested in learning with access to many online educational resources, such as videos, tutorials, articles, and documents (Huillcahuari et al., 2022). This allows them to learn at their own pace and time.

Engineering is one of the main activities in the innovation process, because its existence is the main basis for a company or country to develop a high level of competitiveness with the help of high

innovation standards. In general, innovation between one country and another depends largely on the level of higher education of its population, with countries with engineering education being the highest (Cely Calixto et al. 2022). Data analysis, another tool commonly used in ICT, helps students to collect, process and study large sums of data to improve decision making in engineering projects (Hernández, 2017).as well as virtual and augmented reality, where students are given the facility to have an immersive experience and explore structures and projects virtually, allowing them to better understand how they work and experiment with different scenarios (Vinueza and Gallardo, 2017).

1.1 Software Used in ICT

Civil engineering education uses a variety of software to support education and student learning (see Figure No. 1). Some of the most common programs include:

1AutoCAD: It is a computer-aided design software that is used in order to create plans and designs of structures, buildings, bridges, roads, etc. It is widely manipulated by architects, engineers and construction professionals to design detailed plans and drawings of buildings, infrastructure and other structures. structures (Dajud et al., 2009). The software can also be used in manufacturing, product design and other industries. AutoCAD can be found on Windows and Mac, as well as in web and mobile versions (Da Silva, 2018).

2. SAP2000: It is a structural analysis and design software used to simulate and analyze the behavior of structures under different loads and conditions (Londoño et al., 2016). It is developed and sold by Computers and Structures, Inc (CSI). SAP2000 is used to model, analyze and design building structures, bridges, towers, infrastructure buildings, among others. The software has a wide range of features, including static and dynamic studies, design of steel and concrete structures, and an easy-to-use interface. SAP2000 is available for Windows (Berrocoso, 2008).

3. Revit: is an architectural design and construction software used to create 3D models of buildings and structures. Revit allows designers, architects and engineers to work together on a shared model, ensuring that the information is accurate and consistent throughout the project (Furió, 2017). In addition, it allows generating plans, sections, details and 2D views automatically from the 3D model. It is available for Windows and Mac.

4. Civil 3D: is a civil engineering and surveying software for creating topographic maps and designing roads, sidewalks, culverts and other projects. The software has a wide range of tools to create accurate designs, automatically generate plans and sections, and visualize 3D designs (Chakole and Wadhay, 2022). In addition, it enables collaboration on projects, allowing multiple users to work on the same model at the same time (Lopez-Gomez and Catellanos-Paz, 2018).

5. ETABS: is a structural analysis and design software for modeling and analyzing building and bridge structures. It is widely used in the design of steel structures, concrete structures, and timber structures in the construction industry. The software has an intuitive interface and several advanced tools for static and dynamic analysis, structural design, automatic drawing and report generation (Anjaneyulu and Prakash, 2016).

6. MATLAB: It is a numerical computation and data analysis software used for analyzing and modeling problems in civil engineering, such as behavior of structures, sensor data analysis, etc. It is widely used in research, education and industry, due to its ease of use, large number of mathematical functions and visualization tools (Herrera et al., 2016). In addition, it has a wide variety of toolboxes (specialized function packages) for specific applications such as image processing, machine learning and artificial intelligence (Blaber et al., 2015).

7. Rhino: is a 3D design software used for modeling and analyzing structures and projects in civil engineering. Rhino is known for its ability to accurately model complex shapes and designs. The software has an easy-to-use interface and extensive modeling tools, including curves, surfaces, solids and editing tools (Song et al., 2023).

These are just a few examples of software used in

civil engineering education, there are many others and new software is emerging all the time.

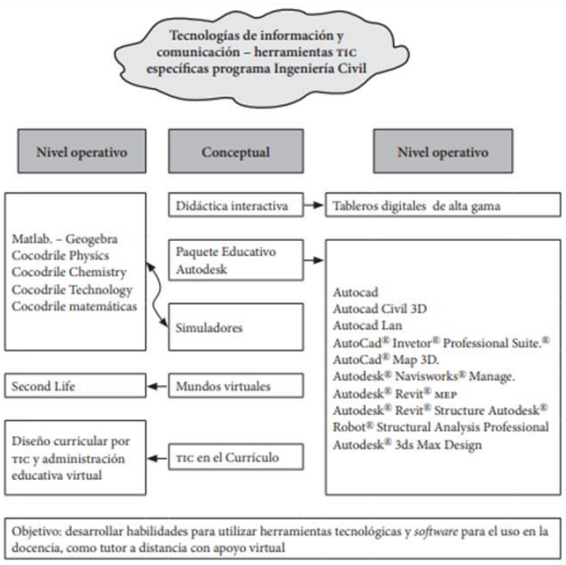

Fig No 1: ICT Applied in Civil Engineering Education.

Source: Adapted from Arango-Carrillo et al., 2014.

1.2 Coordination of Computer Models

Coordination of computer models is essential in civil engineering to ensure that all designs and drawings of a project are synchronized and correspond to each other (see Fig. No. 2). This is especially important when working on large-scale projects, such as buildings, bridges, roads, etc.

There are several ways in which computer models can be coordinated in a civil engineering project. Primarily, Silva et al., (2018), find that running project management software allows different design and construction teams to share and update their designs and drawings in real time, which helps maintain coordination. They also highlight the use of common file formats such as AutoCAD, Revit, etc. allows different teams to open and edit other teams' designs and drawings.

Using a content management system where different teams can share and update their designs and plans on a centralized platform, which helps to maintain coordination (Castillo et al., 2018). As is also the case with real-time collaboration tools such as videoconferencing, chat, etc. lets different teams collaborate and discuss designs and plans in real time, which helps maintain coordination (Macias-Macias and Romero-Velez, 2021).

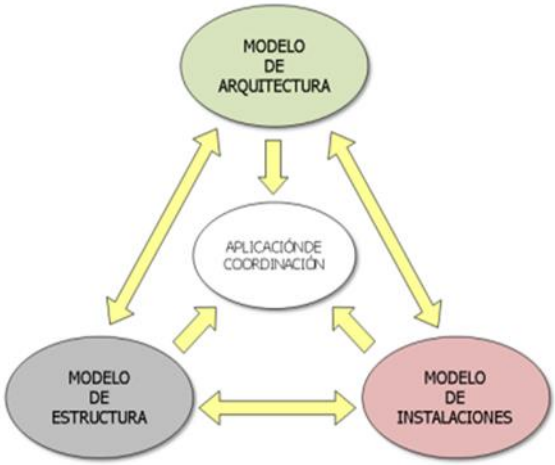

Fig No. 2: Coordination of Computer Models.

Source: Adapted from Carvajal et al., 2018.

In summary, there are several ways to coordinate computer models on a civil engineering project, such as using project management software, common file formats, content management systems, real-time collaboration tools, and change management systems. It is important to use these tools to ensure that designs and drawings are synchronized and match each other, which will help ensure the success of the project.

1.3 Integrated Educational Management System

It is an educational management system that consists of a group of tools and computer applications that access to manage various aspects of educational institutions such as admissions, grades, schedules, educational programs, etc. (García de Paz and Bonilla, 2021) Figure 3 As shown, these systems usually include administrative, academic and human resources management modules with the main objective of optimizing the efficiency and effectiveness of the management of educational institutions.

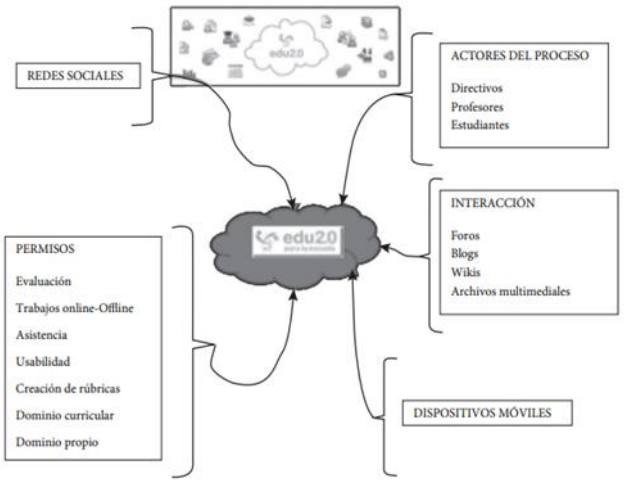

Fig No. 3: Components of the Integrated Education Management System.

Source: Adapted from Arango-Carrillo et al., 2014.

In civil engineering, an integrated educational management system can be used to manage aspects such as project planning and scheduling, human and financial resource management, performance evaluation and educational quality control. It can also be used to track research and professional development activities and manage relationships with students, faculty and other members of the academic community.

Conclusions

The use of the different softwares described in the study brings enormous benefits in the learning of the civil engineering student, as it was seen, most of these systems fulfill multiple functions that are of great help for decision making, project structuring, risk analysis and architectural designs, therefore, it is recommended the inclusion of these technologies in the teaching of students to improve the competitiveness of future graduates.

Likewise, it was possible to see the need to train educators in these new technologies, seeking to take full advantage of the capabilities of the systems and encouraging students' curiosity to master ICT and its components.

The rapid evolution of technology implies the commitment of government authorities to keep the country's educational centers up to date in ICT technologies, both in the acquisition of new equipment and software and in the training of students and teachers.

References

[1] Alarcón, C. H. M., León, C. E. D., Donoso, L. J. G., Tinoco, L. M. E., & Alarcón, F. P. M. (2021). Educational training methodology based on virtual learning environments for Civil Engineering students. Mastering Science, 7(2), 530-550. https://dialnet.unirioja.es/servlet/articulo?codigo=8231863.

[2] Anjaneyulu, B., & Prakash, K. J. (2016). Analysis and design of flat slab by using Etabs software. International Journal of Science Engineering and Advance Technology, 4(2), 105-112. https://core.ac.uk/download/pdf/235196708.pdf.

[3] Arango-Carrillo, J., Isaza-Domínguez, L. G., & Vargas-Guativa, J. A. (2014). Instructional strategy for the training of civil engineering teachers in the use of ICT. Ingeniería Solidaria, 10(17), 161-174. https://www.academia.edu/download/37339492/Estrategia_Instruccional_para_la_formacion_de_docentes_.pdf.

[4] Berrocoso, J. V. (2008). Free software and good educational practices with ICT. Comunicación y pedagogía, 222(48), 55. https://www.academia.edu/download/33942646/articulo_cp_2007.pdf.

[5] Blaber, J., Adair, B., & Antoniou, A. (2015). Ncorr: open-source 2D digital image correlation MATLAB software. Experimental Mechanics, 55(6), 1105-1122. https://link.springer.com/article/10.1007/s11340-015-0009-1.

[6] Botero, T. S., & Botero, L. F. B. (2015). Building Information Modeling as a new technology in the teaching of civil engineering, architecture and construction. Archetype, (10), 85-110. https://dialnet.unirioja.es/servlet/articulo?codigo=5653986.

[7] Carniel, L. C., & Avila, M. C. (2009). Towards the virtuality of the university. Case of Civil Engineering at UCLA. Apertura, 9(10), 20-33. https://www.redalyc.org/pdf/688/68812679003.pdf.

[8] Carvajal, J., Suárez, F., & Quiñónez, X. (2018). ICT in university education. Universidad Ciencia Y Tecnología, 22(89). https://uctunexpo.autanabooks.com/index.php/uct/article/view/28.

[9] Castillo, J. N., Barahona, A. S. C., Naranjo, P. M. M. M., & Segovia, D. F. J. (2018). Model for computer security risk reduction in web services. Summits, 4(2), 19-30. https://dialnet.unirioja.es/servlet/articulo?codigo=6836549.

[10] Chakole, H., & Wadhai, P. J. (2022). A

Review on the comparison of geometric design using Civil 3D software and manual method. International Journal for Modern Trends in Science and Technology, 117. https://doi.org/10.46501/IJMTST0806017. https://doi.org/10.46501/IJMTST0806017.

[11] Da Silva, Á. S. (2018). Use of AutoCAD software as a didactic tool for academic training in engineering education. Arandu UTIC, 5(1). https://www.utic.edu.py/revista.ojs/index.php/revistas/article/view/47.

[12] Dajud, G. A. B., Reyes, G. R., & Sampayo, R. R. Á. (2009). Diagnosis on the use of AUTOCAD® as support software in the basic and applied areas of civil engineering at UNISUCRE. Revista Educación en Ingeniería, 4(8), 57-69. http://educacioneningenieria.org/index.php/edi/article/view/93. http://educacioneningenieria.org/index.php/edi/article/view/93.

[13] D'Paola Puche, E. H. (2014). New technologies in civil engineering education: BIM and virtual reality [Doctoral thesis, Universidad EAFIT]. https://repository.eafit.edu.co/handle/10784/2855.

[14] Furió, P. M. (2017). Revit families from manufacturers adapted to engineering and site needs. Spanish Journal of Building Information Modeling, (17), 30-44. https://www.farmaindustrial.com/require/archivos/articulos/descarga/rcYyOP3GTW0FvL2MRhhSpZHR.pdf.

[15] Gálvez, D. L. L. D., Ponce, L. A. M., Tarragó, J. C. P., & Rodríguez, A. (2021). Implementation of computational tools as a didactic basis for the Teaching-Learning process in the Civil Engineering career. Serie Científica de la Universidad de las Ciencias Informáticas, 14(8), 116-129. https://dialnet.unirioja.es/servlet/articulo?codigo=8590617.

[16] García-de-Paz, S., & Bonilla, P. J. S. (2021). The transition to virtual education environments in a health emergency context: case study of a teaching team in Basic Vocational Training. Revista de Educación a Distancia (RED), 21(65). https://revistas.um.es/red/article/view/450791.

[17] Guerrero, R. S. (2020). Application of ICT in the teaching of electromagnetism for engineering careers. Informatics and Systems: Journal of Information and Communication Technologies, 4(1), 27-33. https://revistas.utm.edu.ec/index.php/Informaticaysistemas/article/download/2281/2558.

[18] Hernández, R. M. (2017). Impact of ICT in education: Challenges and Perspectives. Purposes and Representations, 5(1), 325-347. https://dialnet.unirioja.es/servlet/articulo?codigo=5904762.

[19] Herrera, A. M., Suhandri, H. F., Realini, E., Reguzzoni, M., & de Lacy, M. C. (2016). goGPS: open-source MATLAB software. GPS solutions, 20, 595-603. https://link.springer.com/article/10.1007/s10291-015-0469-x.

[20] Huillcahuari, E. L., Quispe, P. H., Cardenas, V. A. C., & Arroyo, A. Q. (2022). Information and Communication Technologies as pedagogical and technological innovation in the learning of Calculus I, in students of the school of Civil Engineering, National University of San Cristobal de Huamanga, in context COVID-19. Horizonte de la Ciencia, 12(23). https://revistas.uncp.edu.pe/index.php/horizontedelaciencia/article/view/1470.

[21] L. Ramírez, "Proposal of a meaningful instructional design for the subject technical drawing with the incorporation of ICT in the School of Earth Sciences, Universidad de Oriente. Núcleo Bolívar", Master's Thesis in Education, Universidad de Oriente, Bolívar, Venezuela, 2009. http://mriuc.bc.uc.edu.ve/bitstream/handle/123456789/845/nseverian.pdf?sequence=4.

[22] Londoño, E. M., Vargas, J. L. A., & Montoya, S. M. O. (2016). Educational software for the good use of ICT. Entre Ciencia e Ingeniería, 10(19), 114-125. http://revistas.ucp.edu.co/index.php/entrecienciaeingenieria/article/view/509.

[23] López Gómez, O., & Castellano Paz, A. (2018). Methodology for the automated calculation of design avenues in road projects using AutoCAD Civil 3D software. Universidad & ciencia, 7(3), 205-220.

[24] Macías-Macías, S. R., & Romero-Vélez, E. M. (2021). Analysis of the organizational management of the Provincial Coordination of Health Benefits of the Ecuadorian Institute of Social Security Manabí. Dominio de las Ciencias, 7(2), 3-25. https://dominiodelasciencias.com/ojs/index.php/es/article/view/1779.

[25] Martínez Castro, M. L., & Gritti García, A. L. (2012). The use of ICT in civil engineering career education. Revista Ingeniería Espacio Tiempo, 2(3), 6-10. http://eprints.rclis.org/31646.

[26] Morillo, J. G., Pérez, F. M., Cañas, J. R., Aguilar, P. Á. R., & Díaz, J. A. R. (2017). Use of ICT technologies to involve students in the teaching-learning process in engineering. Revista de Innovación y Buenas Prácticas Docentes, 23-29. https://www.uco.es/ucopress/ojs/index.php/ripadoc/article/view/9608.

[27] Peña, M. A. M. M., & Ancco, V. N. V. (2022). Matlab in the learning of kinematics in Civil Engineering students. Horizon of Science, 12(22), 132-142. https://revistas.uncp.edu.pe/index.php/horizontedelaciencia/article/view/1074.

[28] Rodríguez, O. T., Avila, M. C., & Chourio, E. D. (2010). The b-learning model applied to the teaching of the mathematics I course in the civil engineering career. Revista Electrónica" Actualidades Investigativas en Educación", 10(3), 1-28. https://www.redalyc.org/pdf/447/44717980015.pdf.

[29] Santoyo, L., & Huitzilopochtli, Y. (2021). Impact of the use of OVAs designed for the teaching of derivative in civil engineering. [Master's thesis, Universidad Michoacana de San Nicolás de Hidalgo. http://bibliotecavirtual.dgb.umich.mx:8083/xmlui/handle/DGB_UMICH/6442.

[30] Silva, A., Ledesma, E., Castorena, J., Domínguez, A., & Riojas, A. (2018). Utility of the Unified Modeling Language (UML) in professional software development within the business and educational sector. CienciaCierta revista de divulgación científica, 56. http://www.cienciacierta.uadec.mx/articulos/cc56/Lenguaje.pdf.

http://www.cienciacierta.uadec.mx/articulos/cc56/Lenguaje.pdf.

[31] Song, W., Jiao, H., Xu, X., & He, P. (2023). An optimized modeling for in-situ stresses based on Rhino accurate modeling and large-scale transverse isotropic theory. Scientific Reports, 13(1), 691. https://www.nature.com/articles/s41598-023-28039-8.

[32] Terreros, N. V. (2019). Proposal of a support system for the teaching of geometry in the career of Civil Engineering-Catholic University of Santiago de Guayaquil. Alternativas, 20(1), 21-29. https://dialnet.unirioja.es/servlet/articulo?codigo=7445917.

[33] Vinueza, S. F. V., & Gallardo, V. P. S. (2017). Impact of ICT in Higher Education in Ecuador. Publicando Journal, 4(11 (1 (1)), 355-368. https://core.ac.uk/download/pdf/236644472.pdf. https://core.ac.uk/download/pdf/236644472.pdf

[34] Cely N; Palacios W; Caicedo A (2022) Engineering, innovation and its importance for the future of civil engineering in Colombia (pp 11-12).