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Industrial needs and Latin American engineering education

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Abstract

In Latin America, the digital economy gap continues to widen compared to other world regions. Due to this, updating teaching and digital convergence are aspects that cannot wait to shorten the technological gap and thus achieve greater competitiveness economically in the region. This paper presents a bibliographic analysis of the progress in implementing asynchronous study modalities in Latin America and the academic self-management of students throughout the region. The main results show a digital gap in education technologies adoption concerning other world regions and methodologies still based on the traditional teaching model.

Keywords: educational methodologies, economic innovation, academic self-management.
Las necesidades industriales y la educación latinoamericana en ingeniería

Introduction

Economic globalization has allowed many regions in different countries to integrate into a value chain that supplies all industries worldwide with raw materials, components, services, and finished goods. As technological development advances, so does the tech innovation and sophistication of all those components and products within this global value chain (Breznitz, 2021), (Flor, et al., 2022). To remain within this productive dynamic, regions

and countries invest in research, technology, and development that allow them to innovate and remain firm in their business niches (Taylor, 2016). Latin America and Africa are mainly outside this global supply chain, so the ability to generate jobs and development opportunities for their citizens is not only at a disadvantage. However, it could also keep generations at economic levels below the global average, reinforcing a negative cycle of poverty and inequality.

Undoubtedly, part of the solution to this problem lies in the training of professionals trained in science, engineering, and technology, who should graduate from the study centers of the region. For this reason, it is essential to know the teaching strategies used in higher education centers in the fastest growing regions and compare them with those used in Latin America, as well as to carry out various qualitative and quantitative analyses. Such studies would make it possible to identify those aspects that keep them at the forefront, and even stand out even more in the global economy, and to implement them or even create them in Latin America for the economic support of the region (Montaño, 2021).

The COVID-19 pandemic has become a historic milestone in multiple ways. It has led to accelerated digital tools, platforms, and resources adoption in educational environments. These have expanded and even transformed the academic offerings, opening a broad debate around the teaching methodologies applied in educational institutions worldwide (Vijayan, 2021), (Aleman, et al., 2021). Many nations used social isolation as a necessary measure to reduce the spread of COVID-19. This measure caused millions of students to move from a face-to-face teaching modality to a completely virtual one, which turned multimedia platforms and social networks into the main supports of the teaching-learning process. Few educational institutions had in advance a digital educational platform allowing students to continue with a certain continuity of a program of studies according to their level. Latin America was no exception; the abrupt change from a face-to-face to a virtual mode brought an unprecedented emerging scenario whose adoption produced unequal results throughout the region. This paper proposes a bibliographic analysis to learn about the methodological strategies used in virtual education in Latin America. The aim is to evaluate the online teaching mechanisms used during the COVID-19 pandemic and how this opens the scenario for new approaches and new educational strategies in which asynchronous methodologies and the role of student self-management within these new teaching-learning scenarios stand out.

Economics and Education

Global value chains directly result from the internationalization of the production and consumption of goods and services. These value chains translate into supply networks of components, machinery, software, and many other elements required by different companies. These circumstances have given shape to what is known as the fragmentation of production. These circumstances have given rise to what is known as the fragmentation of production, i.e., the supplies needed to manufacture a product do not come from a single region but are located in different parts of the world. It is due to regions in various countries specializing in niche markets, offering high-quality components and products at very competitive prices. It is what happens in Taiwan with its microchip production companies. It is the case in Taiwan, whose microchip production companies, TMSC and UMC, are significant producers of these fundamental components for the industry today. They have expertise in designing and manufacturing chips to the specifications of their customers (such as Apple, NVIDIA, Samsung, and others), putting them ahead of traditional chip manufacturing companies such as Intel (Breznitz, 2007). While it is true that these companies need multiple factors to excel in a

highly competitive market, the fundamental premise can be applied to this industry like any other: the need for trained and skilled labor in these niche markets. The same is true in China. One of the production advantages of that country over other regions is the ability to find not only the most discrete raw materials and components, such as a specific type of screw but also the possibility of hiring qualified personnel without the need to bring them from other countries. It is part of the basis for these regions' strength in attracting capital and more skilled labor. However, as is evident, everything has a beginning, based on the qualification of the labor force, investment in education, and research and tech innovation. It is a fundamental principle.

The COVID-19 pandemic burst upon the world at a time when the integration of information technologies with industrial models was giving way to new ways, some unprecedented, of producing, selling, and marketing goods and services. This unexpected event has subverted many aspects of both economic and social life. In education, it is necessary to know the methodological approaches of the regions and countries that lead global production to know how they maintain the educational models that have been successful for them, taking into account the changes introduced by the pandemic crisis.

2.1 Approaches used worldwide

In mathematics courses in European countries, such as Spain or Germany, studies indicated that the emergency caused by COVID-19 imposed a massive adoption of virtual media to maintain academic continuity. This scenario highlighted two teaching models: one based on synchronous classes, where students interact with their teachers in real-time, and another based on asynchronous classes, where interaction is not done directly with teachers but through recorded classes and study materials developed to be consulted and evaluated on digital platforms (Minaya, et al., 2022). Assignments delivered via email also fall into this range. In Germany, because digital resources were more widespread within the educational system, asynchronous digital tools were more required during the health emergency period. Later, it became evident that digital tools were integrated into the academic routine of both teachers and students. For the students, it meant study periods with a more excellent range of autonomy, having to plan on their own the time and effort to fulfill the checkpoints satisfactorily. In the Spanish case, a greater use of synchronous tools was noted, where teleconferencing and instant messaging tools were the most used channels (Barlovits, et al., 2021). In Spain, and contrast to Germany, the socioeconomic conditions of the students showed the existence of a notorious digital divide that conditioned the time of access to the Internet and, therefore, the time of study on digital platforms and access to digital material. It also stands out that teachers explained the subjects they taught with an approach similar to that used in their face-to-face classes (Ceballos & Huaita, 2021).

Studies conducted in Switzerland show that online education generally represents a more significant challenge to the attention and commitment of students and teachers than in traditional face-to-face classroom systems (Alvarez, et al., 2022). However, it is concluded that it is necessary to adopt measures that allow teaching and learning mechanisms that take advantage of the potential of digital tools in terms of reference material and asynchronous student access. It is in line with research conducted in Estonia, where the development of blended learning programs, i.e., active learning and traditional learning approaches in higher education. The study showed that university students were more interested in material that could be accessed asynchronously, such as virtual laboratories, teaching materials, and quizzes (Vodovozov, et al., 2022). It contrasts with studies conducted at one of Russia's leading universities, which, while noting the potential of digital tools, consider that digital educational approaches should again be complementary and not a model to be adopted in the future

(Volkov, et al., 2022). This position is not the one adopted by most European countries. There is still debate about what the predominant models will be once the health pandemic is over (Kerres & Buchnner, 2022). However, there is a clear trend toward hybrid models, which leverage asynchronous and synchronous modalities and face-to-face integration of digital materials such as chats, quizzes, and live groups o (Dubois, et al., 2022). This same experience was observed in higher education institutions in China, where hybrid approaches had positive results in contrast to entirely virtual education (Xiufeng & Saghaian, 2022). In concordance, in the United States, some studies showed that students showed greater interest in learning when multimedia resources such as videos and presentations were used. Learning content was flexible in separate modules and straightforward explanations from professors in lectures and labs (Mikhailova, et al., 2022). Thus, the overall picture indicates that qualitatively students have preferred education systems where they have greater autonomy in exploring study materials virtually, coupled with clarifications and explanations in the classroom. The studies also quantitatively showed that student performance was above the results obtained in entirely virtual classes and comparable to or better than face-to-face classes (Barlovits, et al., 2021).

2.2 Approaches in Latin America

During the pandemic in Latin America, the necessary transition to virtual education produced great upheavals in both the teaching and student population, revealing significant gaps in social inequality and access to education. Previous preparation in using learning methodologies supported by virtual tools was particular and not representative in the region. This generalized lack of knowledge led to the adoption of videoconferencing platforms for synchronous lectures, which, together with the use of instant messaging platforms, formed the core of tools used during the health emergency to teach classes and socialize the documents to be evaluated. The lack of teaching experience with digital tools and the scarce access to digital materials led most teachers to adopt a methodology similar to the face-to-face one. The result was a simplification of the educational effort, i.e., a decrease in the effective teaching hours occurred. The consequence was reducing class hours without any didactic compensation to reinforce the unused hours. The same happened with the evaluation methods; simplifying the evaluation models resulted in low effectiveness when supervising the expected learning. Therefore, educational performance suffered, leaving a worrisome scenario of general delay in competencies (Moreira Teixeira & Miguel, 2021). However, in those experiences that integrated virtual education with asynchronous consultation elements, the results showed a remarkable level of engagement of both teachers and students. It reinforces the idea that with the use of digital tools with flexible characteristics in terms of access and use and, with the academic accompaniment of the teacher, students achieve the learning objectives (Salas-Pilco & Yang, 2022).

Methodology

An investigation of the synchronous and asynchronous methodologies adopted in countries where education has excelled in innovation, empowering students to lead their training, was carried out in this study. The works consulted were from the Scopus database, without considering other sources of information.

The inclusion criteria used were:

- Distance Education
- Online Education
- Covid-19

- Year of publication

The most relevant aspects that were considered are:

- Student autonomy
- Synchronous education methodologies
- Asynchronous methodologies
- Education for innovation

Different bibliographic bases were reviewed according to the description provided in Figure 1. It can be seen that a significant number of articles were purged because they did not meet the criteria of topicality and subject matter or because they were duplicates. A total of 20 effective documents remained.

The selected information was completely current, performing a content analysis in each case, considering the contributions offered for understanding educational methodological strategies in Latin America, both face-to-face and virtual, taking into account the education in reference countries.

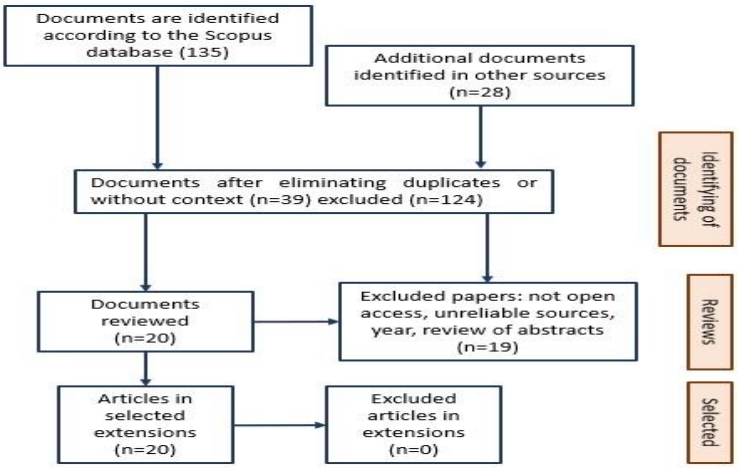

Figure 1. *Bibliographic review and content analysis.*

In the documentary identification phase, key elements were considered based on the research questions centered on the worrisome academic situation in Latin America, where dropouts and low science levels continue to prevail.

In the revision phase, the specific content of each document was analyzed, highlighting the contributions in the Latin American situation concerning the teaching methodologies used in countries such as Germany, Estonia, China, United States, which are considered leading countries in technological and economic innovation.

Finally, the selected documents showed the realities of countries that are pioneers in innovation, with educational systems in progress and a vision that contrasts with Latin America.

Results

Once the academic material was evaluated, it was possible to detect the following results:

1. Hybrid approaches applied in countries where innovation is highly observable have proven to be the most efficient for achieving academic training in young people. Education is undoubtedly the most suitable way to motivate innovative economic systems, where each person's individual skills prevail in multidisciplinary teams. The hybrid education model allows the integration of knowledge, online models with face-to-face models for specific topics, with diverse activities that favor motivation and innovation in academic profiles.
2. Hybrid approaches benefit the student's global formation, from their organization for time and activity management to conceiving academic problems and attending to their solutions in favor of their student performance.
3. Online teaching material is a resource of great relevance to achieve students who can contribute to their formation, as long as the teacher-student communication is the most appropriate so that the online resources are in tune with the activities and expectations of the students. Access to online material will allow the student to review the content, improve their understanding of the topics and take advantage of it to develop tasks and activities.
4. The regions with the lowest rate of innovation have used the digital experience more, similar to a face-to-face class, and achieving professionals with few skills. Online classes cannot and should not be a replica of face-to-face classes, with the same rules, the same premises, the same ways of working, and the same methodologies. Monitoring students in virtual classes should be done differently, allowing the student autonomy and decision-making regarding time and management of activities. Regions with less innovation, such as Latin American regions, have developed virtual classes as a replica of face-to-face classes, failing in student motivation, low grades, dropouts, and lack of innovation.
5. Countries with low innovation, primarily Latin, have more excellent resistance to change, greater resistance to new technologies, and less motivation for new educational methodologies. Likewise, these countries showed more attachment to traditional methodologies, in virtual or face-to-face mode, but both cases, with traditional methods that are not in tune with the new social characteristics of students.
6. The countries with a minor innovation also showed to be nations with much resistance to allowing student autonomy, critical thinking, and self-management of time students.

Conclusions

1. In Latin America, a coordinated effort is required among countries to promote the integration of curricula, that is, linking teaching strategies with social and industrial needs. The students can propose creative ideas for problem-solving based on the knowledge acquired and, on the leadership, and innovation skills that the educational system has allowed for the integration of skills. Although this practice has been successfully implemented in countries such as Venezuela, there is still a long way to go for curriculum integration in Latin America to be consolidated as a Latin American educational community for local development.
2. In Latin America, traditional education prevails where the teacher gives guidelines, and students obey, restricting most of the skills to propose ideas and generate innovation from the University Society and industry. These educational limitations show a broad resistance to the maternal liberation of the student, who continues to wait for specific instructions to perform tasks without the motivation to investigate, search, and research by himself.
3. Innovation is born from the school, spreads through the different academic scenarios, and promotes the development of nations. However, in countries where education

remains traditional, the possibilities for innovation become less and less, and employers increasingly question the professional skills developed by students.

4. It is necessary to study the region's contrast between education and innovation policies.

References

Aleman, Y., Alarcon, P., Monzon, G. & Pastor., K., 2021. Education priorities in he wake of the COVID-19 Pandemic. Minerva Journal, 2(5), pp. 5-12.

Alvarez, L., Carrupt, R., Audrin, C. & Gay, P., 2022. Self-Reported Flow in Online Learning Environments for Teacher Education: A Quasi-Experimental Study Using a Counterbalanced Design. Education Sciences, 12(5), pp. 351-362.

Barlovits, S., Jablonski, S. L. C., Ludwig, M. & Tomás, R., 2021. Teaching from a Distance—Math Lessons during COVID-19 in Germany and Spain. Education Sciences, 11(8), pp. 406-422.

Breznitz, D., 2007. Innovation and the State: Political Choice and Strategies for Growth in Israel, Taiwan, and Ireland. New York: Yale University Press.

Breznitz, D., 2021. Innovation in Real Places. New York: Oxford University Press.

Ceballos, E. & Huaita, A., 2021. Engineering projects and educational paradigms. Athenea Journal, 2(5), pp. 55-60.

Dubois, C. y otros, 2022. Impact of COVID-19 on eLearning in the Earth Observation and Geomatics Sector at University Level. Education Sciences, 12(5), pp. 334-360.

Flor, O., Verónica, T., Marlene, B. & David., L., 2022. Students' perception of the quality of virtual education in times of COVID-19 pandemic. Athenea Journal, 3(7), pp. 37-41.

Kerres, M. & Buchnner, J., 2022. Education after the Pandemic: What We Have (Not) Learned about Learning. Education Sciences, 12(5), pp. 315-322.

Mikhailova, E. A., Post, C. J., L., Y. G. & Schlautman, M. A., 2022. Connecting Students' Interests to a Learning Context: The Case of Ecosystem Services in STEM Education. Education Sciences, 12(5), pp. 318-333.

Minaya, C., Briones, J., Arias, I. & Minaya, A., 2022. Education for engineers in times of pandemic. Athenea Journal, 3(7), pp. 23-29.

Montaño, D., 2021. Evaluation digital of tolos for the management the portafolio educational. Minerva Journal, 2(4), pp. 55-61.

Moreira Teixeira, A. & Miguel, Z.-R., 2021. Presentacióndel número especial de RED Transición de la educación convencional a la educación y al aprendizaje en línea, como consecuencia del COVID19. Revista de Educación a Distancia, 21(65), pp. 1-8.

Salas-Pilco, S. Z. & Yang, Y. Z. Z., 2022. Student engagement in online learning in. British Journal of Educational Technology, 53(1), pp. 593-619.

Taylor, M. Z., 2016. Politics of Innovation: Why Some Countries Are Better Than Others at Science and Technology. New York: Oxford University Press.

Vijayan, R., 2021. Teaching and Learning during the COVID-19 Pandemic: A Topic Modeling Study. Education Sciences, 11(7), pp. 347-361.

Vodovozov, V., Zoja, R. & Patlenkov, E., 2022. Active Blended Learning Engineering Students: A Case Study. Education Sciences, 12(5), pp. 344-357.

Volkov, A. y otros, 2022. Using Digital Tools to Teach Soft Skill-Oriented Subjects to University Students during the COVID-19 Pandemic. Education Sciences, 12(5), pp. 335-348.

Xiufeng, X. & Saghaian, S., 2022. Learning Outcomes of a Hybrid Online Virtual Classroom and In-Person Traditional Classroom during the COVID-19 Pandemic. Sustainability, 14(9), pp. 5263-5276.