# ADVANCING SUSTAINABLE EDUCATION: DESIGN A NOVEL STEAMS MODEL INTEGRATING TECHNICAL AND PSYCHOLOGICAL FACTORS

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Over the past decade, the integration of Science, Technology, Engineering, MathemaICTs, and Social Sciences (STEAM) disciplines into educational models has emerged as a crucial aspect of preparing future generations. This integration, facilitated by innovative technologies like virtual reality, gamification, and social platforms such as Webex and Teams alongside conventional tools, significantly enhances the overall learning experience.

However, adopting these new educational models, particularly those incorporating immersive technologies, brings challenges and opportunities to the current educational landscape. A key challenge lies in the continuous training of educators, necessitating the updating of methodological approaches and the acquisition of proficiency in utilizing emerging technologies and collaborative networks.

In our pursuit of establishing a global STEAM model, our research team conducted a series of sub-studies to investigate the impact of technical and affective factors on the evolving university education model. Comparative studies were undertaken between two distinct university models in Spain and Ecuador, funded publicly and privately, respectively. Beyond technical considerations, our observations extended to the influence of psychosocial risks on these models, notably the anxiety experienced by teachers due to constant methodological updates and technological advancements.

This paper proposes a novel STEAM learning model based on partial results obtained from our investigations. The model incorporates multimedia systems, information and communication technology (ICT), gamification, social networks, and collaborative platforms. Additionally, it addresses stress factors encountered by teachers in challenging work conditions. Emphasizing the significance of work experience, the absence of structured models for classroom application, and the necessity for continuous training, our proposed model aims to alleviate barriers hindering ICT integration. However, the abrupt shift in training methods has adversely impacted teachers' ICT skills, resulting in adverse effects such as emotional disorders (depression, anxiety, and technostress).

In conclusion, recognizing the indispensable role of teachers is paramount for establishing a sustainable higher education system. Addressing the challenges highlighted in this study is crucial for fostering effective STEAM education and ensuring the well-being of educators in the rapidly evolving educational landscape.

Keywords: New Technologies, Social Networks, Collaborative Platforms, Sustainability, Rick Factors, New Steams Models

# 1 INTRODUCTION

Education for sustainability is immersed in the Sustainable Development Goals (SDGs) defined by the United Nations (UN), specifically in objective 4: “Ensure inclusive, equitable and quality education and promote opportunities throughout life for all.” That is, the training of people capable of making responsible decisions, aware of global challenges and applying their knowledge to solve technological, social and environmental problems in their environment is conceived [1]-[7].

Higher education institutions in Europe must continue working to respond to sustainability in their curricula, in accordance with the model proposed in the European Higher Education Area (EHEA) of which Spain is a member. Likewise, Ecuador has a higher education model based on the same principles as those established in the EHEA system and therefore comparable in all its terms.

Information and communication technologies, ICTs, have impacted the educational system and have promoted the use and inclusion of numerous digital tools that facilitate the creation of new educational resources [8].

The latest trends in ICT development, virtual learning environments (LMS) and immersive learning through augmented reality, and the active methodologies and pedagogies based on them have in turn favored the interest of students by promoting their attention and interest [9].

Within these software tools, gamification is an active methodology that integrates game-based elements [10]. There are numerous studies that demonstrate its usefulness in the educational context of basic education, however, at the higher education level, studies focused on its use are scarce, although its benefits have been demonstrated in the limited research carried out to date [11].

It has been proven that gamification contributes to improving the sustainability of education due to its direct impact on science, technology, engineering and mathematics (STEM), since it promotes the awakening of curiosity in students and therefore their desire to investigate and improve knowledge [10]. It follows that it has the potential to improve the motivation of students in their educational process, encourages their participation, promotes the development of more sustainable skills and behaviors and improves the academic performance of students [12].

All these positive effects, described above, facilitate, in turn, the motivation of teachers in their educational work, which translates into an improvement in their working conditions, motivation in their development and therefore in a promotion of your health and well-being [13].

This leads to a more sustainable education system at an educational, technological and human level [14]-[15].

# 2 METHODOLOGY

This research proposes a theoretical-methodological model that conceives for the incorporation of ICT Information and Communication Technologies and gamification for the development of STEM skills in sustainable Higher Education Institutions. For this, a bibliometric was carried out with the objective of analyzing the impact of ICTs and gamification, highlighting positive and negative aspects of their inclusion in higher education, which would allow determining if there was a growing trend in the last decade or specific implementation models of ICTs. its proper implementation in HEIs.

Next, a comparative study was carried out between Higher Education Institutions (HEIs) in Ecuador and Spain, in which a qualitative survey previously validated and distributed online was obtained, to determine the factors of inclusion and use of ICT in HEIs. in two moments before and after confinement. The results showed the essentiality of ICTs to achieve sustainable HEIs, highlighting the benefit of their inclusion in the teaching and learning process and in the development of ICT skills in teachers. Also, it was evident that teachers lacked training and specific models for the correct inclusion and use of ICT in the classroom, which was much more prominent in teachers with more experience other difficulties related to emotional well-being.

In the following qualitative study, the influence of technology and Coivd-19 on teachers with high experience in STEM education in HEIs was analyzed. The results obtained showed the exhibitions presented by teachers in an exceptional situation such as COVID-19 in which the change in the teaching modality, the imposition of the use of ICTs, among other factors, generated high levels of anxiety and emotional stress related to their perception of the online work methodology, regardless of the country of origin. It was also shown that teachers with more training in the STEM

fields and ICT proficiency were less likely to develop technostress, which is why it is considered a preventive effect.

Finally, a general sustainable STEM model is proposed for higher education institutions, which conceives the different actors (students and teachers) and the benefits of the inclusion and use of ICTs in the teaching and learning process that already contributes to development. of their technological skills and emotional well-being.

## 3 RESULTS

The inclusion of active methodologies and ICTs in the teaching process had exponential growth in the first phases of the COVID-19 pandemic, where higher education institutions worldwide implemented action plans in virtual mode. This experience, generated by external factors, demonstrated the importance of ICTs in educational processes, especially in teaching modalities through virtual environments and as a key element for feedback and communication.

These unpredictable conditions allowed studies to be carried out on the use and influences of ICTs both at the teaching level and in the development of the psychological well-being of teachers and students in the pre- and post-pandemic periods.

Based on the research carried out and published, the proposal for a partial teaching model in Higher Education (ICTs and Gamification) is presented that responds to Objective 4 defined by the ODS and that conceives the integration of technological tools as part of the strengthening of the STEM education in Universities in Ecuador and Spain, contributing to the sustainability of the University system in these countries.

In the model (Figure 1), which is proposed in this study, a general scheme is presented applying the factors studied. Information and communication technologies (ICTs) play a fundamental role due to their impact on the educational system, providing the opportunity to include tools and programs for the creation of educational resources, virtual learning environments and new forms of learning. In addition, they have made possible the inclusion of new active methodologies such as gamification that integrates elements based on games and rewards, with the ability to improve the motivation of students in the training process, promote active participation, and the development of more skills and behaviors. sustainable in both students and teachers.

Likewise, the importance of ICTs in educational processes is shown to support unforeseen situations such as the COVID-19 pandemic, in which these tools were the basis for teaching through virtual environments, which allowed maintaining feedback and communication with students.

On the other hand, the proposed model highlights the importance and difference of work experience, the lack of structured models for application in the classroom and continuous training that allows mitigating obstacles to the integration of ICT. However, the abrupt change that occurred in education during the pandemic worsened teachers' ICT skills, given the demands of the moment, triggering emotional disorders such as depression, anxiety and technostress as a negative effect on teachers.

Finally, it should be noted that to obtain a Sustainable Higher Education System, the role of teachers is fundamental and essential. For this reason, it is imperative, on the one hand, to provide training to teachers in models that integrate ICTs and improve the development of their technological skills, and on the other hand, to offer constant supervision and help regarding their updating and working conditions that contribute to their physical well-being. and psychic.

## 4 CONCLUSIONS

Firstly, a bibliometric review of scientific production related to the impact of ICTs, gamification and emotional well-being in Higher Education Institutions was carried out, focused on their teachers and growth in STEM fields, obtaining the following results:

• Tthe scientific production related to gamification lies in experimental studies starting in 2018, mainly research with a qualitative approach where the most significant development is related to the increase in motivation. in students, improvement in academic performance, participation and sustainable behaviors.

• This study shows, through scientific research, the use of gamification as a tool to promote social well-being in various fields including education and health, improving motivation, self-esteem and academic performance in students, creating healthy and sustainable environments at the IES.

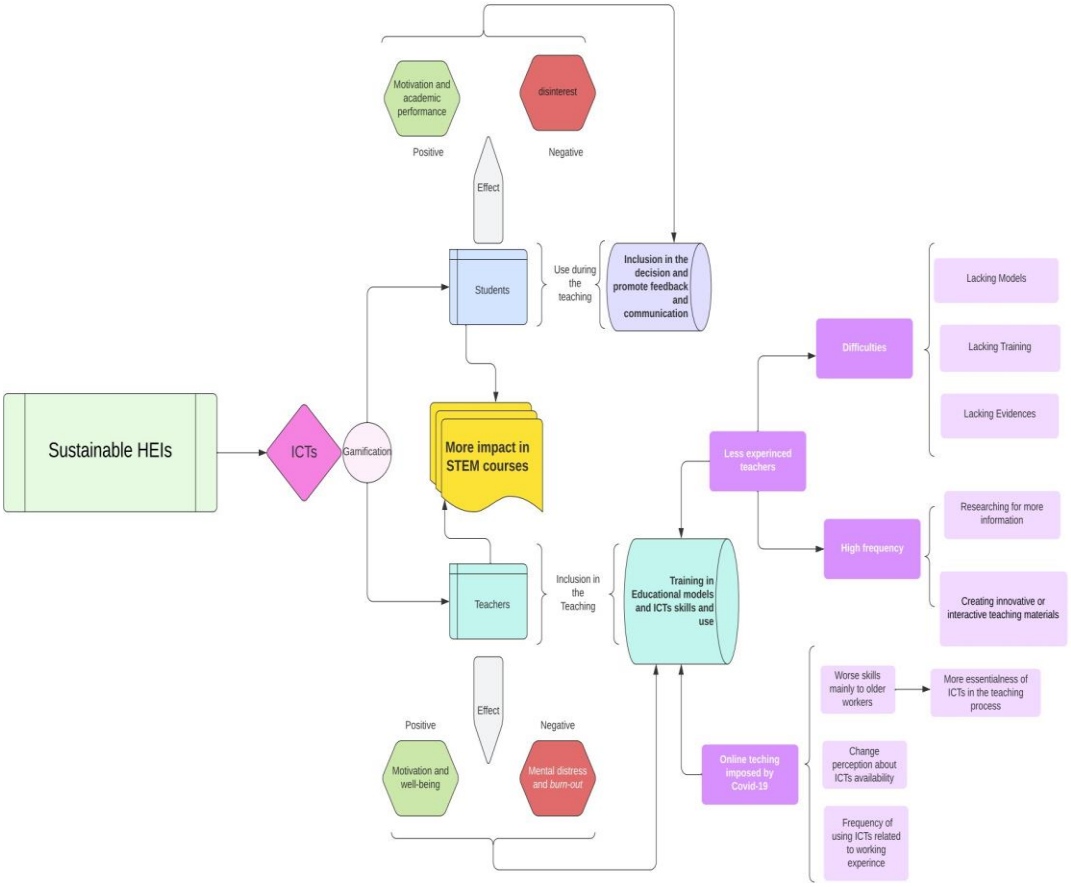


Figure 1. Sustainable STEM model in the context of university teaching: gamification and ITCs

Secondly, a comparative study was carried out through a qualitative online survey, with the objective of determining the factors of inclusion and use of ICTs in higher education institutions at two different times: (pre and post confinement), obtaining the following results:

• The integration of ICT in the educational system is key to creating sustainable educational institutions, being of great importance for the benefit of university teachers, their ICT skills and their impact on extraordinary situations like COVID-19. This study showed how the lack of specific models, available resources and the absence of teacher training for the use and inclusion of ICTs and active methodologies such as gamification, were the main obstacles found, especially in the teachers with more experience.

• There is a relationship between work experience and the use of ICTs. This study showed that teachers with less experience spend more time using ICTs, giving greater importance and criticality to their integration, regardless of the country. Furthermore, the results that compared pre- and post-confinement showed that teachers with less experience, despite having the availability of ICT resources and tools, lacked models for their correct integration. Likewise, it was found that after confinement the perception of teachers with more experience changed in relation to the essentiality of ICTs in the teaching and learning process.

Thirdly, the influence of technology and covid-19 on teachers with extensive experience in STEM education in higher education institutions was analyzed, obtaining the following results:

• The study showed that STEM teachers at the university level perceived different factors such as: COVID-19, the imposition of the use of ICT, technological problems, as obstacles to developing their teaching work, the balance between family and work, and the perception of lack of means, which caused a high percentage of teachers to have high levels of anxiety, depression and their risk of developing them as a mental disorder.

• The study showed that Spanish and Ecuadorian STEM university teachers presented high levels of anxiety and stress that were related to their perception of the online work methodology. The study showed how teachers perceived the relationship of anxiety and depression with various obstacles, such as lack of training, resources, time or research, regardless of the country, caused by different factors related to technology.

• The covid-19 pandemic had great relevance on the mental health of teachers. In this study, which uses mixed research, it supports the impact of ICT and stress, and highlights how STEM teachers have a lower risk of developing mental problems, as part of the effect of STEM education as a preventive factor related to the training of teachers.

Finally, it can be mentioned that, based on the results obtained in the previous studies, a new STEM model has been proposed in which the role of ICT and gamification, continuous teacher training, has been highlighted. and well-being to achieve the sustainability objectives of the higher education system.

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## 2 METHODOLOGY

The research presents a comprehensive theoretical-methodological model aimed at integrating Information and Communication Technologies (ICT) and gamification to foster the development of Science, Technology, Engineering, and Mathematics (STEM) skills in Higher Education Institutions (HEIs) with a focus on sustainability. To lay the groundwork for this model, a bibliometric analysis was conducted to assess the impact of ICTs and gamification in higher education. This analysis aimed to identify both positive and negative aspects of their integration, ascertain any emerging trends over the past decade, and pinpoint specific implementation models within HEIs.

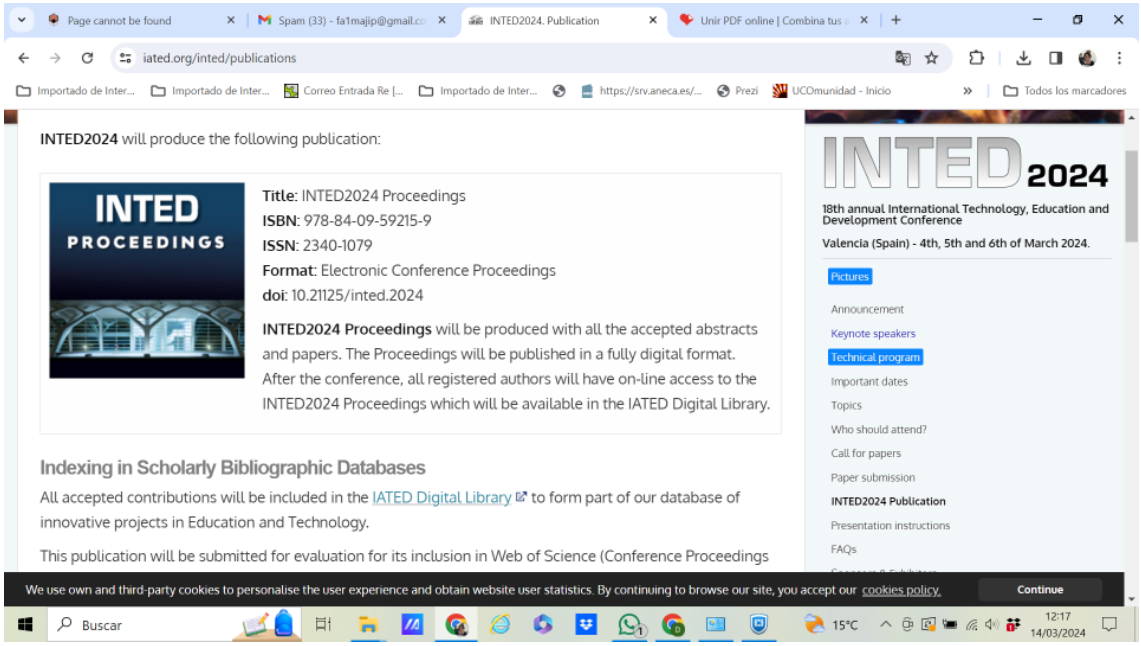
Subsequently, a comparative study was carried out, examining HEIs in Ecuador and Spain through a qualitative survey distributed online. The survey, validated before distribution, sought to uncover factors influencing the inclusion and use of ICTs in HEIs, with a focus on two distinct periods – before and after the onset of the COVID-19 pandemic. Results from this study underscored the indispensability of ICTs in achieving sustainable HEIs, emphasizing their positive impact on the teaching and learning process and the development of ICT skills among educators. However, a notable finding was the lack of training and specific models for the proper integration and use of ICTs in classrooms, particularly evident among experienced teachers who faced additional challenges related to emotional well-being.

A subsequent qualitative study delved into the influence of technology and the COVID-19 pandemic on experienced STEM educators in HEIs. The findings revealed heightened anxiety and emotional stress experienced by teachers due to the abrupt shift in teaching modalities and the mandated use of ICTs during the pandemic. Interestingly, teachers with more STEM training and proficiency in ICTs were found to be less susceptible to developing technostress, highlighting a potential preventive effect associated with advanced training.

In conclusion, the research proposes a holistic sustainable STEM model for HEIs, encompassing students and teachers. This model emphasizes the benefits of incorporating and effectively utilizing ICTs in the teaching and learning process. By addressing technological skills and emotional well-being, the proposed model aims to contribute to the overall development and sustainability of HEIs. This research not only identifies challenges but also provides insights and recommendations for the successful implementation of ICTs and gamification in higher education contexts.

## 3 RESULTS

The incorporation of active methodologies and Information and Communication Technologies (ICTs) into the teaching process witnessed significant growth during the initial phases of the COVID-19 pandemic. Higher education institutions globally swiftly adapted to virtual modes of instruction, prompting the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