Original Paper

A learning model based on the promotion of sustainable entrepreneurship in higher education

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Abstract. *The teaching of sustainability has become increasingly important in higher education. However, some approaches focus only on the environmental aspects, neglecting the social and economic dimensions. The*

aim of this paper is to describe the learning outcomes of an Action Plan, which aims to raise awareness and improve students' understanding of the SDGs as environmentally and socially responsible practices. We conducted a qualitative analysis of the Challenge-Based Model methodology with more than 1,000 university students in Mexico. Using a modern methodology that immerses students in real-life scenarios, significant results were achieved on SDGs related to the environment (SDG 13), clean water and sanitation (SDG 6), ocean conservation (SDG 14), and affordable and clean energy (SDG 7). The aim is to empower and guide university youth to become catalysts for change in their communities. Participation has led to significant progress in promoting sustainability among young students. Those who participated in the Earth Day Rally and the Sustainable Entrepreneurship and SDG Bootcamp events expressed that these experiences helped them develop entrepreneurial skills, participatory and transformative leadership, creativity, initiative, communication and teamwork. In addition, 63% said they had improved their critical thinking skills by tackling challenges in teams. To effectively address the challenges of the future, it is important to fund enriching experiences for young people. These experiences can broaden their horizons and inspire them to imagine and create a more promising and sustainable future. It also encourages their commitment to the SDGs and green entrepreneurship.

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1. Introduction

In recent years, there has been considerable interest in teaching sustainability and sustainable development to younger generations. Since the establishment of the United Nations 2030 Agenda in 2015, building on initiatives such as Agenda 21 and the Millennium Development Goals, many Member States have included specific targets in their policies to mitigate social deprivation and environmental impacts on vulnerable populations (UN, 2015). This context has direct implications for higher education, where young people play a crucial role in knowledge transfer and advocacy for sustainable practices in the environmental, social and economic spheres. Transferring knowledge to younger generations increases their awareness of global issues and encourages the development of

creative and innovative solutions involving the community (CEPAL, 2020). In addition, promoting good practices in sustainability can influence young people's individual choices and catalyse community action to address global challenges that disproportionately affect marginalised populations or those living in high-risk environments.

To address this issue, it is important to understand the vision of sustainability and sustainable, two approaches often used synonymously to describe sustainable development (Kopnina and Blewitt, 2014; Ruggerio, 2021). First, sustainability is based on the integration of environmental, social, economic and now institutional dimensions (Holmberg, 1992; Reed, 1997; Harris, Wise, Gallagher and Goodwin, 2001; Barbier and Burgess, 2017). Throughout history, the United Nations (UN) has played a leading role in promoting the achievement of the 169 goals of the 2030 Agenda. This leadership can be traced back to the 1987 Brundtland Commission, which defined sustainability as an approach that seeks to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 2018). In this sense, sustainability has been popularised as a development model that emphasises the efficient and sustainable use of resources. The second approach focuses on sustainable and aims to create scenarios of best practices, especially those that benefit the environment. The primary objective is to prevent the depletion of natural resources. This allows a more precise definition of the level of sustainability impact by setting specific targets as a reference (Holmberg and Sandbrook, 1992).

An integrative and inclusive perspective, it is important to adopt good institutional practices oriented towards sustainable development. In this context, higher education could implement innovative approaches, such as Challenge-Based Learning, to effectively transfer knowledge. This strategy would take advantage of creative and practical educational programs focused on sustainability and climate change, preparing the younger generation in a multidisciplinary way to face the challenges of their environment. In this sense, this document adopts the sustainability approach as the root of a learning and change-building process. Therefore, in order to promote it through this Action Plan, economic, social and environmental scenarios will be included to achieve a more multidisciplinary understanding. In this way, sustainability is intertwined with sustainable in terms of adopting best practices when proposing solutions to global issues.

However, three main challenges exist in promoting sustainability among university youth. Firstly, there's a need to understand the limits of the

sustainability concept and the role of higher education (Shriberg, 2002; Thomas, 2004). Secondly, there's the perspective of both academics and the university community, which often confines sustainable development to the realm of environmental sciences (Reid and Petocz, 2005). This narrow focus can hinder a multidisciplinary approach that recognizes the interactions among people (Thomas, 2004). Thirdly, there's the challenge of adapting university curricula to current contexts, including critical perspectives on the use of non-sustainable resources across various disciplines to enrich students' education (Sibbel, 2009; Leal Filho, 2017). Many educational programs at the university level employ limited strategies to complement sustainability and circular economy education in the classroom. This highlights the need for knowledge transfer models adapted to the current context of the younger generation, where a participatory role and youth leadership would help to find concrete solutions to global issues.

In this sense, the Action Plan addressed in this document seeks to contribute to the above-mentioned challenges: Firstly, because it promotes sustainability in an inclusive way and for all, understanding the limits and the crucial role of people; secondly, because it makes it possible to displace the idea that the adoption of sustainable approaches is exclusively the domain of environmental sciences, since knowledge about sustainability is multidisciplinary and can be adopted in all actions at individual and institutional levels; thirdly, because concrete actions such as the Earth Day rallies and the Sustainable Entrepreneurship Bootcamp, based on a Challenge-Based Learning (CBL) model, can drive institutional change, pushing curricula to include a sustainability agenda in their curriculum map.

Following this argument, the aim of this paper is to analyse the extent to which the Challenge-Based Learning model promotes the understanding of sustainability among young university students. This strategy is in line with the Good Environmental Practices promoted by the Faculty of Economics and International Relations through the UABC-Yunus Centre of the Autonomous University of Baja California (UABC) in Tijuana, Mexico, which aims to promote institutional change towards more sustainable practices among students, academics and administrators, in line with UNESCO recommendations (2023).

The paper outlines a strategy involving concrete actions, such as SDG Bootcamp and rallies, designed to annually engage university students in the path towards sustainability, with a particular focus on entrepreneurship for social impact and the achievement of the Sustainable Development Goals (SDGs) outlined in the 2030 Agenda. These actions aim to bolster the empowerment and leadership of

university youth in addressing climate change and sustainability issues, intending to cultivate them into change agents within their communities.

Prior research indicates that science education on overarching topics like the environment has the potential to empower individuals to make more informed choices (Jenkins, 2003). By equipping young people with specific knowledge, they can develop confidence in articulating and defending their perspectives within society. This process contributes to the acquisition of cognitive skills, motivational patterns and personal values. An empowered individual feels capable of realizing their goals and integrating cognitive resources with affective ones, fostering a sense of agency in effecting change in the world. This agency extends from personal lifestyle choices to influencing democratic decision-making processes (Schreiner, Henriksen and Kirkeby-Hansen, 2005).

In this context, the paper is composed of the following sections: the second section discusses a theoretical review on sustainable development and the Challenge-Based Learning teaching model; the third section explores the proposed model and describes the method used for the analysis; the fourth section analyses the results, and the last section concludes with final comments and recommendations.

2. Sustainable development background

In the early decades of the United Nations (UN), environmental issues were a limited part of the international agenda. The UN focused its strategies on ensuring that developing countries managed their resources appropriately. However, in the 1970s, events emerged that raised concerns about global environmental security. These events included oil spills, such as the one that occurred in the Bay of Campeche in Mexico, where 140 million gallons of oil were spilled (Baii, Guillén and Abreu, 2017). These incidents demonstrated the need to address and analyse the environment and its degradation, becoming issues on the global agenda.

More recently, the UN has shown a strong commitment to defending the environment and has consolidated itself as a driver of sustainable development worldwide. In 1972, the United Nations Conference on the Human Environment addressed the role of economic development and environmental degradation. As a result of this event, the United Nations Environment Programme (UNEP) was established.

Throughout the 1980s, member countries continued to negotiate environmental issues, including treaties to protect the ozone layer and control toxic waste shipments. However, in 1983, the United Nations General Assembly created the World Commission on Environment and Development to ensure the economic well-being of present and future generations and to protect the world's natural resources.

In this context, the Commission presented the concept of sustainable development to the General Assembly in 1987 as an alternative to development based solely on economic growth. After learning from the experience and evidence of the impact of conventional economic growth on human development, the General Assembly convened the United Nations Conference on Environment and Development, known as the "Earth Summit", in Rio of Janeiro in 1992.

This strategy linked the scope of sustainable development to critical dimensions such as human rights, population, social development, and human settlements. The United Nations defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This approach aims to build an inclusive, sustainable, and resilient future for people and the planet (United Nations, 2018).

The fundamental milestone in the promotion of sustainable development can be found at the 1992 Earth Summit, where governments adopted Agenda 2030, a comprehensive global action plan addressing all aspects of sustainable development. These initiatives have been reflected in subsequent events, such as the 2002 World Summit on Sustainable Development and the 2012 United Nations Conference on Sustainable Development.

Following a series of actions in 2002, the document "The Future We Want" contained a set of voluntary commitments to help member countries achieve concrete results in the area of sustainable development and proposed the idea of developing a set of goals to achieve development. These precedents materialized at the United Nations Millennium Summit in 2000, where the Millennium Development Goals (MDGs) were adopted. The MDGs served as a roadmap for collective action to reduce poverty and improve the lives of the poorest people. Significant progress was made in reducing poverty, with a direct impact on the 21 targets set out in eight goals.

This scenario paved the way for the adoption of the 2030 Agenda for Sustainable Development in September 2015. This agenda aims to follow up on the MDGs and achieve sustainable development in its economic, social, and environmental

dimensions (UN, 2015). The 2030 Agenda consists of 17 Sustainable Development Goals (SDGs) that are cross-cutting and can be addressed by developed, developing, or middle-income countries. The SDGs are made up of 169 targets and 230 indicators, which guide the sustainable future of economies.

The perspective of the 2030 Agenda is inclusive and comprehensive, with the intention of benefiting all people and stakeholders at the global, national and local levels. The guiding philosophy of the 2030 Agenda is based on human rights, where all people have the right to access the resources necessary to realize their full potential. However, despite the commitments made by Member States, many actions have gaps and limited implementation, especially with regard to access to information in middle-income countries such as Mexico.

In this context, establishing learning pathways with human rights focus in a multidisciplinary way can stimulate the participation of future generations in the 2030 Agenda for Sustainable Development. Given the need to transfer and democratize knowledge, higher education becomes crucial to achieve concrete results in promoting sustainability and sustainable entrepreneurship. Therefore, the inclusion of alternative and/or complementary pathways to traditional learning is required to promote sustainable development and entrepreneurship in the student community. This implies the use of different methodologies that allow the development of an inclusive learning guide.

While traditional learning serves its purpose, it can also have limitations in promoting sustainable development for a number of reasons. Firstly, its focus on static content, often centred on the memorisation of facts and concepts, tends to neglect critical skills such as problem solving, systemic thinking and informed decision making (Shapiro, 2015). Second, traditional education often lacks a connection to real-life situations. More effective learning could include practical applications and real-world contexts to make teaching and learning more relevant and effective (Selby and Kagawa, 2016). Finally, traditional education often takes place in an isolated academic environment, which limits the connection with the local community, a crucial aspect for understanding and addressing sustainability issues (Richardson and Kweku, 2011).

Addressing these limitations will contribute to the goals defined by UNESCO (2023) for higher education institutions, whose main purpose is to educate future leaders by providing them with skills and knowledge to contribute to society. Furthermore, it is essential to integrate sustainable values and attitudes into education in order to promote more conscious and responsible development (UNESCO, 2014).

Taking these into account will enable the 2030 Agenda to address the major challenges it faces. Although there has been progress and positive results in some economies, the data show that many goals have not made significant progress. This situation cannot be overlooked, as a combination of factors, such as the impact of wars in some countries and the effects of the global climate change has significantly hindered progress towards the SDGs, especially in the most disadvantaged economies.

According to the United Nations, more than half of the 140 targets set to achieve the Sustainable Development Goals are still far from being realized. Furthermore, over 30% of these targets have shown little recent progress, as reported in the Sustainable Development Goals Report (2023). Globally, the primary concern revolves around the effects of climate change (Climate Watch, 2022; EPA, 2021).

In this context, the Action Plan addressed in this document focuses on the selection of a group of Sustainable Development Goals related to the planet (SDGs 6, 7, 11, 12, 13, 14 and 15), with the aim of raising awareness among young generations about the various changes in our environment and promoting sustainability from a multidisciplinary approach and from the perspective of higher education institutions. To this end, the use of a learning model on sustainability and community intervention among young generations is proposed, which could be replicated in other universities to advance the 2030 Agenda through the adoption of good practices and collaborative work.

2. Methodology

To promote sustainability among university students, the Action Plan employs a methodology informed by the lessons learned from two major programs: the Research, Assistance, and Teaching Program for Micro and Small Enterprises (PIADMYPE), which raises awareness among young people to support entrepreneurs in vulnerable situations, i.e., those living in contexts of inequality and poverty; and secondly, the five stages of learning that students experience during their education on sustainability. Although the two main pillars of this Action Plan are the aforementioned ones, this document summarizes the second pillar and outlines specific actions for phases 2 and 3, described below:

2.1 The UABC-PIADMYPE model to promote sustainability in higher education

Conscious of the social and economic environment at the local and national levels, the UABC has distinguished itself over the last two decades for its work

in community outreach and social responsibility (Mungaray-Lagarda, 2002). This achievement has been realized through the implementation and structuring of educational learning models, driven by initiatives led by academics and students to support micro-enterprises (Mungaray, Ramírez-Urquidy, Texis, Ledezma and Ramírez, 2008).

This journey began with the Research, Assistance and Teaching Program for Micro and Small Enterprises (PIADMYPE), created in 1999 as a professional social service project. In this program, students assist disadvantaged entrepreneurs and microenterprises. It has received funding from various sources, including the Ford Foundation, the Organization of American States (OAS), the National Association of Universities and Institutes of Higher Education in Mexico (ANUIES), and the Mexican Federal Government through the Ministry of Public Education (SEP), the National Council of Science and Technology (CONACYT), and the National Fund for Social Enterprises (Mungaray-Lagarda, Osorio-Novela and Ramírez-Angulo, 2022).

The primary objective of PIADMYPE was to promote the growth of microenterprises and entrepreneurship with a social and low value-added approach, using the assistance and training provided by university students engaged in social services. The PIADMYPE project began with these objectives: (1) to develop a hands-on teaching model for students of economics and related fields through service; (2) to provide free on-site business services to social microenterprises in high-poverty areas; (3) to study microenterprise development through the action research model to strengthen undergraduate programs in economics and related fields.

In 2006, inspired by PIADMYPE's action research approach and with the aim of strengthening collaboration with the microenterprise sector in a more institutional manner, the program was formalized as the Centre for Research, Assistance, and Teaching of Micro and Small Enterprises (CIADMYPE). In 2009, amidst the global economic crisis of late 2008, a partnership was established with the state government of Baja California, through the Secretariat of Economic Development, and with the federal government, through the Business Support Program known as Fondo PYME. The CIADMYPE methodology was adopted as the basis for a countercyclical public policy aimed at mitigating the effects of the crisis, particularly the massive layoffs in the maquiladoras, which, in their efforts to remain competitive, neglected their labour and social obligations (Mungaray-Lagarda et al., 2022).

With this evolution, two main objectives were established: (1) the creation of a public policy to promote the development of microenterprises; and (2) the use of the experience of the PIADMYPE project and the collaboration of university professors and students. In addition, (3) the implementation of project-based learning programs that allow students to apply their skills in formalizing and linking social enterprises with funding sources, integrating them as linkage projects in the academic structure of UABC.

In 2017, CIADMYPE became the UABC-Yunus Centre for Social Business and Wellbeing, with the aim of promoting social responsibility among students through the development of community intervention skills, inspired by the principles of Muhammad Yunus, winner of the 2006 Nobel Peace Prize. The centre's main goals are to create innovative models of service learning and to address poverty and inequality by promoting social enterprise and collaboration. From 1999 to 2023, the program has supported 13,241 microenterprises and involved 1,922 students in operational activities, contributing to their education and promoting their participation in social sustainable entrepreneurship.

Since the creation of the UABC-Yunus Centre, specific goals have been set, indicating that the PYADMYPE action research methodology will continue to guide student learning and knowledge transfer to more vulnerable populations. In this sense, with the aim of being more inclusive and aligned with the global agenda to reduce inequalities, UABC-Yunus has adopted the United Nations 2030 Agenda approach as of 2021 and joined the international Ashoka network to promote social innovation, entrepreneurship, and the training of change agents. This commitment is crucial because, through university education, students will continue to contribute to the transfer of knowledge to diverse populations, supporting entrepreneurs and serving microenterprises with a focus on sustainability and the adoption of best practices, which will help advance the Sustainable Development Goals and mitigate the effects of climate change.

In this context, following the PIADMYPE model of teaching-learning of UABC students, Figure 1 shows the UABC-Yunus intervention methodology. This program represents an educational approach that promotes students' professional development, experience, and sustainable entrepreneurial skills.

This teaching model is complemented by intervention methods in university students that encourage learning and the creation of quick solutions, such as Challenge-Based Learning (CBL). CBL is considered a multidisciplinary method that allows students to learn about the Sustainable Development Goals related to the care of the environment, ecosystems, and underwater life through

innovation and creativity. It uses knowledge in an interdisciplinary way to generate learning in higher education, promoting transversal skills, knowledge, and collaboration (Gallagher and Savage, 2020).

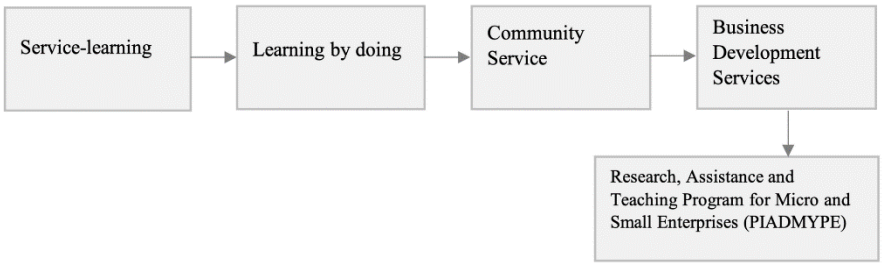

Figure 1. UABC-Yunus Centre Intervention Methodology. Source: Own elaboration

This challenge-based methodology provides real-world scenarios where students can apply the knowledge, they have acquired throughout their academic education to solve global challenges. It also fosters the development of cognitive, critical, and professional skills as students tackle real-world problems and collaborate with key stakeholders (Apple, 2010). The use of problem-based learning formats can lead to student-centred educational innovations, especially when teaching topics related to sustainability and the circular economy (Cörvers et al., 2016; Rodríguez-Chueca et al., 2020; Steinemann, 2003).

In this context, to strengthen learning through the PIADMYPE methodology and Challenge-Based Learning (CBL), students can collaborate with social enterprises, business entities, government representatives, members of academia and civil society, where they apply their knowledge in practice. Problem-based learning allows them to combine their professional skills and competencies while addressing and proposing solutions to various challenging situations.

2.2. Learning about sustainability entrepreneurship in university students

The Sustainability Learning Methodology is based on the premise that young people are essential for sustainable development (UNECE, 2022), a mandate reinforced by the creation of the 2030 Agenda for Sustainable Development. To this end, the Faculty of Economics and International Relations (FEYRI) of the Autonomous University of Baja California (UABC), through the UABC-Yunus

Center for Social Business and Wellbeing, launched a program in 2022 to promote environmental awareness among university students, focusing on topics such as the environment, water resources and the importance of the oceans. This sustainability approach is guided by the 2030 Agenda, which is based on the United Nations Sustainable Development Goals (SDGs), the common goals that humanity has chosen for itself with the agreement of all UN member states (UNESCO, 2023).

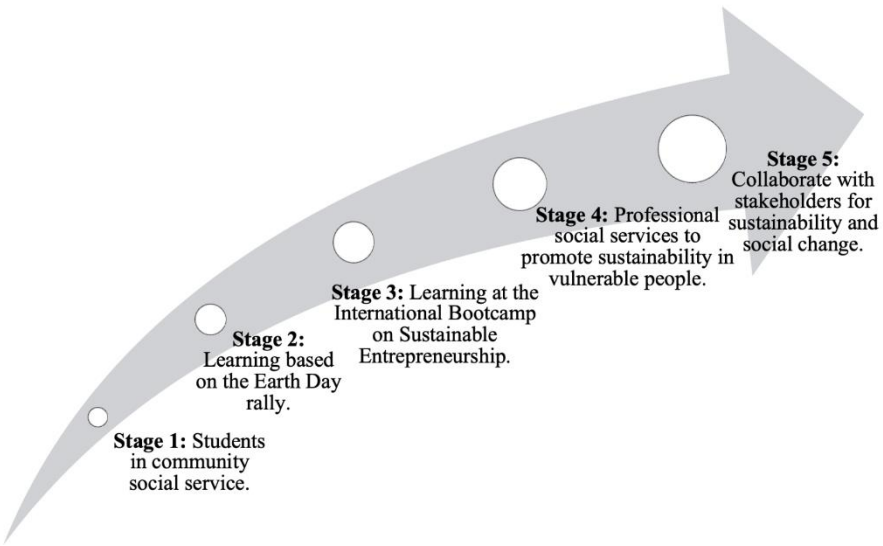

Figure 2. Steps to promote learning about sustainability and Sustainable Entrepreneurship. Source: Own elaboration.

FEYRI and the UABC-Yunus Centre strive to encourage active participation in sustainability learning and Sustainable Entrepreneurship in young people. To achieve this, five stages of learning about sustainable development have been delineated, allowing students to tailor their learning journey to their individual needs, profiles, and interests.

Stage 1. This learning stage targets students in their first to fourth semesters at the university. Students participate in a community service program named

"Sustainable Fibonacci", where they collaborate in teams (five student range) to address issues in their local environment using the Sustainable Development Goals framework. The primary objective of this initial phase is to identify opportunities for establishing Sustainable Entrepreneurship that promote social change.

Stage 2. Involves annual participation in an Earth Day rally on April 22nd, a global initiative to raise awareness about the importance of conserving natural resources. The event includes recreational and educational activities designed to promote the 2030 Agenda, with a particular focus on the Sustainable Development Goals (SDGs) related to the environment: climate action (SDG 13), clean water and sanitation (SDG 6), ocean conservation (SDG 14), and affordable and clean energy (SDG 7). Participation in this stage is open to students from different schools and disciplines, encouraging the formation of multidisciplinary teams. The event aims to help students recognize sustainable practices for environmental stewardship and provide specific information to support green entrepreneurship efforts.

Stage 3. During this phase, students have the opportunity to participate in an International SDG Bootcamp on Sustainable Entrepreneurship and the 2030 Agenda. Held annually during the summer, students collaborate in multidisciplinary teams to address real-world social challenges through sustainable entrepreneurial approaches. The bootcamp employs rigorous methodologies guided by mentors, who may include professors, international or national experts, social leaders, entrepreneurs, government officials and academics.

In particular, in this third stage, the program offers students the opportunity to test their knowledge in a multidisciplinary event, with the intention of strengthening dialogue and fostering participatory youth leadership. This is achieved by participating in an international bootcamp, where they learn about the Sustainable Development Goals (SDGs) of the 2030 Agenda and seek to respond to their implementation through sustainable ventures that encompass social, economic and environmental aspects.

This bootcamp is an initiative of FEYRI and is held annually; it brings together UABC students from various areas of knowledge, including undergraduate and engineering degrees, from the three UABC campuses: Ensenada, Tijuana and Mexicali in Baja California, Mexico. Participating faculties include the Faculty of Marine Sciences of Ensenada, the Faculty of Economics and International Relations of Tijuana, the Faculty of Engineering and Business of Guadalupe

Victoria, the Faculty of Engineering, Administrative and Social Sciences of Tecate, the Faculty of Enology and Gastronomy of Ensenada, the Faculty of Engineering and Business of San Quintin, and the Faculty of Engineering, Architecture, and Design of Ensenada.

During this process, students are fully involved and work in multidisciplinary teams. They are presented with real problems related to their community in the economic, social and environmental fields. Over the course of five days, students develop ideas for sustainable entrepreneurship and put what they have learned into practice. This process is guided by mentors, including professors from the participating faculties and/or invited national and international experts, who support the students in building their knowledge.

Stage 4. Students can carry out their professional social service to put into practice the skills developed in the previous stages, as described in Osorio-Novela, Mungaray-Lagarda and Ramírez-Angulo (2022). However, even if students have not participated in any of the stages described above, the programmes offered will provide them with training on the themes aligned with the Sustainable Development Goals, as transversal learning is promoted in all stages. In this phase of professional development, only students who have completed 60% of their credits, i.e., from the fifth to the seventh semester, are assigned to this phase.

Stage 5**.** In this learning block, students who wish to deepen their understanding of sustainable development can connect with the UABC-Yunus Centre for Social Business and Wellbeing. Similarly, students can collaborate with organisations outside the university, such as civil society organisations and government bodies, enabling them to develop their own projects. The Challenge-Based Learning (CBL) methodology is applied at all stages of the course, allowing students to engage with real-life contexts. The focus of this methodology is to use students' knowledge as one of the means to generate understanding in higher education (see Figure 3).

The five phases for learning sustainability and the PIADMYPE model, implemented through CBL, have yielded significant results among university students as they apply creativity, initiative, participatory leadership, and the execution of their projects to address real challenges in both local and national contexts. This combination of models and methodologies represents a novel educational approach, integrating traditional learning modules with real-life challenges and promoting innovative solutions that are applied in various areas (Vilalta-Perdomo et al., 2022). Moreover, students continue to show interest and

active participation in understanding the UN 2030 Agenda, seeking to contribute actively, particularly to the goals related to climate action (SDG 13), clean water and sanitation (SDG 6), life below water (SDG 14), and affordable and clean energy (SDG 7)

2.3 Method

The aim of this research is to analyse how the Challenge-Based Learning (CBL) model helps young university students to understand sustainability. Using qualitative analysis, focus groups in the form of workshops and conversations were conducted with participants, and their initial learning was assessed through a survey. Following the two learning pillars mentioned above (PIADMYPE and the five-step sustainability pathway), CBL is implemented in stages 2 and 3, with annual events where students discuss concrete challenges. During these phases, real-life scenarios are created, and students experience them for five days, culminating in a pitch to an expert jury (composed of entrepreneurs, businesspeople, academics, government representatives, etc.). The interaction and development of the proposals are carried out by multidisciplinary teams, integrating fields such as exact sciences, social sciences, health sciences, environmental sciences, and administrative sciences.

Figure 3 illustrates the process of the method as implemented in the Action Plan. In stages 2 and 3, students experience the CBL methodology in teams, and then the learning is evaluated. This benefits students by allowing them to openly identify the challenge to be addressed and propose solutions to concrete societal problems (Gaskins, Johnson, Maltbie, and Kukreti, 2015).

In stages 2 and 3, students work in teams, guided by mentors (teachers, students, researchers, activists, entrepreneurs) from different fields. They are provided with information through workshops, lectures, or conferences to develop their entrepreneurial skills, teamwork, and collaboration. This allows them to engage in educational collaboration and develop a deeper understanding of the topics studied in the classroom, with the aim of identifying and solving challenges in their communities and sharing the results as a group (Johnson, Smith, Smythe, and Varon, 2009).

Incorporating this method of learning allows students to identify and solve meaningful problems, learn new ideas and tools to address them, and arrive at a solution. Furthermore, it can be applied to a wide range of curriculum content, as ideas are generated from real-world situations that need to be translated into locally applicable solutions. In this way, students can explore and deepen an

aspect of the challenge and relate it to what is happening around them, thus strengthening the link between what they learn at school and what they experience outside school.

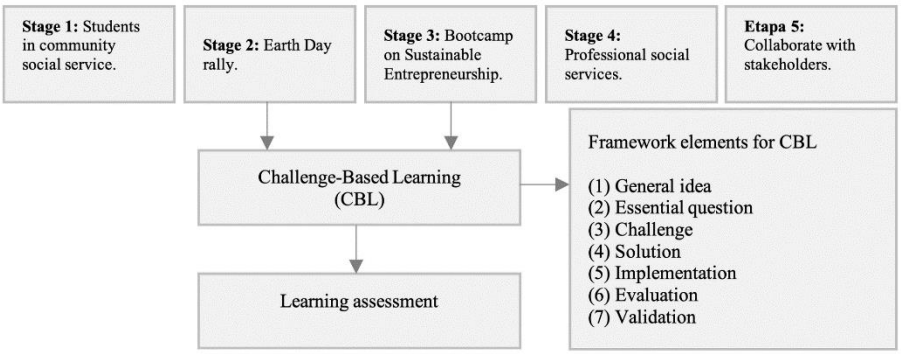

Figure 3. Integrating CBL into the sustainability learning process. Source: Own elaboration.

In this scenario, Figure 4 summarises the stages that contribute to building learning, based on the proposal of Dondi, Klier, Panier and Schubert (2021). The process involves building both individual and team skills. This includes skills for social action, where students develop empathy, solidarity, and social innovation for change. These skills will enable them to acquire essential technical skills for negotiation, entrepreneurship, social innovation, and creativity. Once these skills are acquired, students will develop socio-cognitive and linguistic skills, which in turn will foster socio-affective skills. This will enable them to take an interest in different causes and seek solutions, as well as improve communication and teamwork among students.

Following this suggestion and putting student learning at the centre, in recent years several universities have incorporated CBL methodologies with the aim of connecting with the student community and as part of an educational and didactic model. For example, one of the universities that has implemented this approach is the Tecnologico de Monterrey with its Tec21 educational model (Membrillo-Hernández et al., 2022). Similarly, it has been integrated as part of curricular activities at the TU/e Learning Centre at the University of Eindhoven, which promotes collaboration between students, industry, research and social organisations to develop, maintain and disseminate research-based CBL practices for curricular and extracurricular activities (Reymen et al., 2022). Likewise, in

some European countries, it is implemented in a multidisciplinary way, combining social, natural and exact sciences (De Stefani and Han, 2022), as implemented in the stages of this analysis.

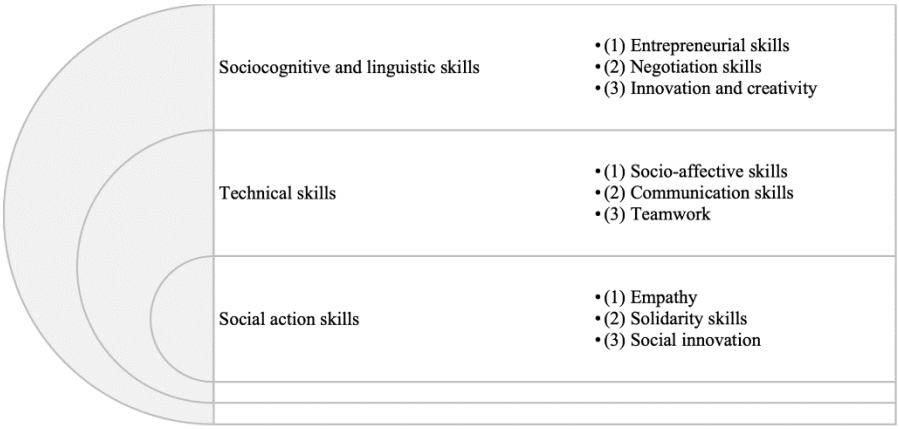

Figure 4. Learning sustainability skills through CBL. Source: Own elaboration.

2.4 The challenge

The process of implementing CBL is detailed in Figure 5. This figure illustrates how different methodologies bring students closer to the SDGs. In addition, they are presented with concrete, real-world problems to find solutions that incorporate a sustainability approach in its economic, social and environmental dimensions. Before the start of the training, students fill in a digital questionnaire to register for stages 2 (rally) and 3 (bootcamp) (see Figure 2). The registration is done in multidisciplinary teams and the questionnaire collects information about the students' profile, their knowledge about sustainability and interest in participating. After registration, on the day of the event, students are guided through a series of steps according to the CBL methodology.

Step 1: Ideation. In this phase, students familiarise themselves with key concepts of sustainability, current challenges and the role of the 2030 Agenda for Sustainable Development. In this first block, the SDGs to be addressed during the challenge are selected.

Step 2: Foundations for solutions. This step helps to define the sectors to be analysed and to propose challenges or social realities. The challenges are local or global problems applied to Baja California, Mexico. Therefore, a group of entrepreneurs, activists and academics assign students problems that reflect the social reality of their environment. Topics include clean water and sanitation, climate change, inequality in the oceans and marine life, green spaces and responsible consumption.

Step 3: Application and evaluation. Guided by business leaders, entrepreneurs and government officials, students use a variety of methodologies that incorporate aspects of the CBL methodology. Core methodologies include Art of Hosting, Design Thinking, Social Canvas and Lean Startup. These methodologies are incorporated with the intention of developing students' problem-solving and critical thinking skills. In this sense, students develop solution proposals with a focus on creating sustainable businesses, considering social, economic and environmental aspects, with mentors helping to refine and polish their ideas from a market and social perspective.

Step 4: Results and reflections. Over a period of approximately five days, the teams create a storytelling presentation of their proposed solution (sustainable enterprise), supported by a market analysis. The proposal must be sustainable and have a social impact. On the fifth day, the students present their proposal to a panel of experts, entrepreneurs, social entrepreneurs, academics and members of civil society. The teams whose proposals are socially relevant, promote good practice and are financially viable and sustainable are declared the winners of the competition.

This process promotes a holistic approach to learning, encouraging the dissemination of ideas, raising students' awareness of sustainability and helping them to develop entrepreneurial skills in teams. At the same time, it encourages the generation of ideas to create businesses with a social change focus, i.e., businesses that address the problems faced by populations living in conditions of greater inequality and vulnerability. Through real-life analysis, students can engage with different mechanisms of action that drive systemic change (Figure 5).

Figure 5 summarises the learning process of students entering stages 2 and 3 of plan of action. The figure shows the selection of SDGs to be addressed during the event, as well as the productive sector and its cross-cutting interconnection with other goals previously described. Consequently, each of the development goals is linked to a challenge that the students must address. The methods are

complementary: Art of Hosting was the central methodology to generate empathy with the participants and engage their interest in the problems presented. The Design Thinking methodology helps them define users and create human-centred solutions. Lean Start-up allows them to define the proposed solution with a business approach, while Social Canvas aims to provide a sustainable approach with social impact. In this way, each of these methodologies complements the students' learning and helps achieve the elements described in Figure 4.

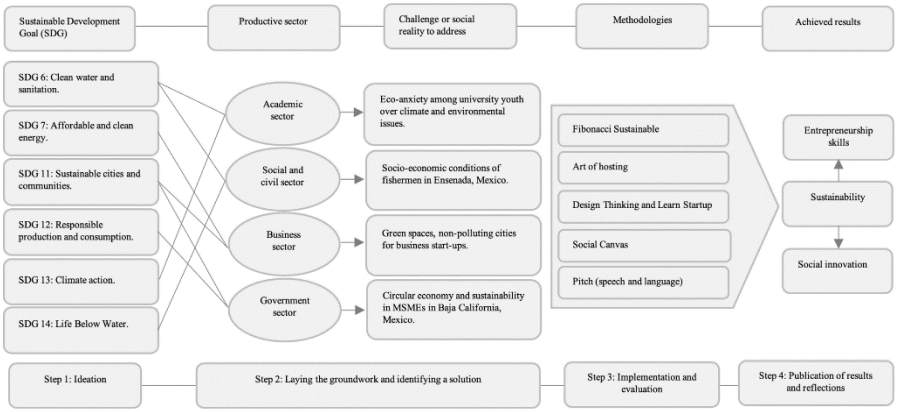

Figure 5. Implementation of CBL in phases 2 and 3 of the Action Plan. Source: Own elaboration.

4. Results

This section first presents an analysis of the diagnosis made by the participants in stages 2 and 3 of the Action Plan. This is followed by a description of the results obtained through the implementation of the methodologies and the project proposals developed by the participating teams.

4.1 Get involved and diagnose

As of 2023, the program aimed at enhancing sustainability learning has engaged just over 1,000 university students. Specifically, in Stage 2, a total of 450 students participated in an Earth Day rally to understand SDGs and green

entrepreneurship, while in stage 3, the International Bootcamp on Sustainable Entrepreneurship and SDGs saw the participation of 580 students.

Table 1 summarises the number of students who have participated in the two main events organised by UABC FEYRI to promote sustainability. Both events were conducted in collaboration with other academic units, with the intention of creating synergies with other UABC faculties. In the case of the Sustainable Entrepreneurship Bootcamp, it was held in two locations to facilitate knowledge transfer and strengthen learning in a multidisciplinary and interdisciplinary manner. According to the scheme in Figure 2, stages 1, 4, and 5 have not yet been completed, so there is no specific information available to determine the impact of the Action Plan.

Table 1. Number of students learning about sustainability. Source: Own elaboration.

Period	*Stage 2*	*Location*	*Stage 3*	*Location*
2022-1	-	UABC, Tijuana-Mexico	15	UABC, Tijuana
2022-2	200		350	
2023	250		215	UABC, Ensenada
Total	450		580	

The results of the survey conducted at the beginning of stages 2 and 3 provide interesting data that offer an initial overview of the students' knowledge about sustainability. The demographic profile of the students who participated in stages 2 and 3, in terms of age, is predominantly young. The data shows that 48.5% of the students are between 21 and 24 years old, while 42.5% are between 17 and 20 years old. Approximately 5.5% are between 25 and 28 years old, and 3.5% are over 29 years old. In terms of gender, a large proportion of the participants are female, representing 63% of the total, while 36% are male and the remaining preferred not to answer.

In the specific case of the Sustainable Entrepreneurship and SDG Bootcamp, which is part of the third phase, student participation data, based on the university population where the academic unit is located (various UABC campuses), shows that 48.5% come from UABC, Ensenada; 14.5% from UABC, San Quintin extension; 24% from UABC, Tijuana; 6% from UABC, Guadalupe Victoria extension; 5% from UABC, Tecate; and 2% from UABC, Valle Dorado.

The distribution of students from various academic units that participated in this event is as follows: 40% from the Faculty of Oenology and Gastronomy, 22% from the Faculty of Economics and International Relations (FEYRI), 12.5%

from the School of Engineering and Business in San Quintin, 7% from the School of Engineering and Business, 5% from the School of Engineering, Administrative, and Social Sciences, 4% from the School of Marine Sciences, 4% from the School of Engineering, Architecture and Design, and 3% from the School of Administrative and Social Sciences. The remainder is distributed among other units such as the School of Natural Sciences, the School of Medicine, the School of Chemical Sciences and Engineering, the School of Accounting and Administration, and the School of Tourism and Marketing.

The participation of students from various academic units across different UABC campuses demonstrates a significant commitment to teaching sustainability as a transversal axis in higher education, especially, in events that address real-world scenarios related to environmental protection, good business practices, and government involvement. The diversity of student profiles has been fundamental in validating ideas within working teams and following the Challenge-Based Learning (CBL) methodology. Moreover, this diversity has facilitated the identification of creative and specific solutions to societal problems.

The professions that have participated in the events supported in stages 2 and 3 include economics, international relations, public administration and political science, marine science, oceanology, management, accounting, marketing, design, nanotechnology, oenology and science, among others. This diversity of disciplines enables students to take leadership roles and bring different perspectives to sustainability challenges.

Prior to the bootcamp, a short survey was administered to the participants asking about their familiarity with the SDGs. Of the responses, 63.8% of the students indicated that they had heard of the SDGs, while 36.2% had no prior knowledge of them. This provides an opportunity to transfer knowledge on these issues during the event. The students who gave a positive response reflect that they have gone through some stages of the sustainability education model, in one of its forms. In terms of detailed knowledge of the SDGs, 43% of participants said they were not familiar with any of the goals, 26% knew between 1 and 4 SDGs, 14% knew between 5 and 8 SDGs, 6% knew between 9 and 12, and 11% were familiar with more than 13 goals.

In terms of Sustainable Development Goals (SDGs) contributing to the fight against climate change and its impacts, 71% of participants identified SDG 13: Climate Action as the primary effort to mitigate climate change effects, while 23% indicated they were not familiar with this SDG, and the remaining respondents provided other responses. Another highly relevant SDG discussed

during the bootcamp was SDG 6: Clean Water and Sanitation, identified by 76% of participating students.

4.2 Challenge participation

The process of transferring sustainability knowledge to young people closely follows the Challenge-Based Learning (CBL) methodology and the PIADMYPE model. In this case, Table 2 summarises the five phases that help students to learn and find solutions to social problems in a fast and multidisciplinary way. According to Apple (2010), these phases can be integrated from the ideation stage to the presentation of results. The aim of the Entrepreneurship and SDG Bootcamp is to work over five days, giving students the opportunity to present their proposed solutions to a specialised panel, mostly composed of experts in the field and including participation from the public, private, civil and government sectors.

The phases implemented in the challenge process closely follow the guidelines of the CBL method. In each phase, complementary methodologies are used to engage students and raise their awareness of the 2030 Agenda and sustainable development (Figure 5). For example, in the ideation phase, an agile methodology is used to connect students to the problem and help them define the issues they want to address during the session. In the second phase, the Art of Hosting methodology is used to identify the guiding questions by dividing participants into small groups for roundtable discussions. This is done with the aim of discussing a specific topic and exchanging ideas, and is one of the key strategies for phases 2 and 3.

This methodology is one of the main ones used in these learning phases, as it allows for reflection and the organisation of activities. It allows students to learn techniques, concepts and elements that help them to describe themselves, understand problems and transform their theoretical knowledge into practical skills (Quick and Sandfort, 2014). In addition, the method allows facilitators or "hosts" to legitimise collective wisdom, explore inquiry and experimentation, and take the group to the edge of learning (Holman, Devane and Cady, 2007).

From the data in Table 2, it can be seen that in the third stage, "Identifying a solution", methodologies are used to help students identify possible solutions. The methodologies that accompany this process include design thinking, which helps to develop entrepreneurial skills (Linton and Klinton, 2019), and Lean Start-Up, which is used to teach students about value creation in entrepreneurship and identifying markets and business models (Zott and Amit,

2024). Therefore, one of the methodologies that allows students to evaluate and propose solutions based on business creation is the Canvas Business Model, which consists of a tool that allows the concrete identification of the problem, infrastructure, capabilities and use of resources for any entrepreneurial proposal (Sparviero, 2019).

Table 2. Phases that make up the Challenge-Based Learning process.

Phase	SDGs	Target	Learning methodology	Challenges
Phase 1: Ideation	Agenda 2030 (17 SDGs)	Raise student awareness of the importance of sustainable development.	Sustainable Fibonacci	Identify social problems.
Phase 2: Build the foundation solution	▪ SDG 6: Clean Water and Sanitation ▪ SDG 7: Affordable and clean energy ▪ SDG 11: Sustainable cities and communities ▪ SDG 12: Responsible consumption and production ▪ SDG 13: Climate action ▪ SDG 14: Life below water ▪ SDG 15: Life on land	Identify guiding questions about the challenge.	Art of hosting.	Find solution to an assigned challenge.
Phase 3: Identify a solution		Research, document and develop a solution and identify the implementation steps.	Design Thinking and Learn Startup	Identify potential solutions and prototype.
Phase 4: Application and evaluation		Measure results, reflect on what has worked and what has not, and then determine if it is the right way to go.	Social Canvas and Kanban	Evaluate whether the selected solution can deliver the expected results.
Phase 5: Presentation of results and reflections		Argue and defend the chosen solution in front of experts.	Pitch	Present the solution proposal to a jury.

Source: Own elaboration. Note: The phases presented in this table correspond to the learning process delivered to university students during stages 2 and 3 of the sustainability programs.

The implementation of these methodologies, guided by the CBL and Art of Hosting approaches, facilitates the development of the participants' language skills and enables them to present themselves through a group pitch in which they outline their proposed solutions, which are mentioned below.

4.3 Proposals for solutions

The proposed solutions to the different problems analysed by the students are shown in Table 3. All participants were divided into eight teams, each of which was given one problem, and from these teams the four best solutions that met key aspects of sustainability were selected. The table only shows the solutions that performed best during the workshops and those that were presented on the pitch day, so the best solution was taken for each problem.

The proposed include the creation of cooperatives, social enterprises and public spaces with a recreational approach to preserving green spaces. During the event, for example, four proposals were presented to the participating teams. The first focused on SDGs 6 and 13, addressing the challenge of environmental anxiety

among university students. Their proposed solution was to create an organisation that provides comprehensive support to young people, linking them to small actions that create positive change and contribute to the environment (see Box 3). In another case, to address the problem of transition to green areas and formalisation of micro and small enterprises in Baja California, the proposed solution was to provide advisory services to micro-enterprises that promote formalisation and the adoption of environmentally friendly practices.

Table 3. Proposed solution projects by the students.

Problem	Tackling the problem using sustainable entrepreneurship
(1) Eco- anxiety among young university students on climate and environmental issues.	Organisation that helps to generate experiences of social change in students through concrete actions that involve contributing to an action that has an impact on the environment.
(2) Socio-economic conditions of fishermen in Ensenada, Mexico.	Creation of a social cooperative to help market the fishermen's products, incorporating elements of fair trade.
(3) Green spaces, non-polluting cities for business start-ups.	Creation of Eco-parks in some areas of Baja California, Mexico. In these areas it will be possible to provide guides to promote ecotourism in areas with a high cultural and historical content.
(4) Circular economy and sustainability in MSMEs in Baja California, Mexico.	Consultancy to help formalise and transition to environmentally friendly practices.

Source: own elaboration. Note: The results of the proposed solutions to the problems correspond only to stage 3 of the Action Plan. The issues addressed are discussed in Figure 5 of this document.

In order to develop a proposed solution, each participating team worked closely with mentors who provided specialist assistance in developing proposals based on sustainability entrepreneurship. The decision to select only four of the projects created during the event helps to assess the students' learning outcomes, as these projects meet the requirements of a socially relevant enterprise that addresses a social problem and adheres to good environmental practices.

5. Discussions

Finally, a satisfaction survey was conducted among the student community that participated in the Earth Day rally events and the Entrepreneurship and SDG Bootcamp, which provided important responses for the implementation of this Action Plan. For example, among all participants, it was expressed that these experiences mainly contributed to the development and acquisition of

entrepreneurial skills, participatory and transformative leadership, creativity, communication and teamwork. In addition, 63% of participants indicated that they had developed critical thinking skills while working through challenges in teams.

In this context, the impact and potential of this programme to promote sustainability as a cross-cutting theme in higher education through events that connect students with real scenarios in their environment is significant. This impact is not only educational, but also academic and social, which could make it attractive for other basic education institutions to implement. In addition, a link could be established with civil society organisations and businesses to create a model of good practice that promotes sustainability. Furthermore, the results of the proposed solutions in these phases of the Action Plan help to highlight the potential of using Challenge-Based Learning, which enables students to tackle global problems with local claims. This will be consolidated in universities as a framework for generating sustainable and innovative keys, while promoting active and multidisciplinary learning (Martínez-Acosta, Membrillo-Hernández and Cabañas-Izquierdo, 2022).

6. Conclusions

Incorporating sustainability and green entrepreneurship dimensions into learning programs becomes crucial for promoting education among university students. This initiative began in 2022 as a learning strategy within the FEYRI student community, focusing on topics related to the environment, climate change and social entrepreneurship. Aligned with the academic unit's 2020-2024 development plan, this action strategy aims to contribute to its zero waste, energy efficiency, and green campus programs. Therefore, the vision of sustainability promoted by this university is based on a multidimensional concept of development that includes environmental, social and economic sustainability (UNESCO, 2023).

This approach underscores youth as pivotal in promoting education among university students. Among the seventeen goals proposed by the United Nations, those related to the environment (SDG 13), clean water and sanitation (SDG 6), ocean conservation (SDG 14), and affordable and clean energy (SDG 7) are selected as overarching goals. Employing a methodology that immerses students in real-life scenarios, it has been observed that over a thousand university students have strengthened and developed skills such as creativity, initiative,

leadership, and execution through challenges presented in both local and national contexts.

The objective of this project is to nurture the empowerment and leadership of college youth, enabling them to become catalysts of change within their communities. It is evident that the Challenge-Based model proposed in this document can serve as an effective framework for teaching sustainability to college students. A robust sustainability education model in higher education is of paramount importance, equipping students with versatile tools essential for both professional endeavours and daily life.

The participation of students from all UABC campuses in various real-world challenges has yielded significant advancements in promoting sustainability among university students. This approach emphasizes hands-on learning methods, facilitating direct engagement with the tangible challenges confronting their communities. Numerous organizations, such as the NGO Higher Youths, exemplify the empowerment of youth by advancing their education and furnishing them with employable skills through methodologies aimed at enhancing their capabilities (Green and Portelli, 2018).

To effectively address future challenges, it is imperative to conduct activities in a self-sustaining manner, which means allocating resources to enriching events for the student community. This entails allocating resources to organize meaningful events for the student community. Such an approach ensures the continued progress of the program in a sustainable manner and facilitates the dissemination of knowledge to faculties that have not yet participated. This experience can broaden students' horizons and inspire them to envision a more promising future dedicated to environmental preservation and the adoption of sustainable practices. Moreover, it fosters their commitment to the Sustainable Development Goals and the establishment of green businesses.

7. Limitations

The document can be a useful tool for promoting sustainability among university students, fostering knowledge, participation and values. However, its effectiveness will depend on factors such as available resources, cultural context, resistance to change and the ability to measure its impact. One of the main limitations of this Action Plan is the limited resources available, such as teacher training and funding for events promoting sustainability in higher education. Another limitation to the implementation of this Action Plan is resistance to

change. For example, many educational institutions, communities or young people have limited acceptance and effectiveness when trying to incorporate this model into their teaching, which could mean a challenging and slow process.

In terms of impact measurement, as this document only summarises stages 2 and 3 of the Action Plan, there is no comprehensive evidence of all stages. Therefore, extending the period of analysis could help to provide a long-term perspective for evaluation and continuity. Furthermore, the document presents brief data on student learning, so it is considered advisable to include more information on the learning experiences of the students who participated in the events, as well as the related stages 1, 4 and 5 on learning about sustainability.

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