
Review

Project-oriented learning as an optimal methodology for the incorporation of the SDGs in university teaching: A Systematic Review

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Abstract: The use of active methodologies in the university is a priority to achieve higher quality learning. One of these methodologies with the greatest potential for training in competencies is Project-Oriented Learning (PLA), using it in an innovative way. Associating the use of this methodology with the objectives of sustainable development, which have become even more important since the Pandemic by COVID-19, can be a good idea to achieve a more sustained and situated learning. The aim of this study is to find out to what extent research on teaching innovation with Project-Oriented Learning is associated with the Sustainable Development Goals. A systematic review was carried out as indicated by PRISMA through the following databases: WOS and Scopus. WOS found 15 articles on AoP and 6 on Project-Oriented Learning and sustainability. In Scopus 2 were found in 2019. The main results show that in the University, especially in the branches of engineering, AoP is widely used, however, it is rarely related to SDGs. Among the conclusions, we highlight the need for research on project-oriented learning and sustainable development goals.

Keywords: Project-oriented learning; sustainable development objectives; teaching innovation; situated learning; COVID-19.

1. Introduction

Since the beginning of the COVID-19 pandemic, there has been an impact in all fields: in the economy, in health, in education, in society. And the question arises, what will happen next, will the world change? We are convinced that the world will not change by itself, unless the human being at a planetary level effectively implements actions for sustainability. Interestingly, the environment improved, due to the confinement of human beings and the drastic reduction of movements. We believe that the answer to what urgently needs to be done can be found in the 17 Sustainable Development Goals (SDGs). The question is how? Some solutions may be easy to imagine, even if they have been around for a long time, for example CO₂ reduction. The question is therefore whether we will be able to learn the lesson from what happened at the planetary level with the pandemic and implement global, solid and effective actions. "If history teaches us anything, it is that the world is not changed by pandemics, but by human beings". (Calvo Alvero, 2020) [1]. It is true that we can agree that it is necessary to strengthen international solidarity, to make real an intense scientific cooperation to perfect the methods of development of vaccines and treatments, the implementation of economic solidarity efforts, etc. But many would doubt that this will happen easily. At best, following the reflections of the previous author, the pandemic will most likely serve as a catalyst for phenomena that already existed. In other words, it may serve as a driver for the improvement of many processes, and we should not waste this opportunity. Sustainability is a very important issue because phenomena such as the possibility of returning to the central role of States,

facing the crisis of globalization, strengthening the role of international organizations, increasing development and humanitarian aid, etc., are at stake. Economic, political, social and environmental aspects, which, if not reversed, could have much more devastating consequences than the virus itself.

Higher education is a key player in addressing the sustainable development goals proposed by the 2030 Agenda. On the one hand because the key mission of higher education is the generation of knowledge, teaching and innovation for sustainability. In this sense, it is necessary to integrate sustainability values transversally in management, research and teaching. (Tejedor et al., 2019)[2].

Both UNESCO and other international organizations recommend training young people to implement the SDGs in universities. (Albareda-Tiana et al., 2018)[3].

Teaching for sustainability is fundamental in all areas, although it is necessary to highlight the importance of teaching sustainability in the faculties of Education, since future teachers will be in charge of teaching other generations in turn.

A priority area in universities is innovation in teaching methodologies. The teaching profession should take advantage of this impulse or emergency to rethink the need for quality education, and change traditional teaching for active methodologies, such as case studies, exercise and problem solving, problem-based learning, project-oriented learning and cooperative learning. Service-Learning stands out now more than ever, as a model that aims for students to learn at the same time they provide a service to the community. We highlight the use of Project-Oriented Learning (PLA) and Problem-Based Learning (PBL).

2. Materials and Methods

The aim of this study is to find out to what extent research on teaching innovation with Project-Oriented Learning is associated with the objectives of sustainable development.

To this end, a systematic literature review was carried out following PRISMA guidelines through the following databases: WOS and Scopus. WOS found 15 articles on AoP and 6 on Project-Oriented Learning and sustainability. In Scopus 2 appeared on Project-Oriented Learning and sustainability in 2019, with nothing in 2020 or 2021. However both records already appeared in WOS.

In the case of the WOS search, we searched in the last 5 years, the descriptor: Project-Oriented Learning, and in the second case, with the descriptors AoP and sustainability, we searched in all dates and in all fields.

In the first case, we discarded two articles since they referred to Primary and Secondary respectively. And in the second case, in WOS, we discarded two other articles because they did not focus on university teaching.

3. Results

The results obtained with this bibliographic review are shown in Tables 1 and 2. Table 1 shows the analysis of the studies found on Project-Oriented Learning in the university, through the Web of Science (WOS) database, and Table 2 shows the analysis of the studies found on Project-Oriented Learning and sustainability in the university, through the same database. As explained above, the Scopus search yielded two articles that were already included in the WOS search.

Table 1. Analysis of the studies found on AoP in WOS

Authors, year and title	SDG	Methodology	Main results
Savant, B. N., & Pawar, S. S. (2017)[4]. Implementation of Project Oriented Problem based learning in the Analog Electronics Course	Not specified	Quantitative and Qualitative	The students who followed the POPBL acquired specialized skills through teamwork, communication skills, decision-making, analysis, leadership and good interpersonal skills.
Leite, V (2017)[5]. Innovative Learning in Engineering Education: Experimenting with Short-term Project-oriented Research and Project-based Learning.	Renewable energies	Qualitative	The teamwork, the practical application and the availability of the teacher were positively valued. What did not work so well was: short time and large group.
Arras, P., Van Merode, D., & Tabunshchyk, G. (2017)[6]. Project Oriented Teaching Approaches for E-learning Environment	Not specified	Qualitative.	The implementation of the Internet of Things and the Industrial Internet of Things requires special expertise, multidisciplinary knowledge, teamwork and soft skills. The boundaries between different fields of study are becoming blurred.
Chassidim, H., Almog, D., & Mark, S. (2018)[7]. Fostering soft skills in project-oriented learning within an agile atmosphere	Not specified	Quantitative	AoP is worked on in software engineering. The results of a survey evaluating the perceived value of the course showed that the greatest contribution from our environment was in the effectiveness of teamwork and the overall project development process.
Efren Mora, C., Machado-Toledo, J., Fabiani-Bendicho, P., Martin-Gutierrez, J., & Gonzalez-Perez, S. (2018)[8]. Project-oriented Problem Based Learning to build skills linked with industrial controllers.	Not specified	Quantitative	Improves analytical and interpretation skills to solve problems related to industrial controllers. Seminars are given by the students, followed by the development of a project to solve a real technical problem. The use of active learning strategies linked to advanced theories such as situated learning are possible in the field of control engineering. It improves motivation and performance but there are other factors to take into account, such as previous inertia and procrastination.
Hermann, J., & Gruhn, V. (2018)[9]. M-Learning to Support Project-Oriented Higher Education in Software Engineering.	Not specified	Not specified	Practical examples and relevant learning units are provided in a mobile multimedia toolbox.
Machado-Toledo, J., Mora, C. E., Anorbe-Diaz, B., Gonzalez-Marrero, A., & Martin-Gutierrez, J. (2018)[10]. Project-Oriented Problem-Based Learning for an Entrepreneurial Vision in Engineering Education.	Not specified (affects almost everyone). Problems relevant to science or society.	Not specified	Project and Problem Based Learning (PBL) is one of the most widely used strategies in engineering education. Teaching them to take risks, get out of their comfort zone, make changes that have positive impact, business and entrepreneurial skills, turn their vision into real actions, find creative solutions to complex problems, teamwork, multidisciplinary approaches, reflection and sustainable financial resources. Solve ill-structured problems through teamwork projects. The problem-solving

			process must involve problem analysis, proper planning, risk assessment, financial and process analysis. Entrepreneurial approaches in engineering education can be the basis for positive change for today's problems.
Palazuelos, E., San-Martin, P., Montoya del Corte, J., & Fernandez-Laviada, A. (2018) [11]. Perceived utility of Project-Oriented Learning for competence-based training. Application in the subject "Auditing".	Not specified	Exploratory and descriptive. Perception of 173 students of Business Administration, Auditing course.	Objective: to determine the usefulness of AoP for skills training. They had to elaborate and present a professional journal on the subject. The results obtained are indicative of the effectiveness of POL for the acquisition of knowledge, the development of skills and the promotion of relevant attitudes/values. In addition, it allows the promotion of creativity, with a high degree of satisfaction compared to lectures.
Sancho, M., Garcia-Fayos, B., & Arnal, J. M. (2018) [12] Analysis of Results After the Implementation of an Innovation Teaching Project for the Integration of Project Oriented Learning	Not specified	Not specified	Previous experiences with the application of this methodology in similar experimental subjects have shown that it improves learning and motivation of students, among other reasons, due to the approach to the professional environment.
Zhang, Y. (2018) [13]. Project-oriented Learning Process Analysis in PBL Approach for "Emerging Engineering" Education	Emerging engineering	Not specified (It follows that Quantitative-qualitative)	Real problems drive learning. PBL cultivates the skills to systematically analyze problems and solve complex problems. AoP and ABP can improve the quality of electromechanical talent cultivation. Especially, the construction of "Emerging Engineering" in the electromechanical field, such as "intelligent manufacturing", "robotics", etc.
Iriondo, I., Montero, J. A., Sevilano, X., & Socoro, J. C. (2019) [14]. Developing a videogame for learning signal processing and project management using project-oriented learning in ICT engineering degrees.	Emerging ICT	Quantitative	Multidisciplinary experience with 4 subjects. Working in groups in a simulated corporate scenario, students learned the basics of emerging technologies such as 3D audio, computer vision and speech recognition, while developing soft skills such as negotiation and work planning. The attendance rate rose from around 50% to over 90%, and the average pass rate from 72% to 93%. A survey was conducted at the end of the project and 3-5 years after completion of their post-graduate studies, all of them being integrated into the labor market. Eighty-five percent showed a high degree of satisfaction, and an overwhelming preference for the new methodology over classical learning methodologies.
Lima, B. L. S., Almeida, F. J. M., Garcia, P. A., & Santos, R., V. (2019) [15]. Robotics Application Project-Oriented Programming: Learning and Competition	Not specified	Quantitative and Qualitative	Students are challenged to solve logic problems and participate in a sumo wrestling competition with their robots. Before facing the challenge, the students are trained in the LabVIEW (R) programming language. In a multi-disciplinary context, the students had the opportunity to have an introduction to robotics concepts, programming logic, sensors and automation. The experience was

very successful and there was great motivation and engagement. Their confidence improved and the academic results were very good. The improvement is highlighted when there is more follow-up. This methodology allowed the students to face new problems as the process progressed.

Robberts, A. S., & van Ryneveld, L. (2019) [16]. Work in Progress: Enabling Learning Environments for Underprepared Engineering Students: Blending Game-Based and Project-Oriented Methodologies.

Not specified

Quantitative and Qualitative

It aims to develop 21st century skills, the so-called 4Cs (communication, collaboration, creativity and critical thinking). Three learning activities are presented: an Amazing Race game, a GoGreen project and a LEGO team task, and relate to existing learning theories. It increases engagement with their learning.

Ai, X., Jiang, Z., Hu, K., Chandrasekaran, S., & Wang, Y. (2020) [17]. Integrating a Cross-Reference List and Customer Journey Map to Improve Industrial Design Teaching and Learning in "Project-Oriented Design Based Learning".

Not specified

Quantitative and Qualitative

The AoP experience is to be designed correctly, so that it has the desired effects. Design-based learning (DBL) and project-oriented design-based learning (PODBL) are planned. It improves the effectiveness of learning in engineering design courses. The learning experience has been very positive. The results show that the cross-reference list and the critical factors could improve the learning effectiveness and the learning experience significantly.

It is important to consider the criteria for selecting projects and multi-disciplinary cooperation: experts from the company's technology department were invited to give lectures on the internal structure and connecting structure of the module. They are provided with a large number of books and a 3D printer.

de Groot, B., Leendertse, W., & Arts, J. (2020) [18].). Building Adaptive Capacity through Learning in Project-Oriented Organisations in Infrastructure Planning.

Transportation infrastructure networks are currently challenged by rapidly changing contexts, such as climate change, new information and mobility technologies, aging infrastructure, demographic changes and increasing stakeholder engagement.

Quantitative and Qualitative

An in-depth case study of a typical project-oriented organization in infrastructure planning is conducted.

As we can see, most of the studies implement Project-Oriented Learning without specifying the objective of sustainable development. Most of them are engineering studies and of the 15 papers, 5 include references to sustainable development objectives, albeit unintentionally. These are the following cases: 1. renewable energy, 2. (affects almost all) Problems relevant to science or society, 3. emerging engineering, 4. emerging ICT and 5. transport infrastructure networks are currently challenged by rapidly changing contexts such as climate change, new information and mobility technologies, aging infrastructure, demographic changes and increasing stakeholder engagement. In general, it becomes clear how the use of AoP and PBL, alone or combined with gaming, has positive effects on the development of competences related to teamwork, communication skills, decision making, analysis, leadership and good interpersonal skills, etc.

Table 2. Analysis of the studies found on AoP and sustainability in WOS

Autores, año y título	ODS	Metodología	Principales resultados
Filho, W. L., Shiel, C., & Paco, A. (2016) [19].). Implementing and operationalising integrative approaches to sustainability in higher education: the role of project-oriented learning.	We are talking about sustainability literacy.	Not specified	<p>AoP is explored as a tool to support integrative approaches to sustainability in a higher education context. Successful examples of AoP as well as some trends are presented. The case studies described illustrate five trends</p> <p>trends in relation to the potential of PBL as an example of integrative approaches to foster sustainability.</p> <p>of integrative approaches to foster sustainability, especially in higher education contexts.</p> <p>higher education.</p> <p>Trend 1-Thematic flexibility.</p> <p>Trend 2 - Use of multiple stakeholders</p> <p>Trend 3 - Action orientation.</p> <p>Trend 4-Problem-solving approach to learning.</p> <p>Trend 5 - Development of valuable skills.</p> <p>teamwork, problem solving, project management, research skills, and interpersonal competence.</p>
Stock, T., & Kohl, H. (2018) [20]. Perspectives for International Engineering Education: Sustainable-oriented and Transnational Teaching and Learning.	Development of a start-up company based on sustainable innovation	Quantitative	<p>A transnational and project-oriented teaching and learning framework is outlined, which provides future key competences for young engineers.</p> <p>Based on this framework, the inter-university master course "European Team of Engineers" is presented. The master course fosters the development of sustainable and entrepreneurial initiatives by guiding students through the development phases of a start-up company based on sustainable innovation. A first evaluation of the master course shows, that most of the students' key competencies have improved significantly, thus, except for Commitment / Reliability, English Language, Problem Solving / Innovation and Teamwork, they improve in everything else: Enterprise Development, Process Development and Design, Business Model Development / Design, Sustainability, Dealing with Sustainability, Dealing with the Environment, Business Development / Design, Sustainability, Dealing with the Environment and</p>

			Sustainability. Design, Sustainability, Dealing with valued rules/standards of other cultures of other cultures, presentation and medication, leadership-race, etc.
Gladysz, B., Urgo, M., Gaspari, L., Pozzan, G., Stock, T., Haskins, C., Jarzebowska, E., & Kohl, H. (2018) [21]. Sustainable Innovation in a Multi-University Master Course	Not specified	Not specified	13 European students from four countries participated in a new project-based course called "European Engineering Team". The students focused on the development of two innovative and sustainable products. The aim of this work is to present the thermal cover for pallets. The process of realization of the project is presented. It provides the overview and discussion of the engineering and management tasks that the students performed in the transnational environment, working remotely on their own campuses between the scheduled transnational meetings. The work contributes to project-oriented learning that can form a basis for teaching holistic engineering courses in mechanical and industrial engineering departments.
Albareda-Tiana, S., Vidal-Ramentol, S., Pujol-Valls, M., & Fernandez-Morilla, M. (2018) [22]. Implementing Pedagogical Approaches for ESD in Initial Teacher Training at Spanish Universities.	Not specified	Not specified	They use a holistic approach. The participants in the study are students in initial teacher training. The experimental educational model used for the development of sustainability and research competencies consists of a methodological sequence of AoP and a Transdisciplinary Workshop on Sustainable Food. This study provides evidence that the POL is an excellent methodology for developing sustainability competencies and facilitates the relationship between sustainability and research competencies.
Tejedor, G., Segalas, J., Barron, A., Fernandez-Morilla, M., Teresa Fuertes, M., Ruiz-Morales, J., Gutierrez, I., Garcia-Gonzalez, E., Aramburuzabala, P., & Hernandez, A. (2019) [2]. Didactic Strategies to Promote Competencies in Sustainability.	Not specified	Qualitative. Research-Action	Through a collaborative work between experts from 6 Spanish universities participating in the EDINSOST project (education and social innovation for sustainability). The role of five active learning strategies (service learning, ABP, AoP, simulation games and case studies) in education for sustainability is reviewed. The results provide a synthesis of their objectives, rationale and application stages (planning, implementation and evaluation of learning), which can serve as valuable guidelines for teachers.
Albareda-Tiana, S., Garcia-Gonzalez, E., Jimenez-Fontana, R., & Solis-Espallargas, C. (2019) [23]. Implementing Pedagogical Approaches for ESD in Initial Teacher Training at Spanish Universities.	3,6,12 y 15	Qualitative. The initial and final ecological footprint (EF), as well as a rubric to measure the level of acquisition of sustainability competencies, were used as data	Four case studies of the degree in Primary Education in three Spanish universities are analyzed. The objective is to study the suitability of three active strategies: ABP, AoP and a transversal workshop. Another objective is to promote the integration of education for sustainable development (ESD) and to measure the level of acquisition of various sustainability competencies and change in consumption habits. When sustainability is implemented with active

collection instru- ments.	strategies, students acquire sustainability compe- tencies, in addition to contributing to a change in consumption habits by observing a reduction in EF. There is a relationship between the reduction of EF and high levels of acquisition of sustainability competencies.
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In this case we find three papers that refer to sustainable development objectives, two of them in a more imprecise way. They refer to sustainability literacy and the development of an emerging company based on sustainable innovation. In the third case we do find a more complete reference to the SDGs, explicitly working on SDGs 3, 6, 12 and 15. In a similar way as in Table 1, reference is made to the benefits of AoP in certain competencies and skills that would otherwise not be developed. The AoP methodology is also developed in different ways that may be models.

4. Discussion

Table 1 highlights the most comprehensive reference to SDGs in one of the papers that explicitly refers to transport infrastructure networks that are currently challenged by rapidly changing contexts such as climate change, new information and mobility technologies, aging infrastructure, demographic changes and increasing stakeholder engagement. This is a very comprehensive reference to the SDGs and invites us to interrelate different aspects of sustainability.

We also highlight the work of Iriondo, I., Montero, J. A., Sevillano, X., & Socoro, J. C. (2019) [14], as they have applied the AoP for 3 years and have tested the effects on students. Moreover, they have done it in an interdisciplinary way, involving four technical and management subjects included in the curricula of ICT engineering degrees. The students consider it as a good experience to a high extent. The students' vision of the methodology used was good both at the end of the postgraduate course and later when they were already working, valuing the soft skills acquired. In general, the students stated that although they have to work more than with traditional teaching, they prefer it. It should be noted that the pass rate increased and the dropout rate decreased very significantly. The results of this study are very satisfactory, with the measures found in relation to the ability to work in groups, ability to plan future work, improvement of values, understanding of concepts, preference for the POL methodology (80%) as opposed to the classical one (20%), etc., being between completely and fairly satisfactory. These authors conclude that it is more time consuming from a teaching point of view, but it should be taken into account that the learning achieved by the students is much deeper, and the motivation and learning results (both in terms of technical and soft skills) of the students are improved.

The combination of AoP and gamification has very positive effects, as Robberts, A. S., & van Ryneveld, L. (2019) [16], claim the improvement of communication, collaboration, creativity and critical thinking, increasing the commitment to learning.

5. Conclusions

We agree with Savant & Pawar (2017)[4] that 21st century students need active teaching that promotes sustained and meaningful learning. The authors point out the importance of starting in teaching from a set of data, observations, problems, cases and students are asked to interpret them, analyze them or solve a real-world problem.

Although it may not seem real to us, teaching is still based on lectures, focused on content. This is expressed by Leite (2017) [5] highlighting that in that way retention is very low, pointing out that it is 5% according to the learning pyramid.

Project-oriented learning is an excellent active methodology that makes students face real problems. As long as teachers have the explicit intention of including in their project planning topics or problems directly related to the objectives of sustainable development, we will be able to collaborate in making a more sustainable world supported by well-trained professionals with deep and sustained learning.

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