L2 VIRTUAL EXCHANGES AND LABORATORY EXPERIMENTS IN ENGINEERING EDUCATION: NEW HORIZONS FOR SUSTAINABLE, TRANSVERSAL AND LINGUISTIC DEVELOPMENT

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Abstract

The progress of meaningful learning within virtual environments that prioritise sustainability, capacity building and interculturality has been a challenge despite extensive research efforts. Engineering and foreign language educators recognise the importance of combining Sustainable Development Goals (SDG), transversal competences, and second language (L2) acquisition through laboratory experiments.

To address these targets, a cooperative training scenario can be employed. This Sustainable Active Virtual Learning - SAVL - model adaptation not only complies with the provisions of the university curriculum but also generates quality instruction opportunities. Therefore, by following this approach in the first term of 2023, we conducted a quantitative and qualitative study on seven inter-university virtual collaborations, each related to a specific material science laboratory task.

25 engineering students from the third year of the Aerospace Engineering Degree at the Spanish Technical University of Valencia /"Universitat Politècnica de València (UPV)" and 5 counterparts from the second and third year of Material Science at the Ukrainian Dnipro University of Technology (DUT) actively participated in collaboration via online meetings retransmitted from UPV laboratory facilities. Small groups of 5-6 international learners performed technical tasks and delivered reports while communicating in English. Their feedback and task assessment created a favourable background for enhancing curricular settings in both polytechnic institutions.

The experimental findings support collaborative interactions for achieving the central pillars of Agenda 2030 - people, planet, prosperity, peace and partnership - and bringing new meaningful training opportunities to future engineers. Additionally, as internet-based educational exchanges continue to grow, our research can benefit instructors, students and universities by overcoming geopolitical disadvantages and conflicts.

Keywords: virtual exchange, sustainability, transversal competences, second language acquisition, technical students, engineering education.

1 INTRODUCTION

Sustainability has become a challenging concept to understand and apply in educational settings over the past few decades. The global 2030 Agenda [1] and Sustainable Development Goals (SDGs) have introduced transformative pedagogy as a means of providing capacity-building and lifelong learning opportunities in higher education institutions. But also, SDGs necessitate a shift in pedagogical approaches to foster active learning, critical thinking, and skills development [2], [3].

In the context of engineering education, the Technical University of Valencia "Universitat Politècnica de València (UPV)" has aligned its strategic plan with the targets of becoming a sustainable, international, relevant, vital and excellent university [4]. The SIRVE Strategic Plan emphasises the commitment to serving society and aims to build a university that is sustainable, inclusive, diverse, and prioritises research and educational excellence, innovation, and technology transfer.

This framework prioritises providing quality education that is inclusive and equitable (SDG 4) while promoting global partnerships (SDG 17) in degree programs. In line with this, the direct connection between university and sustainability might be related to meaningful and innovative learning processes. As such, we advocate for online inter-university projects with the common ground of technical training and professional communication in English.

In this study, we focus on organising and implementing pedagogic cooperation tailored for transversal competences achievement within a virtual environment. The primary objectives and interventions of this initiative are multifaceted due to the earlier-mentioned aspects: sustainability goals, technical education and second (L2) language acquisition.

Firstly, the initiative aims to showcase the advantages of intercultural didactic exchange by conducting laboratory experiments within mixed inter-university groups. Secondly, it seeks to enhance the exposure of university students to virtual interaction in a foreign language, fostering a more immersive and dynamic learning scenario.

Lastly, a key objective is to cultivate reflective capacity among students, emphasising the progress of both intercultural competence and professional capacities. Through these targeted goals and interventions, the training initiative aspires to contribute significantly to the realm of sustainable university education and the acquisition of global languages.

2 METHODOLOGY

We propose a methodology to address the four-tier structure of the training approach in response to the need for a meaningful training setup. The Sustainable Active Virtual Learning (SAVL) model is an innovative method that oversees online collaboration schemes [5]. This method empowers stakeholders to engage with a better perspective on collaborative learning objectives, societal challenges, technical and linguistic issues.

In Figure 1, we illustrate the way each level of the model helps organise collaboration between two technical universities: Spanish UPV (Valencia) and Ukrainian DUT (Dnipro). Starting with the "S"-level, the organising parts and the UPV Didactic Innovation Project "Sostenible_EDU" members selected SDG 4, targeting inclusive and equitable quality education, as well as SDG 17, addressing global partnerships implementation. The next "A"-level combines laboratory experiments, reports and presentations in mixed inter-university groups, whereas the upcoming "V"-level supports Microsoft Teams and other digital tools. Finally, the "L"-level introduces technical and professional English language settings directly linked to transversal competences of effective communication and teamwork.

	Specific model details	UPV - DUT adapted model
S	Sustainable Development Goals & Agenda 2030	
A	Active Learning Methodologies & Cooperation	Joint lab experiment, report writing, oral presentation & Online cooperation of UPV & DUT students & instructors
V	Virtual exchange system & Digital tools	Microsoft Teams meetings & PowerPoint, MS Forms
L	L2 /3 learning process / outcomes & Competences	Professional English for Engineering & Effective communication competence Teamwork competence

Figure 1. Sustainable Active Virtual Learning model. Adapted from Polyakova & Galstyan-Sargsyan (2022).

Although the applied model looks quite clear and open, the initial preparation for SAVL use requires mentoring and training seminars for educators. It is also worth noting that once adopted, the scheme offers a lot of flexibility and does not require additional investments.

2.1 Planning, organisation and design

This research study centres on the applied sessions of the "Aircraft Materials" course, which constitutes a section of the Aerospace Engineering programme at the Higher Technical School of Design Engineering at UPV. The course, comprising of practical laboratory exercises, is instructed during the first semester of the third year of the program.

The research encompassed a cohort of 25 (UPV) and 5 (DUT) students distributed into six groups. Students from Dnipro University of Technology (DUT) in Ukraine participated in the laboratory sessions through online meetings using the Microsoft Teams environment. Spanish students initially established contact with the Ukrainian students by following distribution lists according to the groups and exchanging

contact information. However, the students preferred to work with the students they initially connected with during the laboratory practices.

Each laboratory session lasted two hours, and seven sessions were conducted from September 2023 to January 2024. During the laboratory sessions, students from both universities communicated with each other in English via chat. Spanish students explained the experimental setup to their Ukrainian counterparts, and together, they completed experiments and obtained results. The mixed groups then exchanged data and discussed their findings. Professors provided theoretical explanations and assisted in resolving any doubts the students had.

After completing the experiments, the students wrote reports in a predetermined format that included explanations and discussions of the results. These reports were evaluated by professors from each respective university. In the final session, the students prepared oral presentations of their reports, which was followed by a question-and-answer session. Table 1 provides an overview of the didactic planning of the sessions, outlining the respective content covered in each session.

Table 1. Didactic planning. Source: own design.

Lab session	Laboratory experiments	Virtual activities	Hybrid activities
1	Non-destructive analysis magnetic particles	Teams Video sessions. Discussion of technical aspects of lab sessions and experiments. Exchange of experimental data and discussion of obtained results	Chat conversation during the Teams session for description of experimental procedure and results. Writing professional reports.
2	Non-destructive analysis Ultrasonic technique		
3	Mechanical prosperity of campsite materials		
4	Steel heat treatment		
5	Aluminium alloy heat treatment		
6	Titanium alloy heat treatment		
7	Oral presentation of 1-6 laboratory experiments	Team meeting to organize the presentation and create questions list	Oral presentations with questions and answers sessions

2.2 Assessment

After the laboratory sessions, technical reports underwent a rigorous evaluation process utilising well-defined rubrics. Initially, students were allowed to engage in self-assessment exercises to understand the evaluation methodology better. Subsequently, the instructors reviewed the reports and offered the students constructive feedback during the ensuing session. The primary objective was to rectify any errors and aid the students in enhancing the quality of their reports.

Throughout the collaborative project, the oral presentations and responses to questions were evaluated using well-defined and previously validated by two more experts on English language and university pedagogy rubrics. These rubrics were thoughtfully created as MS Forms for this specific purpose. The evaluation process included valuable components such as self-evaluation by the presenting group, evaluation by peers from other groups, and evaluation by professors from both universities and colleagues from the Didactic Innovation group.

Upon completing the project, the participating students completed a learning outcomes self-assessment questionnaire. This allowed us to gather valuable insights into their experiences and perspectives, which we believe will help us to improve and refine our collaborative efforts in the future.

3 RESULTS

3.1 Activities

The activities carried out during the virtual exchange explored a variety of different formats, varying from technical laboratory experiments to oral presentations in English. Among the most challenging tasks,

we would mention virtual and hybrid activities primarily focused on procedural aspects of engineering instruction. Below, we illustrate some of the learning process details and products:
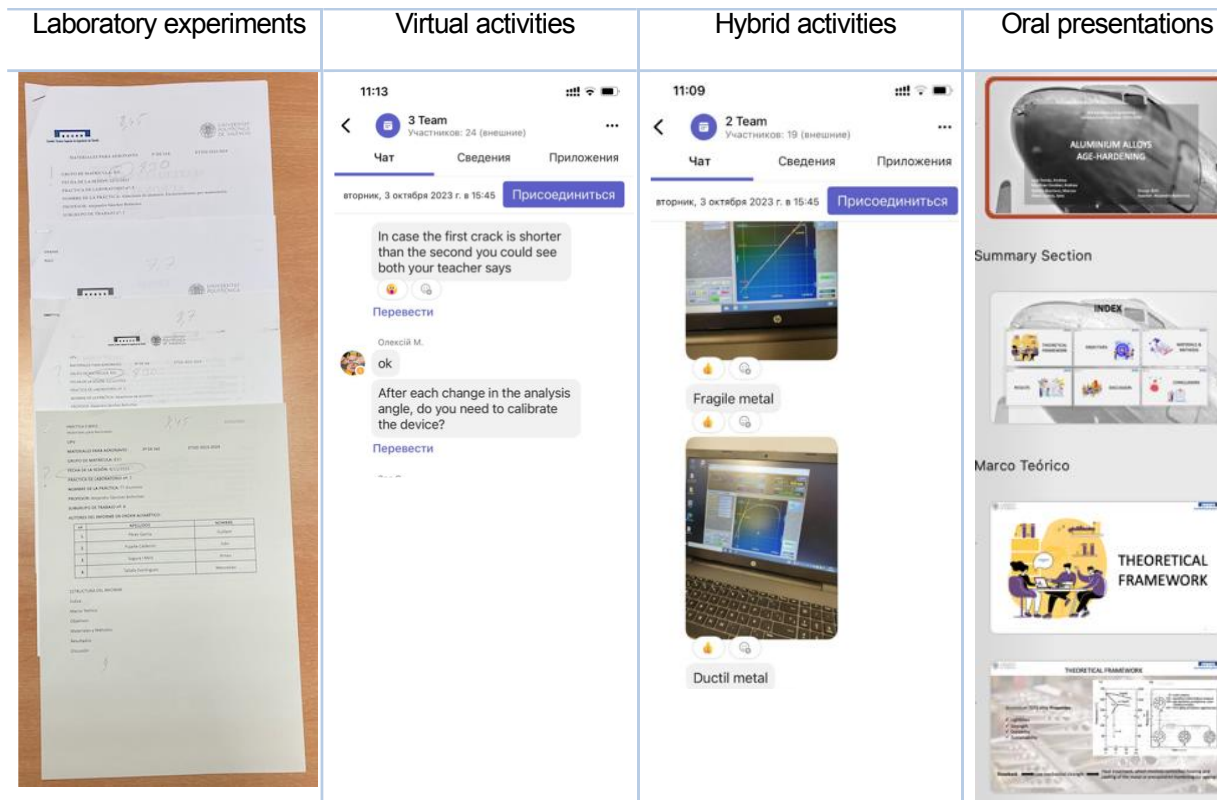

Figure 2. Collaboration activities. Source: own design.

3.2 Learning outcomes

Assessing the learning outcomes is a vital part of education as it helps in understanding the effectiveness of instructional methods and the achievement of educational goals. In our case, this process involves assessing the students' insights into sustainability goals 4 & 17 and the development of communicative and teamwork competences. To determine the perceptions of Spanish and Ukrainian students in these areas, we have incorporated some ideas from a survey conducted by Gonglewski & Helm [6].

At the end of the oral presentation session, the students evaluated their progress based on the programme's learning outcomes. After completing the training programme, 50% of the students strongly agreed, and 40% agreed that they could now compare the perspectives and practices of SDG 4, "Quality Education", in Spain and Ukraine. A slightly lower percentage (43% strongly agreed and 40% agreed) was achieved when linking SDG 17 "Global Partnerships" to the virtual exchange experience. Furthermore, the majority of the exchange participants strongly agreed (53%) and agreed (30%) on their ability to effectively communicate in English, while teamwork competence via online collaboration was found to be a bit more challenging for them (47% strongly agreed and 38% agreed).

These trends exploring sustainability and competences advancements are supported by an open-ended question asking to relate their project experience by choosing only 5 keywords. The words shown in Figure 3 indicate the main priority of this didactic initiative: "communication" (repeated 6 times). Closely linked to this cornerstone of the project appear "teamwork" and "cooperation" (repeated 5 and 4 times, respectively).

To explore more specific outcomes, an open-ended question was asked to the participants, where they were required to relate their project experience by choosing only 5 keywords. The main priority of this didactic initiative was found to be "communication" (repeated 6 times). Closely linked to this cornerstone of the project mission were "teamwork" and "cooperation" (repeated 5 and 4 times respectively) as per the words shown in Figure 3.

Figure 3. Feedback word cloud. Source: own design.

4   CONCLUSIONS

This study aims to analyse the results of the collaborative work during laboratory experiments carried out by students from Spain's UPV and Ukraine's Dnipro University of Technology. The study covers three main aspects: Sustainable Development Goals (SDG), transversal competences, and utilizing English as a second language (L2). The study indicates that communication skills and cooperation have improved the most, based on the students' opinions.

The collaboration between the students has resulted in a higher level of recognition and identification with SDG 4 - Quality Education compared to SDG 17 - Global Partnership. The study suggests that the emphasis on quality education resonated more strongly with the participants, highlighting the importance they placed on this goal. However, the level of recognition and identification with the goal of global partnership was relatively less pronounced among the students involved in the collaboration.

During the collaboration, the students noticed an improvement in their English communication skills. However, they also recognized that the development of teamwork abilities played a more significant role in their educational experience.

In summary, the collaborative work forum between students from two universities has proven to be productive, paving the way for the continued development of this teaching methodology in the future.

ACKNOWLEDGEMENTS

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