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A Cooperative Interdisciplinary Task Intervention with Undergraduate Nursing and Computer Engineering Students

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Abstract: This study proposed a collaborative methodology among university students in different grades in order to find sustainable strategies that are an added value for students, teachers, and society. In daily professional practice, different professionals must develop skills to collaborate and understand each other. For that reality to be sustainable, we believe that experiences must begin in the context of higher education. Social network analysis offers a new perspective on optimizing relationships between university students. The main goal of this study was to analyze students' behavior in their networks following an educational intervention and the association with academic performance, resilience and engagement. This was a descriptive quasi-experimental study with pre–post measures of a cooperative interdisciplinary intervention. Participants comprised 50 nursing and computer engineering students. We measured help, friendship, and negative network centrality, engagement, resilience, and academic performance. No significant differences were observed between pre–post-intervention centrality measures in the negative network. However, the help and friendship networks presented statistically significant differences between inDegreeN, OutDegreeN and EigenvectorN on the one hand, and resilience and engagement—but not academic performance—on the other. Academic performance was solely associated with the team to which participants belonged. Cooperative interdisciplinary learning increased the number of ties and levels of prestige and influence among classmates. Further research is required in order to determine the influence of engagement and resilience on academic performance and the role of negative networks in network formation in education. This study provides important information for proposals on sustainable assessments in the field of higher education.

Keywords: academic performance; cooperative learning; engagement; engineering; interdisciplinary learning; nursing; resilience; social network analysis; students

1. Introduction

The university context is essential for university students to be sensitive to behaviors aligned with sustainability [1]. Universities have considered joining the the Sustainable Development Goals

(SDGs) as a strategic factor. They have carried this out through multiple organizations, such as the Sustainable Development Solutions Network (SDSN), the Environmental Association for Universities and Colleges (EAUC), the Association for the Advancement of Sustainability in Higher Education (AASHE), and the Australasia Campus towards Sustainability (ACTS). The SDGs are a set of priorities and aspirations to guide all countries to address the most pressing challenges in the world, including health and social welfare issues [2]. In this context and aligned with the definition of sustainable development [3], the concept of "sustainable assessment" emerges in the early years of the 21st century. Sustainable assessment is defined as an assessment "that meets the needs of the present and [also] prepares students to meet their own future learning needs" [4].

The main idea behind sustainable assessment is to prepare students to undertake assessment tasks that they will have to face during their lives [4]. Learning cannot be sustainable if it requires continuing information from teachers on student's work [5]. University students must build the capacity to become judges of their own learning; this includes self-assessment but also peer and collaborative assessment. In this sense, assessment must go beyond the idea of getting a mark for a given course: It must be seen as an educational tool and not as a simple measure or learning outcomes. In relation to sustainable assessment, the concept of "evaluative judgement" has gained attention today in higher education contexts, being defined as "the capability to make decisions about the quality of work of self and others" [6].

Learning in a collaborative environment is one of the scenarios where the ideas from sustainable assessment can be more beneficial, beyond the traditional ideas of summative and formative assessment [7]. Self-, peer-, and lecturer-based assessment can be used in conjunction in order to obtain a sustainable assessment system, as in the case of the authentic assessment for sustainable learning model [8].

Sustainable assessment is a field of current active research that needs to explore a plethora of possibilities; however, there are few applied studies on interventions that develop such sustainable practices [5]. We consider that studying networking in a collaborative and interdisciplinary learning experience is a good proposal within the sustainable assessment approach, as interdisciplinary collaboration during the future working lives of the students will be an everyday issue. To perform this kind of studies, teachers must design teaching–learning strategies that assess these collaborations. This research explores learning and assessment approaches based on interdisciplinary and collaborative work among students from the degrees of nursing and computer engineering, with an emphasis on studying the social relationships that are established during this collaboration and how these social interactions affect engagement and academic outcomes.

The period of adolescence is accompanied by changes in the socioaffective process that affect perception, ties between peers, and inclusion in social groups [9]. During this process, social influence between peers reaches its zenith, while the same influence exerted by parents begins to decline [10]. Peer relations in the classroom can promote the knowledge, skills, and social capital necessary to successfully transition from adolescence to adulthood [11]. In addition, the development of classroom relationships is intimately related to students' academic performance [12].

Understanding engagement and resilience in the classroom helps to elucidate the formation of ties between students. When forming working groups, the selection of team members by the students themselves improves engagement and motivation [13]. Furthermore, promoting engagement has positive effects on academic performance and reduces dropout [14]. Moreover, resilience helps students to solve problems [15] and enhances subjective wellbeing [16]. It is highly important to instil resilience in future health professionals [17]. Interpersonal behaviors can affect engagement and resilience as a result of the status generated and reputation processes within groups.

Classroom relationships generate a rich ecosystem of social ties that requires a theoretical research framework to gain understanding. Social network analysis (SNA) comprises a method for analyzing the structure of ties within a network, which is its main difference from other methods of analysis [18]. SNA is based on the idea that the ties between network participants are meaningful. Hence, these ties are analyzed to elucidate their significance [19]. A social network is a set of nodes, some of which are linked by lines. The nodes represent individuals or groups, and the lines indicate that the nodes are connected among them, generating a social structure [20]. This network of relationships or networks transfers resources inherent to the structure generated among individuals [21]. SNA studies the contact that exists not only between the actors but also between their goals and objectives, since their objectives are achieved through connections and relational behaviors [18,22,23].

Friendship and help networks have been among the most frequently analyzed networks in SNA, while more recently, the negative network has also emerged as a subject of study. Analyses of the friendship network examine friendship ties between nodes and the degree centrality of their intensity [24]. Centrality is defined as the position of the actor in the network [25]. Findings are useful to determine the influence of friendships and ties between peers on the acquisition of new values and behavior modification [14] or the importance of the most popular students and their impact on the dynamics of relationships [26]. Analyses of the help network assess the connection and intensity between nodes when problem-solving or seeking advice [27]. Previous studies have confirmed the utility of the help network when seeking prenatal information in the absence of formal resources [28] or receiving support and acceptance from students in the case of speech difficulties [29]. In relation to negative networks, it has been demonstrated that nodes avoid interacting with other nodes [30], and researchers have underlined the influence of negative ties in the workplace [31,32]. Negative relationships refer to the intensity of disgust established between two nodes and to whether the person knows that the other person dislikes him or her [31].

The structural analysis of networks can be applied to various fields of study, such as business relationships [33], tourist travel intentions [34], resilience in disasters [35], and mental health [36]. In the field of education, the context of the present study, SNA has been applied to explore (i) the social influence of ties on adolescents' mental health [37], (ii) the social dynamics of groups in educational camps [38], and (iii) the formation of friendships between students from different ethnic groups [39].

Among engineering students, SNA has been used to determine the influence of networks on performance, demonstrating that a higher number of ties is associated with better academic outcomes [40]. In nursing students, SNA has been used to explore the influence of networks on engagement and resilience [41] and determine their role in the development of technological competence [42]. It has been found that the network perpective is suitable for the analysis of resilience, since it is developed in sociological systems [43]. The network perspective is focused on the study of the structure of these sociological systems, and the ability of that structure to be resilient. A command of information and communication technologies is not among the competences instilled in nursing. Gamification is considered a novel and interesting approach to the development of competencies in new technologies [44] and its use to instil computing skills in the nursing profession has proven effective as a means to achieve a better command of these technologies [45].

These issues motivated the present study of how the dynamics of social interaction are associated with classroom behavior when sharing ideas in order to achieve a good academic outcome. The interdisciplinary intervention aimed at determining nursing and computer engineering students' behavior that has not previously been analyzed and remains unexplored in the literature. Notably, our SNA included an analysis of negative networks between students, which has not previously been examined in this population. In particular, the recent literature contains few studies that have focused on students and the impact of engagement and resilience [41,46], and none of them included academic performance among their variables. The present study is the first to include SNA in an interdisciplinary intervention with university students.

The study objectives were:

- To quantify pre–post changes in behavior following a cooperative task intervention, analyzing centrality variables in the help, friendship, and negative networks of computer engineering and nursing students engaged in the fields of information, communications, and health science.

- To graphically represent pre–post changes following a cooperative task intervention in the help, friendship, and negative networks of computer engineering and nursing students engaged in the fields of information, communications, and health science.
- To determine pre–post changes in engagement and resilience following a cooperative task intervention.
- To determine the relationship between academic performance and centrality, engagement, resilience, and sociodemographic variables.

The objectives allowed us to propose a cooperative and multidisciplinary framework, which will be sustainable for Nursing and Computer Engineering degrees.

2. Materials and Methods

This was a quasi-experimental descriptive study with pre–post-intervention measures.

2.1. Sample Description

Participants were recruited using convenience sampling [47]. Students from two undergraduate courses were approached and presented the project. One of the courses belongs to the fourth year of the Computer Engineering degree and the other one to the third year of the Nursing degree. These degree courses were taught on different campuses located 113 kilometers apart. As shown in Table 1, 26 students from the Nursing degree course and 24 students from the Computer Engineering degree agreed to participate in the project after being informed. Interdisciplinary work groups were formed with randomly selected students, so that there would be a similar number of nursing and engineering students in each work team.

Table 1. Descriptive data and comparison of pre–post-intervention centrality variables (N = 50).

Degree	**Sex**								
	Men	**N**	**(%)**	**Women**	**N**	**(%)**	**Total**	**(%)**	
Nursing	4	15.4	(%)	22	84.6	(%)	26	100	(%)
Computer engineering	19	79.2	(%)	5	22.08	(%)	24	100	(%)
Total		23			27		50	100	(%)

The sample consisted of 50 students taking two different degree courses at a public university in Spain. All the individuals participated voluntarily in the study after being informed.

2.2. Variables

The variables analyzed were as follows (Table 2):

Table 2. Variables and conceptual variables.

Metrics	**Conceptual Definition**
Degree studied, sex, team	Descriptive variables of the sample.
Engagement	Work-related, positive or satisfactory, persistent cognitive affective state. It is composed of three basic dimensions: absorption (concentration), vigor (tenacity, effort), and dedication (enthusiasm, inspiration, pride, defiance) [41,48].
Resilience	Individual's capacity to respond to stress in a healthy manner, such that they can achieve goals at the lowest physical and psychological cost [41,46,49,50].
Academic performance	Students 'knowledge of a cooperative interdisciplinary task [12].
Centrality structural variables	IndegreeN (degree of received ties surrounding the individual), OutDegreeN (degree of emitted ties), EigenvectorN (degree of prestige or influence), BetweennessN (degree of intermediation [19,41].

2.3. Instruments Used to Collect Data

Data on variables were collected by means of an online questionnaire viewable on any device (desktop, laptop, mobile device or tablet). The questionnaire was accessed via a URL, entering a username and password, and incorporated an automatic anonymization system. The server ensured secure data transfer via SSL encryption and HTTPS (Hypertext Transfer Protocol Secure).

The questionnaire included the following:

- Each student's degree, sex, and team;
- The UWES-S scale (Utretch Work Engagement Scale-Students) adapted to measure the level of engagement in university students [48,51,52] and validated for the Spanish population [41,45]. This scale consists of 17 items scored on a scale from 0 (never) to 6 (always or every day);
- The Connor–Davidson scale, version CD-RISC, validated in Spanish in 2011, used to measure resilience. This consists of 10 items scored using a Likert scale from 0 (never true) to 4 (almost always true) [49,50];
- Academic performance was measured based on the mark obtained in the subject, scored from 0 to 10. This mark included individual marks for team work and a written test;
- Centrality structural variables were measured using a 5-point Likert scale to assess the sociocentric networks of all study participants. The networks assessed were (a) friendship network: Which of the following classmates do you consider a friend? [24]; (b) help network: Which of the following classmates do you ask for help when you have a problem/doubt/difficulty regarding course work? [27] and (c) which of the following classmates do you avoid interacting with? [30]

2.4. Procedure

Data were collected on two occasions: first in the initial face-to-face session and again on the day when the completed task was presented.

Descriptive variables, engagement, resilience, and marks were processed using Microsoft Excel.

Structural variables of sociocentric network centrality were analyzed using square matrices for each network. It was necessary to dichotomize the data using intermediate encoding of the friendship, help, and negative networks. We used normalized data for centrality values in accordance with UCINET v. 6.666 [53] (Table 3).

Table 3. Dichotomization of network interactions.

Network	Centrality Variable	Values
Help	Without support	0, 1
	With support	2, 3, 4
Friendship	Without friendship	0, 1
	With friendship	2, 3, 4
Negative	Without avoidance	0, 1
	With avoidance	2, 3, 4

2.5. Intervention

The interdisciplinary intervention consisted of dividing the class into nine teams of five or six students each from both degree courses; these teams were required to carry out a cooperative task on applications in the field of health. Participants were taught at different campuses located 113 kilometers apart, so they only met face-to-face at the initial session when the teachers presented the cooperative task. Their subsequent contacts took place via online networks.

The cooperative task involved three stages: (a) an initial face-to-face session to explain the task objectives and method and establish personal contact during a 5-hour session in a non-academic environment (a cafeteria with brunch included); (b) implementation of the task over the course of 40 days subsequent to the initial session, communicating by means of mobile phones, emails, and instant messaging; (c) presentation of the completed work by all members of the team via videoconference between the two campuses.

To complete the task, the nursing students had to explain a healthcare need, and the engineering students had to formulate a technological solution for the identified healthcare need. In their oral presentations, all team members were required to present part of the completed work but with the caveat that the nursing students had to present the technological solution and the engineering students had to talk about the healthcare need.

Assessment was achieved by both teacher and peer evaluation of the collaborative work. The nursing degree students evaluated the computing engineering students' presentations (except those from their own working group) and vice-versa: The computer engineering students evaluated the nursing students' talks. Academic performance was measured as the individual mark awarded for the results of the cooperative task (evaluated by the teacher), a multiple-choice test (for the peer evaluation previously described), and classroom participation.

2.6. Ethical Considerations

Participants were informed of the study objectives and method. Participation was voluntary, and students could cease to participate at any time. All personal data were processed ensuring confidentiality and anonymity. Simulated names were generated with the aid of the tool described in Benítez et al. (2017) and used to create the network graphs [54]. This study was approved by the University of León Ethics Committee (Ref. ETICA-ULE-026-2018) and adhered to the Declaration of Helsinki, Law 15/1999 of 13 December, on Personal Data Protection, and Law 14/2007, of 3 July, on Biomedical Research.

2.7. Data Analysis

We used the Kolmogorov–Smirnov test with Lilliefors correction to determine the normality of values for all the variables analyzed except those for centrality measures. The descriptive statistics are given as means and standard deviations.

To determine differences between pre- and post-intervention variables, we used the Student's *t*-test when distribution was normal and Wilcoxon's *t*- test when it was non-normal.

To determine correlations between parametric values, we used Pearson's correlation coefficient, while for nonparametric values, we used Spearman's correlation coefficient.

Significance was set at $p < 0.05$ and $p < 0.01$. All statistical analyses were performed using SPSS v. 25.0.

2.8. Results

Universities are the institutions of higher education (HEI) whose objective is to contribute to the sustainable transformation of societies through the training of future professionals. In this sense, this sustainability and transformation project must start from the lectures at the university campus, with specific actions in the curricula and oriented towards what UNESCO calls the "Focus of the whole school". The study of collaboration networks among students of different grades constitutes a strategy for fostering the future sustainability of professionals. In our case, it was proposed that a nurse and/or an engineer could improve patient care. This is based on the fact that a nurse knows what the patient demands, and the engineer knows how to propose a technological solution and integrate the use of technologies in health systems. To achieve this, the nurse and the engineer must develop effective communication channels, have critical thinking, and know how to work in networking teams with professionals from different disciplines.

If this method of working achieves positive outcomes among the students, it will possibly be achieved also in the future, when the students become professionals. Our intervention was related to sustainability because trying to demonstrate that interdisciplinary work solves problems responds to societal demands and achieves objectives effectively.

The application of SNA helped us to deepen the structures of collaborative networks among students. The specificity of the method allowed the identification of relational roles, such as Indegree, Outdegree, Eigenvector, and Betweenness. In addition, this research related these relational roles with fundamental constructs for teamwork, such as resilience and engagement, as detailed below.

Table 4 gives the descriptive data and a comparison of normalized network centrality variables pre- and post-intervention. We found that the help and friendship networks presented variables with significant differences in InDegreeN, OutDegreeN and EigenvectorN. By contrast, no significant differences were detected for any negative network variable.

Table 4. Descriptive data and comparison of pre–post-intervention centrality variables (N = 50).

Network	Centrality Variable	Pre-Intervention	Post-Intervention	Student's *t*-Test	Sig.
Help	InDegreeN	0.10 ± 0.05	0.18 ± 0.08	−13.775	<0.001 **
	OutDegreeN	0.10 ± 0.08	0.18 ± 0.12	−4.611	<0.001 **
	EigenvectorN	13.35 ± 15.04	16.87 ± 10.85	−2.761	0.008 **
	BetweennessN	2.78 ± 3.91	2.76 ± 2.89	0.029	0.977
Friendship	InDegreeN	0.12 ± 0.06	0.18 ± 0.07	−10.326	<0.001 **
	OutDegreeN	0.12 ± 0.07	0.18 ± 0.12	−4.229	<0.001 **
	EigenvectorN	11.85 ± 16.28	17.16 ± 10.38	−3.643	0.001 **
	BetweennessN	2.78 ± 3.91	2.56 ± 2.08	0.359	0.721
Negative	InDegreeN	0.12 ± 0.05	0.12 ± 0.05	−0.01	0.992
	OutDegreeN	0.12 ± 0.23	0.12 ± 0.25	0	1
	EigenvectorN	17.31 ± 10.12	17.63 ± 9.53	−0.248	0.805
	BetweennessN	0.58 ± 2.07	0.70 ± 2.02	−0.338	0.737

Legend: InDegreeN, normalized InDegree; OutDegreeN, normalized OutDegree; BetweennessN, normalized Betweenness; EigenvectorN, normalized Eigenvector. * Correlation is significant at 0.05. ** Correlation is significant at 0.01.

Graphic representations of pre- and post-intervention networks are shown in Figures 1 and 2 (help networks), Figures 3 and 4 (friendship networks), and Figures 5 and 6 (negative networks). Blue indicates men and pink indicates women, while squares denote nursing students and circles denote computer engineering students. Tie density in the help and friendship networks showed clear changes over the course of the study. Pre-intervention, most ties in these networks occurred between students on the same degree course, with hardly any ties between degrees. In addition, more interactions were observed between nursing than between computer engineering students, with the latter presenting greater selectivity when forming friendships or seeking help. Post-intervention, the number of interactions increased in the help and friendship networks, but differences still remained. Meanwhile, the pre- and post-intervention negative networks presented a series of central nodes that connected the majority of ties, and it was more difficult to distinguish between the two degrees.

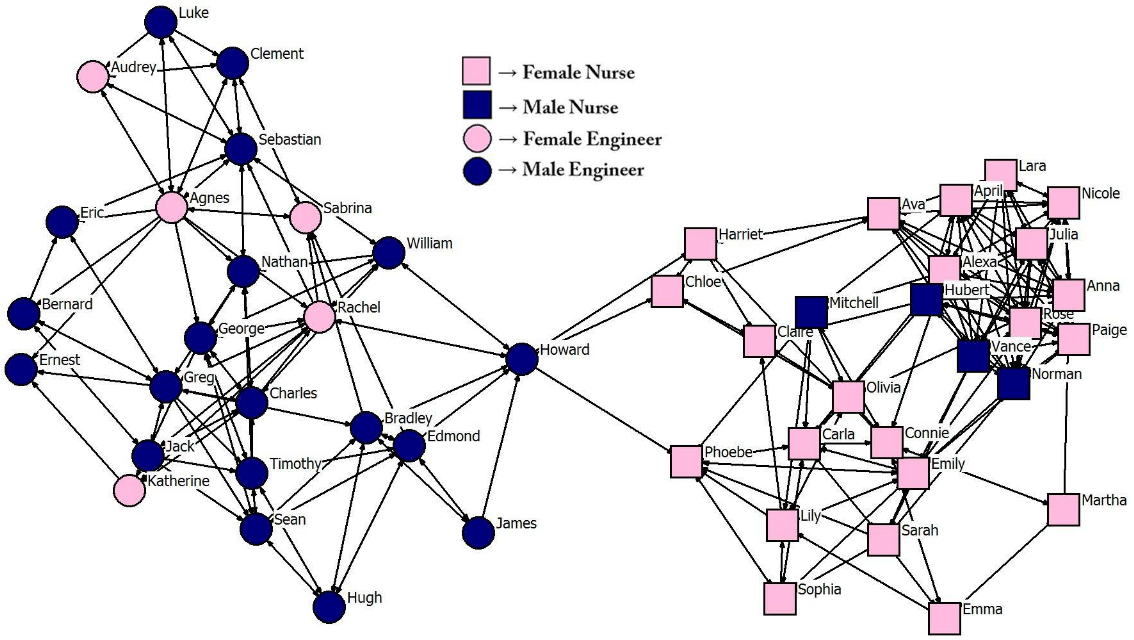

Figure 1. Graph of the pre-intervention friendship network (simulated names).

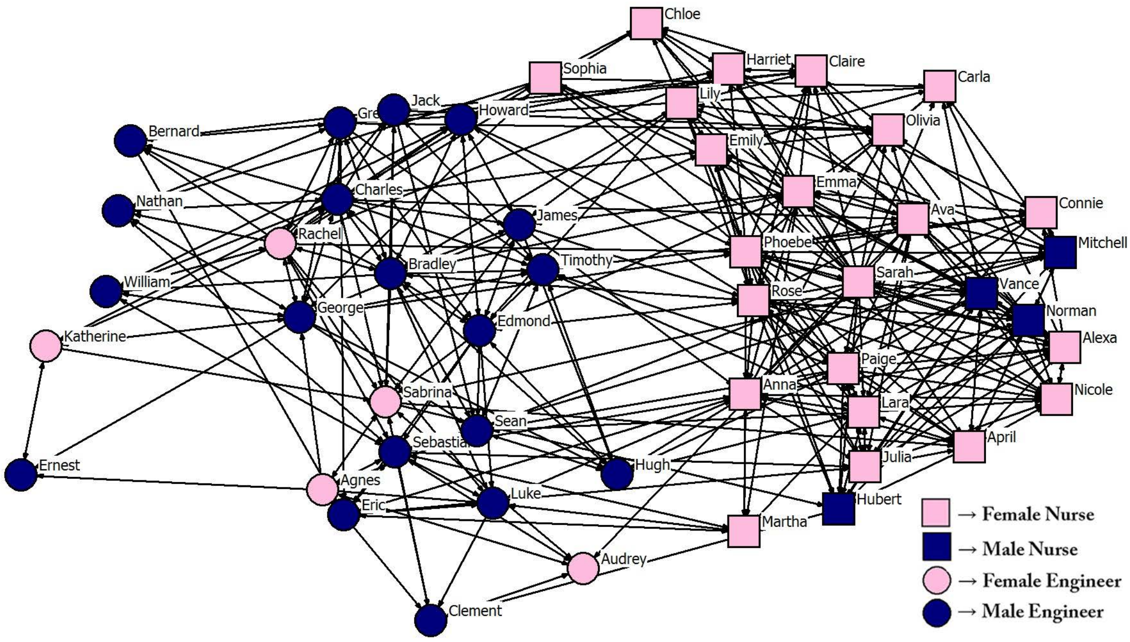

Figure 2. Graph of the post-intervention friendship network (simulated names).

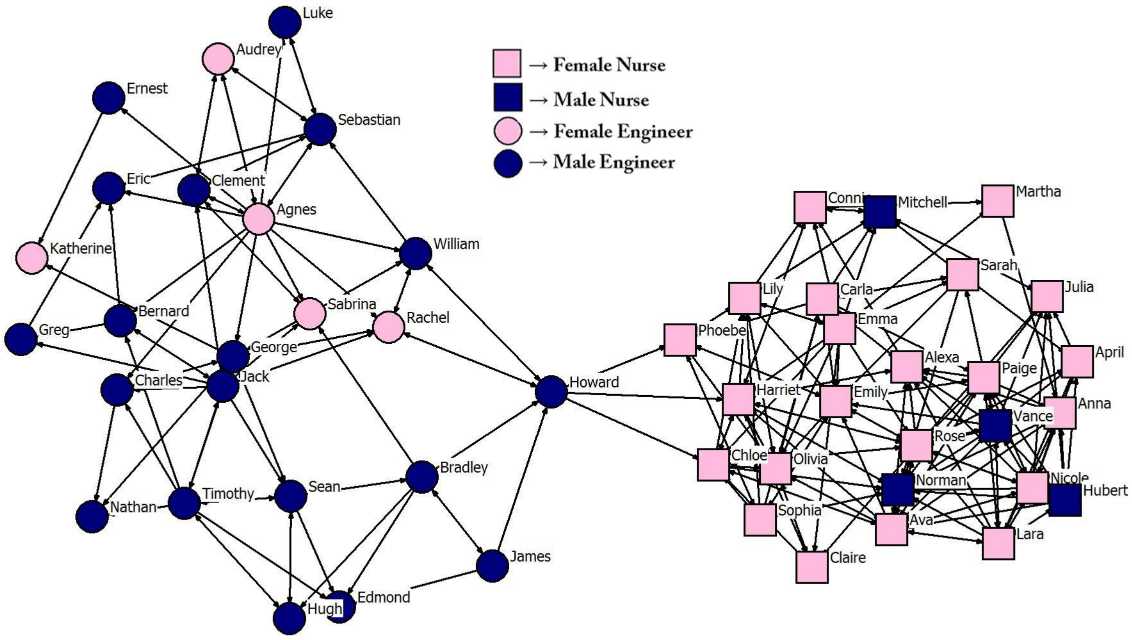

Figure 3. Graph of the pre-intervention help network (simulated names).

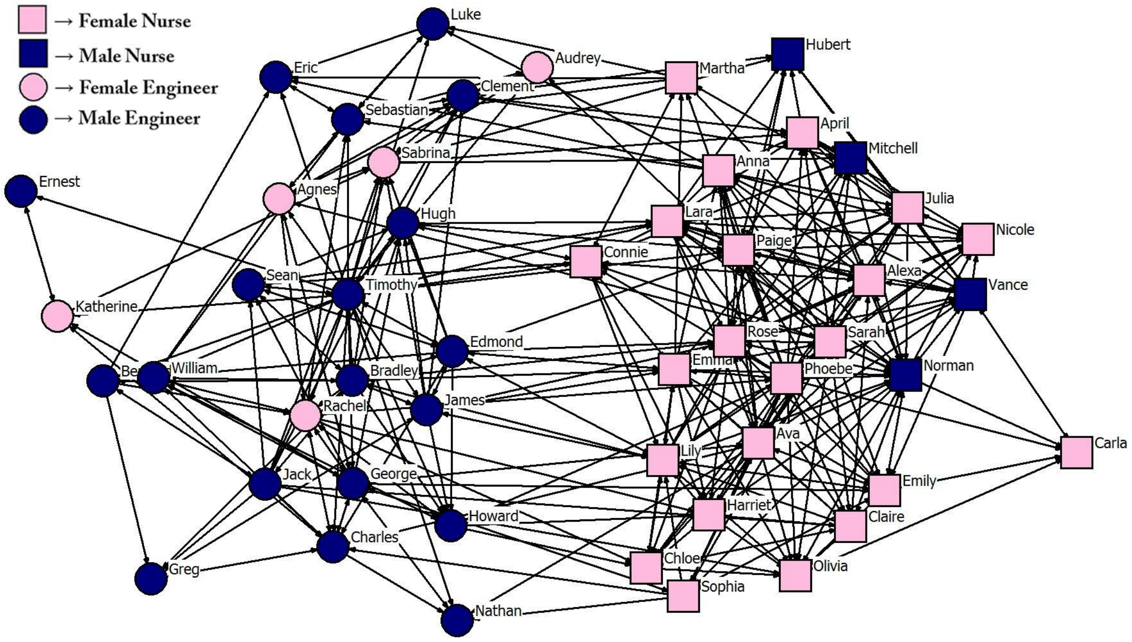

Figure 4. Graph of the post-intervention help network (simulated names).

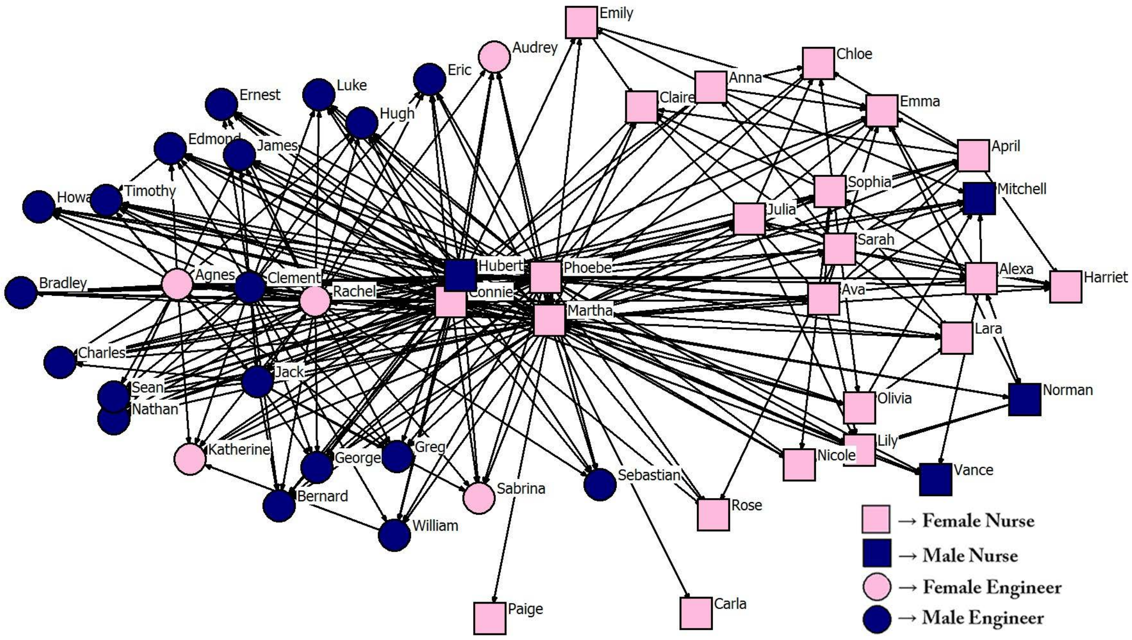

Figure 5. Graph of the pre-intervention negative network (simulated names).

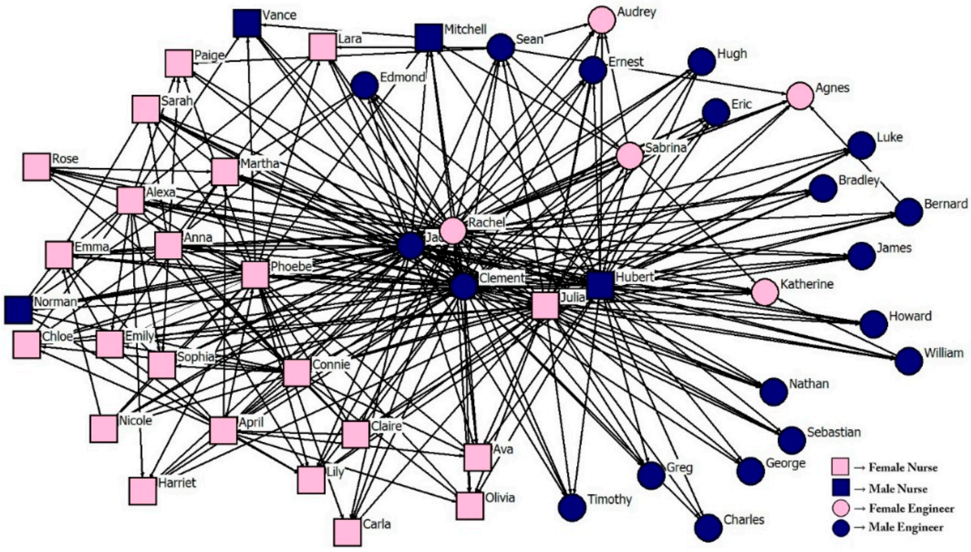

Figure 6. Graph of the post-intervention negativa network (simulated names).

Tables 5 and 6 show the behavioral change in engagement (subscales dedication, vigor, and absorption) and resilience, which was statistically significant. All the variables showed an increase following the educational intervention.

Table 5. Descriptive data and comparison of pre–post-intervention centrality variables (N = 50).

Network	Centrality Variable	Pre-Intervention	Post-Intervention	Student's *t*-Test	Sig.
Help	InDegreeN	0.10 ± 0.05	0.18 ± 0.08	−13.775	<0.001 **
	OutDegreeN	0.10 ± 0.08	0.18 ± 0.12	−4.611	<0.001 **
	EigenvectorN	13.35 ± 15.04	16.87 ± 10.85	−2.761	0.008 **
	BetweennessN	2.78 ± 3.91	2.76 ± 2.89	0.029	0.977
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	BetweennessN	2.78 ± 3.91	2.56 ± 2.08	0.359	0.721
Negative	InDegreeN	0.12 ± 0.05	0.12 ± 0.05	−0.01	0.992
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	EigenvectorN	17.31 ± 10.12	17.63 ± 9.53	−0.248	0.805
	BetweennessN	0.58 ± 2.07	0.70 ± 2.02	−0.338	0.737

Legend: InDegreeN, normalized InDegree; OutDegreeN, normalized OutDegree; BetweennessN, normalized Betweenness; EigenvectorN, normalized Eigenvector. * Correlation is significant at 0.05. ** Correlation is significant at 0.01.

Table 6. Comparison of pre–post-intervention engagement and resilence variables (N = 50).

Variable	Subscale	Pre-Intervention	Post-Intervention	Wilcoxon's *t*-Test	Sig.
Engagement	Dedication	3.0 ± 1.1	3.4 ± 1.3	−2.340	0.019 *
	Vigor	3.1 ± 1.0	3.4 ± 1.2	−2.955	0.003 **
	Absorption	4.0 ± 1.0	4.2 ± 1.2	−2.483	0.013 *
Resilience	Resilience	28.4 ± 4.9	29.8 ± 5.4	−2.239	0.025 *

* Correlation is significant at 0.05. ** Correlation is significant at 0.01.

As regards correlations between the variables of centrality and engagement, we found relationships in the help and friendship networks, but not in the negative network. The help network was statistically significantly related to the three engagement subscales and, in particular, the relationship between BetweennessN and all three engagement subscales presented a level of significance of 0.001. The same behavior was observed between EigenvectorN and the absorption subscale of engagement (Table 7).

Table 7. Correlations between network cantrality variables and engagement (N = 50).

Network	Centrality Variable	Engagement	Correlation	Sig.
Help	BetweennessN	Dedication	0.378 (P)	0.007 **
	InDegreeN	Vigor	0.345 (S)	0.014 *
	OutDegreeN		0.299 (S)	0.035 *
	EigenvectorN		0.289 (S)	0.042 *
	BetweennessN		0.451 (S)	0.001 **
	InDegreeN	Absorption	0.543 (S)	<0.001 **
	OutDegreeN		0.349 (S)	0.013 *
	EingvectorN		0.417 (S)	0.003 **
	BetweennessN		0.414 (S)	0.003 **
Friendship	EigenvectorN	Absorption	0.298 (S)	0.035 *

Legend: InDegreeN, normalized InDegree; OutDegreeN, normalized OutDegree; BetweennessN, normalized Betweenness; EigenvectorN, normalized Eigenvector; P, Pearson's correlation coefficient; S (Spearman's correlation coefficient). * Correlation is significant at 0.05. ** Correlation is significant at 0.01.

Relationships between resilience and the centrality variables of all networks were statistically significant for half of the variables in the help and friendship networks. Both networks presented an association with the normalized OutDegree and normalized Betweenness. In particular, the relationship between the help network and normalized Betweenness presented a significance of 0.001. Once again, no statistically significant relationships were observed for the negative network (Table 8).

Table 8. Correlations between network centrality variables and resilience (N = 50).

Network	Centrality Variable	Spearman's Correlation	Sig.
Help	OutDegreeN	0.297	0.036 *
	BetweennessN	0.445	0.001 **
Friendship	OutDegreeN	0.405	0.004 **
	BetweennessN	0.35	0.013 *

Legend: InDegreeN, normalized InDegree; OutDegreeN, normalized OutDegree; BetweennessN, normalized Betweenness; EigenvectorN, normalized Eigenvector; P, Pearson's correlation coefficient. * Correlation is significant at 0.05. ** Correlation is significant at 0.01.

The only statistically significant relationship observed between the sociodemographic variables (sex, degree, team) and centrality variables for the three networks and academic performance was identified between the team and academic performance (r = 0.283; sig. 0.046).

3. Discussion

In the present study, we conducted an educational intervention based on a cooperative interdisciplinary task carried out by undergraduate nursing and computer engineering students. The intervention was implemented on a management course (nursing) and a semantic modeling course (computer engineering). It was based on mixed working teams where the nursing students had to identify and explain a health demand and the computer engineering students had to formulate a technological solution. Assessment of the task formed part of each participant's final mark for academic performance.

We determined changes in the students' help, friendship, and negative networks through measures of centrality, engagement and resilience. These assessments were performed pre- and post-intervention. As regards the analysis, we correlated centrality, engagement, resilience and sociodemographic variables with the final mark for academic performance in the courses analyzed. Our main finding was that the centrality variables in the negative network did not present any statistically significant changes after the cooperative task intervention. However, we did observe statistically significant results for engagement, resilience and centrality variables in the help and friendship networks, except for Betweenness centrality. We obtained correlations between help and friendship network centrality variables and engagement and resilience. With respect to academic performance, we only found a correlation for the variable "team".

In relation to the educational intervention, we found that the cooperative task generated changes in student behavior. These findings are consistent with those reported in similar studies using team work to help students to acquire subject competencies [55], especially in health education teaching placements [56] and crossdisciplinary workshops in universities about different sustainability issues [1,2]. As regards the study population, we did not find any studies that analyzed a population as disparate as our sample (nurses and computer engineers), although some analyzed distinct but similar populations such as medical and nursing students, using a model of interprofessional problem-based learning to assess the effect on learning (mutual understanding of roles, appreciation, and interprofessional communication and collaboration) [46,57]. In this respect, our study incorporated a novel and risky interdisciplinary perspective, but with considerable success. The technological complexity of health care is rising, and this will mean that professionals in various areas of knowledge must know how to work in teams.

The main contribution of our study is the application of SNA as a quantitative methodology to determine relational behavior change. Our intervention required students to interact in order to carry out an academic task for subsequent assessment. Hence, we generated a need on the basis of which each group of students had to establish relations of interdependence to achieve a shared goal: to complete the academic task and obtain a good academic outcome. The literature indicates that relationships emerge when there is a shared goal or vision, but the results suggest that SNA applied to collaborative learning has not reflected this same diversity of actors and relational ties but instead has solely explored one-mode networks of learners connected by communication-based relational ties and has been limited to a descriptive report of SNA results [40,58]. However, SNA facilitates a structural interpretation of relationships in undergraduate learning and their impact on learning outcomes, which can inform educators in unique ways and improve educational reform [59].

We found no evidence in the literature review of any study that had conducted this type of educational intervention with the variables analyzed, and it is therefore not possible to perform a direct comparison. SNA has been used as an instrument to analyze or explain interdisciplinary behavior in the field of education [33,60]. Our research yielded associations between students and change in friendship and help but not negative networks. Both the friendship and help networks presented significant differences in the centrality variables of InDegree, OutDegree, and Eigenvector, suggesting that cooperative work with a shared goal exerts the most influence on the number of ties received and emitted and the capacity for influence in the classroom. By contrast, the negative attitude of avoiding a peer, measured by means of the negative network (which of the following classmates do you avoid interacting with? [30]), did not lead to changes following our educational intervention. One explanation for this may be that a negative perception of someone is not a barrier to working together in a team when there is a shared goal which requires interaction. Put more simply, you might not like working with someone, but when you have to in order to achieve a goal, you are capable of working efficiently with the people around you. These findings are in line with those reported by Wang et al. (2015), who proposed a machine learning algorithm for predicting positive and negative relationships in social networks. They found that both types of relationships, which include support and opposition, and trust and suspicion, are present in all networks, and that research in this context could help us to understand the formation of relationships and network structures. In turn, this would enable us to optimize them in order to achieve shared goals.

As regards the significant change in the help and friendship networks, this may be associated with two factors. First, the cooperative task intervention enhanced network contacts, because members shared experiences, frustrations, and achievements, furthering cohesion. In this respect, our findings are consistent with those of studies by Dreier-Wolfgramm et al. (2018), who showed that their problem-based learning intervention with nursing and medical students had increased each participant's level of knowledge through contact with the others and had exerted a positive effect in terms of mutual appreciation [57]. Second, cooperative work enhanced the students' self-esteem because it helped them to clarify doubts, solve problems, and achieve their goals. In other words, the intervention generated friendly sociability. An earlier study with adolescent students found that self-esteem heightened sociability, reduced symptoms of depression and sadness, and increased the number of ties with other students [37].

The graphical representations of the networks show that the number of contacts increased over the course of the intervention and that the students mainly formed groups within their discipline rather than according to sex. Thus, nursing students interacted more with each other, as did computer engineering students. This could be explained by homophily, the tendency of individuals to interact with others similar to themselves [46]. In this context, similarity would refer to the same team, race, sex or degree course. In our study, nursing students shared a common context and language in terms of health, while computer engineering students shared a context more related to technology. Previous studies of networks have found that the main variable associated with the closest ties in a class of nursing students was sex [41]. However, in this study, it was not possible to extrapolate the data in the graphics as regards sex because our sample was not homogeneous in terms of the number of men and women on each of the degree courses.

Our findings indicate that cooperative work significantly changed the psychological variables analyzed, which is consistent with the results of previous studies. With regards to university student engagement, authors such as Persky (2012) observed this change in team-based learning in a foundational pharmacokinetics course [61]. Similarly, Promo et al. (2018) suggested that incorporating tasks based on interdependence can promote engagement in small teams as well as in an entire class of undergraduate students [62]. In relation to resilience, our study highlights its role in helping university students to overcome adversity and learn from experience. Thomas and Asselin (2018) advocated strengthening resilience in order to improve clinical placements and promote support, education, and reflection in the context of university clinical education [63].

The post-intervention results obtained for the three subscales of engagement were 3.4 ± 1.3 for dedication, 3.4 ± 1.3 for vigor, and 4.2 ± 1.3 for absorption, which differ slightly from those reported in similar studies. One study conducted with 90 nursing degree students obtained means of 4.4 for dedication, 3.08 for vigor, and 3.21 for absorption [46]. Another study conducted with 134 nursing degree students obtained means of 4.82 for dedication, 3.13 for vigor, and 2.98 for absorption [41]. In both cases, it can be seen that the subscale of dedication obtained the highest means. However, in our study, the subscale of absorption (an individual's capacity to be totally focused on work) obtained the highest mean. One explanation for this finding might be that since our students were studying two different degree courses taught on different campuses, they had to overcome the obstacle of geographical distance, optimizing the time invested in work without distractions.

The result obtained for resilience post-intervention was 29.82, similarly to other studies on nursing students, with results between 28.6 and 34.7 [41,46,64]. Achieving a high degree of resilience is important because it is associated with experiencing less psychological distress and, above all, less academic burnout [65]. This may be explained by the high levels of stress experienced during university studies, which could diminish undergraduate nursing and computer engineering students' preparedness to exercise their profession. Previous studies of nursing students have found that burnout during nursing education predicts lower occupational preparedness and future clinical performance, together with high stress levels in new students [65,66].

As regards associations between the variables of centrality and engagement, we observed numerous statistically significant correlations in the help and friendship networks, with the exception of Betweenness. Similarly, Fernández-Martínez et al. (2017) observed the same behavior in 48 first-year nursing students [41]. Relationships between the variables of centrality in the friendship and help networks were associated with resilience, in contrast to the findings of previous studies with nursing students, in which resilience was only related to the friendship network [41]. In addition, it should be noted that we found relationships between the negative network and engagement or resilience, suggesting that negative ties involving enduring and recurrent negative judgements and feelings do not prevent actors from performing a task. Other researchers have claimed that workplace ties are "friendly", "positive", or at least "neutral", and that although occasional upsets may arise, creating temporary discontent with individual or team achievements, positive ties transcend negative ones, canceling the latter's effects on the actors [32].

Lastly, academic performance did not correlate with any variable except the team to which each participant belonged. One explanation for this result is that the teams obtained different marks and, therefore, students on the same team would have similar marks because the team mark contributed to individual marks. This was a surprising finding because previous studies on nursing students have reported that a better result for the three subscales of engagement was associated with better academic performance [67]. Another study found a similar result for adolescents, concluding that promoting engagement in adolescence would lead to better performance in high school [14]. The means obtained for the engagement subscales might have been affected by student motivation. Since our students were studying different degree courses, they did not know each other and, consequently, could not select their own teams, which were assigned by the researchers. This may have influenced engagement, although in a positive sense via the formation of new networks. In turn, students with greater OutDegree centrality tended to present a higher level of engagement [13]. Social prestige as measured by students' Eigenvector has been associated with better academic outcomes in some—but not all—studies [12,68]. In our study, performance in the group task did not present any statistically significant relationship [69]. The importance of the results obtained is not only in the replicability of the interventions in different educational contexts, but also in their sustainability over time, to be able to respond to the problems and demands generated by the students. These conflicting results in the literature indicate the potential importance of social prestige arising from the formation of social networks. In the recent literature, as a measure of social capital, the Eigenvector has been positively associated with academic outcome, as has InDegree [70]. Nevertheless, none of the networks obtained in our study presented any correlation with academic performance, possibly because we used the final mark as our measure of performance, which included other criteria in addition to the cooperative task, such as multiple-choice test results and classroom participation.

Our study presents several limitations. First, we did not include more variables that might have better elucidated the results obtained. Secondly, we did not include a control group undergoing a similar experience in a different form, and it was therefore not possible to compare differences between a control and experimental group. However, the inclusion of all the students and the creation of similar teams generated added value when interpreting the data. Another limitation was the correlation only between performance and equipment. This should be considered for future research so that the yield variable includes evaluations of relational competencies. This study did not aim to generalize or prove cause–effect relationships but to test some innovative and initial hypotheses that will be further tested at a larger scale in a future study with other degrees.

4. Conclusions

One of the most important premises of the context of high education is that the focus of the teaching–learning processes is oriented to the demands of society and developed in a sustainable way. In our case of health sciences and computer engineering, society increasingly demands that we complement and understand each other. That is, the nursing professional captures the demands of the patients and must be competent to evaluate the cost–benefit of the proposals to meet their needs. On the other hand, the evidence demonstrates that technological applications can be useful for patient care and save costs, but nurses are not trained to make those proposals. Computer engineers do have the core of knowledge to provide technological solutions.

This way of understanding, through collaborative work between different faculties, how the university context approaches social reality, is a useful way to propose innovative and sustainable solutions in teaching–learning.

In the intervention carried out in this research, students showed that they were able to work in a network, although their areas of knowledge were very different—nursing and computer engineering.

The behavior of nursing and computer engineering students following a cooperative task intervention changed significantly for all network centrality variables in the help and friendship, but not negative, networks.

In addition, we graphically represented these network changes, showing that ties were basically formed between students taking the same degree course.

We observed a significant change in engagement and resilience following the cooperative interdisciplinary task intervention.

We analyzed centrality, engagement, resilience, and sociodemographic variables and academic performance and found that many of the centrality variables in the help and friendship networks were associated with engagement and resilience. However, academic performance did not correlate with any variable analyzed except the team to which the students belonged.

As a practical application, teachers should identify engagement, resilience, and networks in order to improve the communication skills necessary to carry out cooperative tasks, an essential aspect of the students' future work.

Currently, the world is conceptualized as global. In this sense, we must also conceptualize the work between professionals from different fields, different organizations, and different countries as collaborative and global, given that the pace of society demands it, and technologies allow it.

We believe our analysis of an interdisciplinary teaching intervention provides some valuable evidence that can suggest future strategies for use by university teachers to develop, in students, important skills needed by professionals, in the context of a sustainable lifelong learning framework.

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