

Article

Teaching Sustainability in European Higher Education Institutions: Assessing the Connections between Competences and Pedagogical Approaches

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Abstract: There has been considerable progress in the incorporation of sustainable development (SD) into higher education institutions' curricula. This has included research on competences for SD and pedagogical approaches used; however, there has been limited research on the connection between how pedagogical approaches are used and how they may develop sustainability competences. A survey was developed, based on the 'connecting sustainable development pedagogical approaches to competences' framework, to investigate sustainability being taught, sustainability competences developed, and pedagogical approaches used in European higher education institutions. The survey was sent to a database of more than 4000 contacts from which 390 complete responses (9.80%) were obtained. The results show that the social dimension was the least addressed at 18% of responses, while the economic, environmental, and cross-cutting dimensions were addressed almost equally. The correlation analyses showed a relation between the contribution to sustainability and the strength of competences, and between the strength of competences and the strength of pedagogical approaches. The results from the survey helped to update the theoretical framework, which provides a more precise perspective on how sustainability competences can be better developed in class, and how to better develop all the sustainability competences.

Keywords: higher education for sustainable development; European higher education institutions; competence; pedagogy; STAUNCH[®]

1. Introduction

There has been considerable progress in the incorporation of sustainable development (SD) into the curricula of higher education institutions (HEIs) [1–4], where European HEIs have been leaders [5–7]. This has included research on competences for SD [8,9], and how to develop such competences through pedagogical approaches [10,11]); however, there has been limited research on the connection between how courses are delivered (pedagogical approaches) and how they may affect sustainability competences.

During the last ten years, there has been a growing body of literature addressing and discussing the definition and use of competences for SD. Competences are a way of describing desired educational outcomes [12–14]. They include cognitive, functional, ethical, and personal dimensions [15] and link complex knowledge, skills, and attitudes [16]. Lists of competences relating to education for sustainable development and their use have been proposed by several authors in recent years. Wiek, Withycombe, and Redman [16] proposed five overall competence groups—systems-thinking, anticipatory, normative, strategic, and interpersonal competences. Rieckmann [17] suggested the following 12 competences—systemic thinking and handling of complexity, anticipatory thinking, critical thinking, acting fairly and ecologically, cooperation in (heterogeneous) groups, participation, empathy and change of perspective, interdisciplinary work, communication and use of media, planning and realizing innovative projects, evaluation, and ambiguity and frustration tolerance. Lambrechts et al. [9] identified six competences—responsibility, emotional intelligence, system orientation, future orientation, personal involvement, and ability to take action. Lozano et al. [18] proposed 12 competences—systems thinking; interdisciplinary work; anticipatory thinking; justice, responsibility, and ethics; critical thinking and analysis; interpersonal relations and collaboration; empathy and change of perspective; communication and use of media; strategic action; personal involvement; assessment and evaluation; and tolerance for ambiguity and uncertainty.

A combination of different pedagogical approaches is needed to develop SD competences [19], which allows students to benefit from different learning processes [20]. Pedagogy is defined as “the art or science of teaching” [21]. The choice of pedagogical approach depends on the pedagogical and educational goals and the specifics of the situation (regarding students, teachers, or the learning environment) [22]. A variation in pedagogical approaches is important to address the diversity of students (e.g., gender or cultural background) [19,20,23]. Nonetheless, alternative pedagogical approaches to traditional lectures have not yet been widely utilized in higher education to convey sustainability content [24,25].

In recent Education for Sustainable Development (ESD) literature, there have been some attempts to collect and analyse relevant SD pedagogical approaches [13,26,27]. For example, Ceulemans and De Prins [23] proposed a range of student-activating methods (e.g., videos, brainstorming, case studies, teamwork, jigsaw, assignments, problem-oriented education, oral presentations, and project learning). Lambrechts et al. [9] identified a number of pedagogical approaches to develop SD competences including the Socratic method, group discussion, roleplay, group or personal diaries, brainstorming, peer assessment, internships, solving real community problems, outdoor education, bibliographic research, problem analysis, value clarification, case studies, and concept mapping. Cotton and Winter [26] suggested the following pedagogical approaches: roleplay and simulations; group discussions; stimulus activities (watching a video or looking at photos, poems, or newspaper extracts to initiate reflection or discussion); debates; critical incidents (students are given an example and asked what they would do, what they could do, and what they should do); case studies; reflexive accounts; personal development planning; critical reading and writing; problem-based learning; fieldwork; and modeling good practice. Lozano et al. [18] proposed twelve pedagogical approaches divided in three groups: (1) Universal—broadly applicable pedagogies that have been used in many disciplines and contexts (case studies, interdisciplinary team teaching, lecturing, mind and concept maps, and project- and/or problem-based learning); (2) Community and social justice—pedagogies developed specifically for use in addressing social justice and community-building (community service learning, jigsaw/interlinked teams, participatory action research); and (3) Environmental education—pedagogies emerging from environmental sciences and environmental education practices (eco-justice and community, place-based environmental education, supply chain/life-cycle analysis, and traditional ecological knowledge).

In spite of the aforementioned efforts, there has been limited efforts combining pedagogical approaches and competences, such as the case-based approaches for sustainability science [28]; the effectiveness of different pedagogical approaches in engineering courses for improving student awareness of sustainability [13]; the connections between pedagogical approaches and knowledge domains (declarative, procedural, effectiveness, and social knowledge); and four key competences (systems thinking, foresight, collaboration, and change-agent skills) in the context of primary and secondary education [29]. Lozano et al. [18] proposed a theoretical framework specifically designed at connecting competences to pedagogical approaches, see Figure 1, where a green cell represents a pedagogical approach that usually contributes to the competence, whilst a yellow cell represents a pedagogical approach that is likely to contribute to the competence. The proposed framework that connects the course aims to deliver in ESD by highlighting the connections between pedagogical approaches and competences. The framework is aimed at helping educators in creating and updating their courses to provide a more complete, holistic, and systemic sustainability education to future leaders, decision makers, educators, and change agents.

The paper is structured in the following way: Section 2 presents the methods, Section 3 presents the results and discussion, and Section 4 presents the conclusions.

Competence	Pedagogy													
	Universal					Community and social justice				Environmental Education				
	Case studies	Interdisciplinary team-teaching	Leaching	Mind and concept maps	Project and/or Problem-based learning	Community Service Learning	Jigsaw / Interlinked Teams	Participatory Action Research	Eco-justice and community	Place-Based Environmental Education	Supply chain/ Life Cycle Analysis	Traditional ecological knowledge		
Systems thinking	Green	Yellow	Yellow	Green	Green	White	White	White	Green	Green	Green	Yellow	White	White
Interdisciplinary work	White	Green	White	Yellow	Yellow	Yellow	Yellow	Yellow	White	White	Green	White	White	White
Anticipatory thinking	Yellow	White	White	White	White	White	White	White	White	White	White	White	White	White
Justice, responsibility, and ethics	Yellow	White	Yellow	White	White	White	White	White	Green	Green	Yellow	White	White	White
Critical thinking and analysis	Green	White	White	Yellow	White	White	White	White	White	Green	White	White	White	White
Interpersonal relations and collaboration	Yellow	Yellow	White	White	White	Green	Green	Yellow	White	Yellow	Yellow	White	White	White
Empathy and change of perspective	Yellow	White	Yellow	White	White	White	Green	White	Green	Yellow	Yellow	White	White	White
Communication and use of media	Yellow	White	White	Yellow	White	White	Green	White	White	White	Yellow	White	White	White
Strategic action	Yellow	White	Yellow	White	Green	Green	Green	White	White	Yellow	Yellow	White	White	White
Personal involvement	White	White	White	Yellow	Green	Green	Green	White	White	Yellow	Yellow	White	White	White
Assessment and evaluation	Yellow	White	Yellow	White	White	White	White	White	Yellow	Yellow	Green	White	White	White
Tolerance for ambiguity and uncertainty	Yellow	Yellow	White	White	Yellow	White	White	White	White	White	White	White	White	White

Figure 1. Framework connecting sustainable development pedagogical approaches to competences. The green cells indicate a high likelihood of addressing the competence, the yellow cells indicate that the approach may address it, and the white cells indicate that the approach does not address the competence.

2. Methods

A survey was developed to investigate teaching sustainability in European higher education institutions. The survey consisted of five sections:

1. Background questions, about the respondent's HEIs, the respondent characteristic, and her/his teaching;
2. Self-assessment of sustainability criteria taught, based on the Sustainability Tool for Assessing UNiverities Curricula Holistically (STAUNCH[®]) criteria divided into economic, environmental, social, and cross-cutting themes (see Reference [3] for more information), and on a four scale (not covered, mentioned, described, and discussed);
3. Pedagogical approaches used, on a five scale (never, seldom, from time to time, often, and all the time);
4. Competences covered in the course, on a five scale (not at all, mentioned, discussed, complementary to the course, and integral to the course);
5. Approaches to develop learning (types of learning)—see Reference [30]—on a five scale (never, seldom, from time to time, often, and all the time); and
6. Open-ended questions about the incorporation of sustainability in courses.

This paper focuses on sections one to four. The survey was applied using the online survey tool SurveyMonkey[®]. The survey was open for three months from September to December 2018.

The survey was sent to a database of 4099 contacts in Europe obtained from conference participation, articles published on sustainability in leading HESD journals, and personal contacts. In addition, 44 anonymous links were received after promoting the survey via social media (e.g., LinkedIn[®]). Three reminders were sent out. From the total list of emails, 164 emails bounced back, 1962 opened the email invitation (48.9%), and 1822 did not open it (45.4%). From the total database, 390 complete responses (9.80%) were obtained for the assessment, pedagogical approaches, and competences questions.

The contribution to sustainability was analysed using STAUNCH[®] (to obtain information about the use and licensing of STAUNCH[®], please refer to www.org-sustainability.com), which was developed with the aim of holistically and systematically assessing how university curricula contribute to SD (i.e., the SD issues' coverage, depth, and breadth) [3,31]. In previous research, the assessment has been on course descriptors [3,32,33]. STAUNCH[®] has been used by universities including Cardiff University [3,31,33], Tecnológico de Monterrey [32], the Georgia Institute of Technology [34], and the University of Leeds [35].

STAUNCH[®] is based on two combined equilibria: Firstly, cross-cutting theme issues (such as holistic thinking and SD statement, see Table 1), which integrate economic, environmental, and social dimensions; and secondly, the SD contribution, which is calculated using formulae that balance the four dimensions, taking into consideration their strengths. These are assessed using the following levels: 0, when an issue is not mentioned; 1, when the issue is mentioned but there is no further explanation given on how it is addressed; 2, when the issue is mentioned and there is a brief description of how it is addressed; and 3, when there is a comprehensive and extensive explanation on how the issue is addressed. The level of contribution is indicated as the 'breadth' and 'depth' of coverage of SD issues (the higher the contribution's value the better the balance amongst economic, environmental, social, and cross-cutting dimensions). Additionally, STAUNCH[®] provides the 'strength' of the course, which is the average of the levels assigned. Table 2 provides an illustration of this, as well as the qualitative level.

Table 1. STAUNCH[®] curricula contribution to sustainable development assessment criteria.

Economic	Environmental	Social
GNP, Productivity <ul style="list-style-type: none"> • Resource use, exhaustion (materials, energy, water) • Finances and SD • Production, consumption patterns • Developmental economics 	<ul style="list-style-type: none"> • Policy/Administration • Products and services (inc. transport) • Pollution/Accumulation of toxic waste/Effluents • Biodiversity • Resource efficiency and eco-efficiency • Global warming, Emissions, Acid rain, Climate change • Resources (depletion, conservation) (materials, energy, water) • Desertification, deforestation, land use • Ozone depletion • Alternatives 	<ul style="list-style-type: none"> • Demography, Population • Employment, Unemployment • Poverty • Bribery, corruption • Equity, Justice • Health • Social cohesion • Education • Diversity • Cultural diversity (own and others) • Labour, Human rights
Cross-cutting themes		
People as part of nature/Limits to growth <ul style="list-style-type: none"> • Systems thinking/application <ul style="list-style-type: none"> • Responsibility <ul style="list-style-type: none"> • Governance • Holistic thinking • Long-term thinking • Communication/Reporting <ul style="list-style-type: none"> • SD statement • Disciplinarity • Ethics/Philosophy 		

Source: [3,31].

Table 2. Sustainable development (SD) contribution and qualitative levels.

Hypothetical Degree	Contribution	Level
MT001	0.00	None
MT101	0.01–0.67	Very low
MT201	0.67–1.29	Low
MT301	1.30–1.99	Medium
MT401	2.00–3.50	High
MT501	>3.50	Very high

Source: [3,31].

It should be noted that, for the analyses, two new variables—strength of the competences and strength of the pedagogical approaches—were created. These were calculated by dividing the sum of the all the items divided by the number of items that were considered to be ‘seldom’, ‘from time to time’, ‘often’, and ‘all the time’ for the pedagogical approaches used, or ‘mentioned’, ‘discussed’, ‘complementary to the course’, and ‘integral to the course’ for the competences.

The responses were analyzed using descriptive statistics, the Friedman test to rank the competences and pedagogical approaches (at $p < 0.01$ meaning that the null hypothesis is rejected at a probability level of 99%), and Spearman correlations. These were done using IBM SPSS 24 [36].

Limitations of the Methods

The internal validity of this research might have been limited by the survey, which may suffer from a non-fully random sample and of potential issues of self-assessment (where the respondents might not have fully understood the question). STAUNCH[®] is aimed at having enough indicators to cover sustainability, yet be manageable; however, there might have been problems of interpretation of the criteria, reliability issues due to self-assessment, or problems of understanding the terms in another language. The number of respondents (390) may not allow a complete generalization to sustainability teaching in all European (or worldwide) countries. The generalizability of the results may be limited

to the application of a non-random sampling procedure with additional input from personal contacts and ‘snowballing’ methods. A non-response bias may be caused by people who refused to answer or complete the survey.

3. Results and Discussion

The respondents were 42.42% females, 56.56% males, with four respondents preferring not to answer this question. Most of the respondents were from a traditional (research intensive) university (74.55%), while teaching in a non-research (vocational) university college (7.20%), a college or polytechnic equivalent (5.66%), the application of (3.60%), further education institution (1.29%) and other institutions (5.91%) were also acknowledged. A non-response bias may be caused by people who refused to answer or complete the survey (19.79%), Spain (14.91%), Sweden (10.54%), Netherlands (5.66%), United Kingdom (5.40%), Finland (4.63%), Portugal (4.63%), Germany (3.60%), Austria (2.83%), Denmark (2.57%), Turkey (2.57%), France (2.31%), Czech Republic (2.06%), Greece (2.06%), Serbia (2.06%), Switzerland (1.54%), Belgium (1.29%), Lithuania (1.29%), Norway (1.29%), Ireland (0.77%), Slovenia (0.77%), Croatia (0.51%), Hungary (0.51%), Iceland (0.51%), Romania (0.51%), Albania (0.26%), Cyprus (0.26%), Malta (0.26%), Slovakia (0.26%), and no answer (1.54%).

Based on the STAUNCH[®] calculations, the contribution to sustainability was, on average, 5.74 with a standard deviation of 7.08. The average strength was 1.88 with a standard deviation of 0.40. The social dimension was the least addressed with 18%, while the other dimensions (economic, environmental, and cross-cutting) were addressed almost equally between 27% and 28%. This was mainly due to the social issues being mentioned rather than described or discussed.

The respondents indicated that the competences covered in their teaching were, in descending order and separated in quartiles using a Friedman significance test (see Figure 2):

First quartile: Critical thinking and analysis (8.41); inter-disciplinary work (7.92);
 Second quartile: Systems thinking (7.39); interpersonal relations and collaboration (7.04); assessment and evaluation (6.90);
 Third quartile: Strategic action (6.58); anticipatory thinking (6.21); personal involvement (5.97); and
 Fourth quartile: Communication and use of media (5.67); justice, responsibility, and ethics (5.59); empathy and change of perspective (5.44); and tolerance for ambiguity and uncertainty (4.88).

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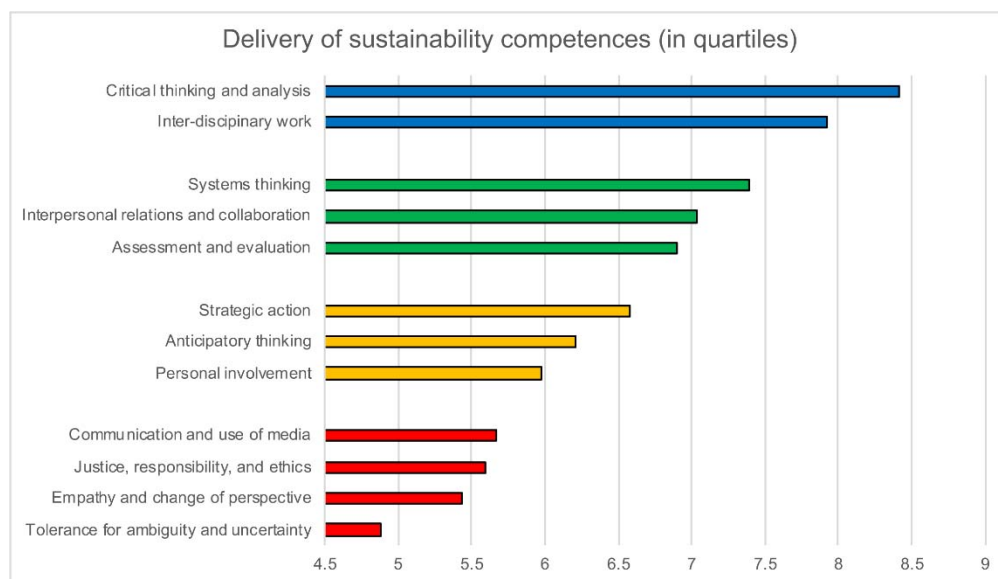


Figure 2. Ranking of the sustainability competences covered (according to the survey results).

- First quartile: Critical thinking and analysis (8.41); inter-disciplinary work (7.92);
- Second quartile: Systems thinking (7.39); interpersonal relations and collaboration (7.04); assessment and evaluation (6.90);
- Third quartile: Strategic action (6.58); anticipatory thinking (6.21); personal involvement (5.97);

On average, 9.67 competences were covered, with 184 respondents covering 12, 34 covering 11, 41 covering 10, 18 covering 9, 17 covering 8, 23 covering 7, 22 covering 6, 19 covering 5, 14 covering 4, 9 covering 3, 10 covering 2, and 37 covering only 1 competence. The average strength of the competences was 2.95 with a standard deviation of 0.59, a maximum of 4, and a minimum of 1. The respondents indicated that the use of pedagogical approaches in their courses to be, in descending order and divided in quartiles using a Friedman significance test (see Figure 3):

- First quartile: lecturing (9.91); case studies (9.52); project- or problem-based learning (9.09);
- Second quartile: inter-disciplinary team teaching (7.45);
- Third quartile: supply chain/life-cycle analysis (6.91); mind and concept maps (6.21); participatory action research (6.01); traditional ecological knowledge (5.89); and
- Fourth quartile: jigsaw/interlinked teams (4.49); place-based environmental education (4.46); community service learning (4.46); and eco-justice and community (3.59).

On average, there were 8.07 pedagogical approaches used per course, with 82 respondents using 12, 27 using 11, 26 using 10, 31 using 9, 46 using 8, 52 using 7, 43 using 6, 42 using 5, 18 using 4, 13 using 3, 8 using 2, and 2 only using 1 pedagogical approach. The average strength of the pedagogical approaches was 2.43 with a standard deviation of 0.76, a maximum of 4, and a minimum of 1.

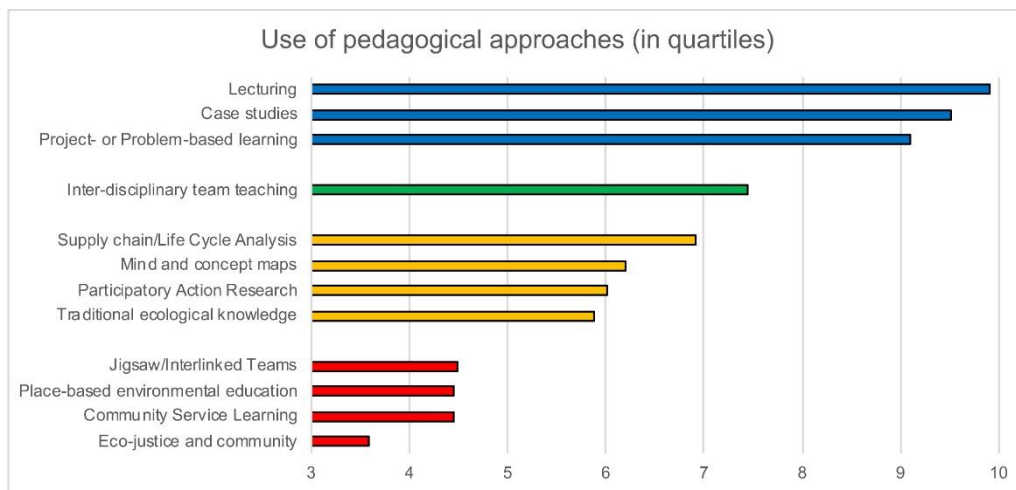


Figure 3. Ranking of the pedagogical approaches used (according to the survey results).

The range of the average results of the competences was narrower (from 1.56 to 2.65) than for the pedagogical approaches one (from 0.53 to 3.01). This implies that there is a better coverage of competences than the use of pedagogical approaches.

The ranking of sustainability competences showed that critical thinking, analysis, and interdisciplinary work were the most most widely covered, followed by systems thinking, interpersonal relations and collaboration, and assessment and evaluation. These competences tend to be more discussed in the literature [66,77], which may explain their recognition and coverage. However, the other competences tend to be less discussed in the literature, which should be noted that the range of the competence coverage is 0.53 (5.88–4.88–4.18). Therefore, this is a competence that is considered by important and all should be covered.

The pedagogical approaches ranking showed that lecturing, case studies, and project- or problem-based learning were considered to be the most widely used (since they have been the most widely used teaching method for many years). However, lecturing and case studies were the third and second effective ways to develop sustainability competences, the other supply chain/life cycle/anal. cycle analysis. The other pedagogical approaches (project- or problem-based learning, interdisciplinary team teaching, mind and concept maps) are some of the most effective ways to develop the competences. From the social community and social justice pedagogical approaches, the most effective one was community service and learning, followed by jigsaw/interlinked teams. From the environmental education ones, the most effective one was eco-justice and community, followed by

develop the competences. From the social community and social justice pedagogical approaches, the most effective one was community service and learning, followed by jigsaw/interlinked teams. From the environmental education ones, the most effective one was eco-justice and community, followed by place-based environmental education, traditional ecological knowledge, and finally supply chain/life-cycle analysis (the one with the least likeliness to develop competences after lecturing). The range of pedagogical approaches was much higher than the competence ones, with a difference of 6.32 between the maximum and the minimum. The pedagogical approaches on the fourth quartile are not highly used (jigsaw/interlinked teams, place-based environmental education, community service learning, and eco-justice and community); however, they have a good potential to develop the competences, especially eco-justice and community. This shows that, although some pedagogical approaches have good potential to develop sustainability competences, it is necessary to combine them to most effectively cover all the competences.

Correlation Analyses

A correlation analysis was done between the contribution to sustainability, strength of competences, and the strength of pedagogical approaches. The results are presented in Table 3. All the results were significant at $p < 0.01$. The results show a good correlation between strength of competences and contribution (0.494), and strength of pedagogical approaches (0.438). The correlation between the strength of pedagogical approaches and contribution was lower (0.233). These insights were used to generate the model in Figure 4, based on the theory that sustainability competences are covered through pedagogical approaches—see [10,11]. This analysis shows that the correlations between (1) the competences and sustainability, and (2) the pedagogical approaches and the competences are higher than those between sustainability and the pedagogical approaches.

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Table 3. Spearman correlations between strength of competences, strength of pedagogical approaches, and contribution to sustainability.

Table 3. Spearman correlations between strength of competences, strength of pedagogical approaches, and contribution to sustainability.

	Strength of Competences	Strength of Pedagogical Approaches	Contribution to Sustainability
Strength of competences	1	0.494 **	0.438 **
Strength of pedagogical approaches	0.494 **	1	0.233 **
Contribution to sustainability	0.438 **	0.233 **	1

** Correlation is significant at the 0.01 level (2-tailed).

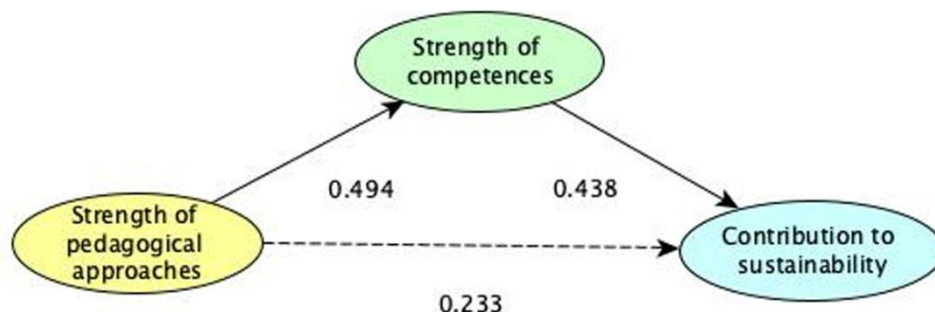


Figure 4. Correlations between strength of competences, strength of pedagogical approaches, and contribution to sustainability model.

From the results in Table 3 and Figure 4, it was decided to carry out more detailed correlations between the competences and the contribution to sustainability, and the pedagogical approaches and the competences:

A correlation analysis was carried out between the sustainability STAUNCH® dimensions (economic, environmental, social, and cross-cutting themes) and the competences. The results obtained were between 0.289 and 0.654. These were transformed to a three-level scale (see Figure 5): 0 to 0.2 (inclusive), labeled as ‘unlikely’ (white cells in the figure); 0.2 to 0.4 (inclusive), labeled as ‘maybe’ (yellow cells in the figure); and 0.4 to 0.66, labeled as ‘likely’ (green cells in the figure). The

Figure 4. Correlations between strength of competences, strength of pedagogical approaches, and contribution to sustainability model.

From the results in Table 3 and Figure 4, it was decided to carry out more detailed correlations between the competences and the contribution to sustainability, and the pedagogical approaches and the competences.

A correlation analysis was carried out between the sustainability STAUNCH® dimensions (economic, environmental, social and cross-cutting themes) and the competences. The results obtained were between 0.289 and 0.554. These were transformed to a three-level scale (see Figure 5): 0 to 0.2 (inclusive), labeled as 'unlikely' (white cells in the figure); 0.2 to 0.4 (inclusive), labeled as 'maybe' (yellow cells in the figure); and 0.4 to 0.6, labeled as 'likely' (green cells in the figure). The analysis showed the number of 'unlikely', 'maybe', and 'likely' cases per sustainability dimension: Economic (5 maybe and 7 likely); environmental (4 maybe and 8 likely); social (2 maybe and 10 likely); and cross-cutting themes (12 likely).

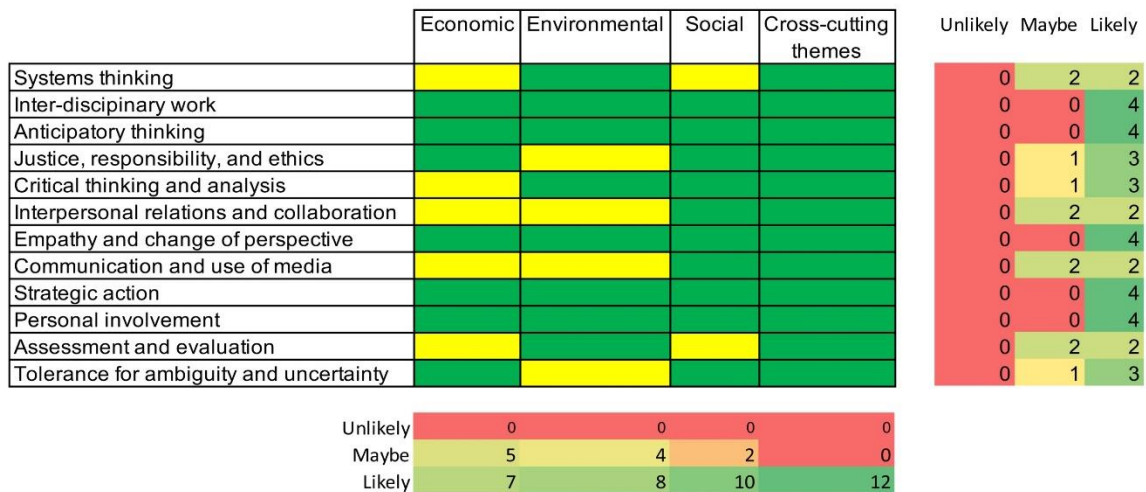


Figure 5. Correlation between the sustainability STAUNCH® dimensions and competences.

The analysis showed the number of 'unlikely', 'maybe', and 'likely' cases per competence: Systems thinking (2 maybe and 2 likely); inter-disciplinary work (2 maybe and 2 likely); anticipatory thinking (2 maybe and 2 likely); justice, responsibility, and ethics (2 maybe and 2 likely); critical thinking and analysis (2 maybe and 2 likely); interpersonal relations and collaboration (2 maybe and 2 likely); empathy and change of perspective (2 maybe and 2 likely); communication and use of media (2 maybe and 2 likely); strategic action (2 maybe and 2 likely); personal involvement (2 maybe and 2 likely); assessment and evaluation (2 maybe and 2 likely); and tolerance for ambiguity and uncertainty (2 maybe and 2 likely).

A correlation analysis was carried out between the competences and the pedagogical approaches. The results obtained were between 0.0426 and 0.5555. These were transformed to a three-level scale (see Figure 6): 0 to 0.2 (inclusive), labeled as 'unlikely' (white cells in the figure); 0.2 to 0.4 (inclusive), labeled as 'maybe' (yellow cells in the figure); and 0.4 to 0.6, labeled as 'likely' (green cells in the figure).

The analysis showed the number of 'unlikely', 'maybe', and 'likely' cases per competence: Case studies (2 unlikely and 10 maybe); interdisciplinary team teaching (11 maybe 1 and likely); lecturing (11 unlikely and 1 maybe); mind and concept maps (11 maybe and 1 likely); project- and/or problem-based learning (8 maybe 8 and likely); community service learning (8 maybe and 4 likely); jigsaw/interlinked teams (11 maybe and 1 likely); participatory action research (12 maybe); eco-justice and community (7 maybe and 5 likely); place-based environmental education (11 maybe and 1 likely); supply chain/life-cycle analysis (5 unlikely and 7 maybe); and traditional ecological knowledge (12 maybe). As it can be seen, most of the correlations are 'maybe', with participatory action research and traditional ecological knowledge having all 12 as 'maybe'; and the competences are a combination of 'maybe' and 'unlikely' or 'maybe' and 'likely'.

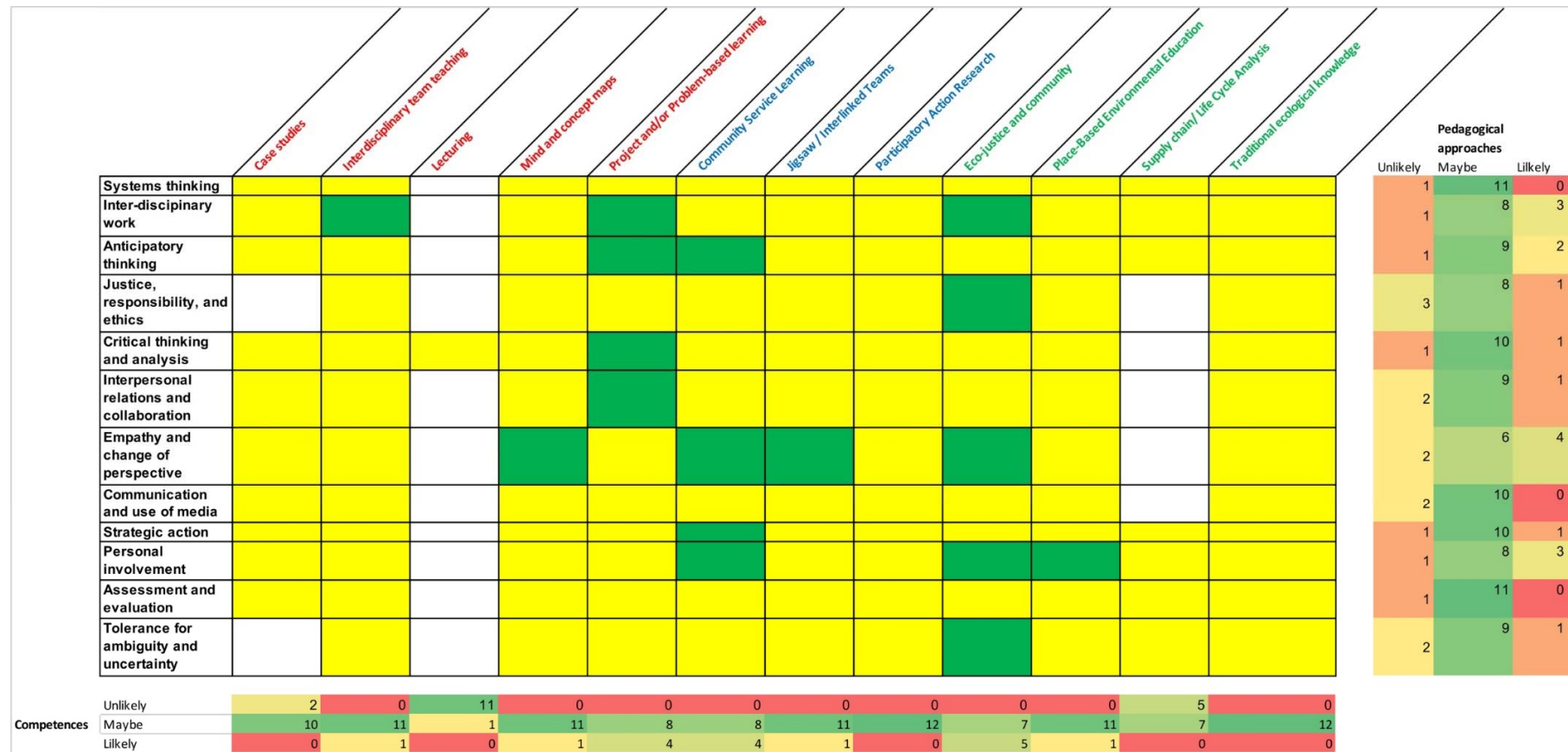


Figure 6. Updated framework connecting sustainable development pedagogical approaches to competences (from the survey results using Spearman correlation). The green cells indicate a high likelihood of addressing the competence, the yellow cells indicate that the approach may address it, and the white cells indicate that the approach does not address the competence.

On the pedagogical approaches, the results show the number of cases to be: systems thinking (1 unlikely, and 11 maybe); inter-disciplinary work (1 unlikely, 8 maybe, and 3 likely); anticipatory thinking (1 unlikely, 9 maybe, and 2 likely); justice, responsibility, and ethics (3 unlikely, 8 maybe, and 1 likely); critical thinking and analysis (1 unlikely, 10 maybe, and 1 likely); interpersonal relations and collaboration (2 unlikely, 9 maybe, and 1 likely); empathy and change of perspective (2 unlikely, 6 maybe, and 4 likely); communication and use of media (2 unlikely and 10 maybe); strategic action (1 unlikely, 10 maybe, and 1 likely); personal involvement (1 unlikely, 8 maybe, and 3 likely); assessment and evaluation (1 unlikely and 11 maybe); and tolerance for ambiguity and uncertainty (2 unlikely, 9 maybe, and 1 likely).

The competences most likely to be developed were: Empathy and change of perspective (by mind and concept maps, community service learning, jigsaw /interlinked teams, and eco-justice and community); inter-disciplinary work (by inter-disciplinary team teaching, project- and/or problem-based learning, and eco-justice and community); personal involvement (by community service learning, eco-justice and community, and place-based environmental education); anticipatory thinking (by project- and/or problem-based learning and community service learning); justice, responsibility, and ethics (by eco-justice and community); critical thinking and analysis (by project- and/or problem-based learning); interpersonal relations and collaboration (by project- and/or problem-based learning); strategic action (by community service learning); personal involvement (by community service learning); and tolerance for ambiguity and uncertainty (by eco-justice and community).

The competences least likely to be developed were: Justice, responsibility and ethics (not developed by case studies, lecturing, and supply chain/life-cycle analysis); interpersonal relations and collaboration (not developed by lecturing, and supply chain/life-cycle analysis); empathy and change of perspective (not developed by lecturing, and supply chain/life-cycle analysis); communication and use of media (not developed by lecturing, and supply chain/life-cycle analysis); tolerance for ambiguity and uncertainty (not developed by case studies and lecturing); and critical thinking and analysis (not developed by supply chain/life-cycle analysis). In addition, the following competences were not developed by lecturing: Systems thinking; inter-disciplinary work; anticipatory work; strategic action; personal involvement; and assessment and evaluation).

The pedagogical approaches with the most likelihood to develop sustainability competences were: Eco-justice and community (inter-disciplinary work, justice, responsibility and ethics, empathy and change of perspective, personal involvement, and tolerance for ambiguity and uncertainty); project- and/or problem-based learning (inter-disciplinary work, anticipatory thinking, critical thinking and analysis, and interpersonal relations and collaboration); community service learning (anticipatory thinking, empathy and change of perspective, strategic action, and personal involvement); inter-disciplinary team learning (inter-disciplinary work); mind and concept maps (empathy and change of perspective); jigsaw /interlinked teams (empathy and change of perspective); and place-based environmental education (personal involvement).

According to the responses, the pedagogical approaches with the least likelihood to develop competences were case studies (not considered to develop justice, responsibility and ethics, and tolerance for ambiguity and uncertainty); supply chain/life-cycle (not considered to develop justice, responsibility and ethics, critical thinking and analysis, interpersonal relations and collaboration, empathy and change of perspective, and communication and use of media); and lecturing, which was considered to maybe develop critical thinking and analysis.

The correlation between the sustainability elements and the competences showed that the cross-cutting themes and social issues were the most covered, followed by the environmental and the economic ones. None of the competences were 'unlikely' to cover sustainability dimensions, which indicates that all the competences are important in sustainability education.

The results from the survey helped to update the theoretical framework (Figure 6) from a proposal of five authors to the responses from 390 European researchers. This update showed that there were more pedagogical approaches that 'may' develop sustainability competences than originally considered.

A comparison of the survey results (updated framework) and the theoretical framework—see Reference [18]—was carried out to detect the differences (as shown in Figure 7). The two tables were then compared. When the result in the framework was higher than the survey then a blue cell was highlighted, whereas when the result in the survey was higher than the framework then a red cell was highlighted. When the numbers were the same, then the cell color was kept white. The sum of blue and red cells was calculated to detect what the differences were. For the competences, this resulted in: Nine differences (jigsaw/interlinked teams, eco-justice and community, and supply chain/life-cycle analysis); eight differences (project- and/or problem-based learning); seven differences (interdisciplinary team teaching, lecturing, mind and concept maps, place-based environmental education, and traditional ecological knowledge); six differences (case studies and community service learning), and four differences (participatory action research). For the pedagogical approaches this resulted in: 10 differences (systems thinking), nine differences (anticipatory thinking, and critical thinking and analysis), eight differences (communication and use of media, strategic action, and personal involvement), seven differences (interpersonal relations and collaboration, assessment and evaluation, and tolerance for ambiguity and uncertainty); six differences (justice, responsibility, and ethics); four differences (empathy and change of perspective); and three differences (inter-disciplinary work).

Three pedagogical approaches appear more likely to develop the most competences (eco-justice and community, project- and/or problem-based learning, and community service learning). This indicates that pedagogical approaches that are more practical and linking to the community appear to have a better likelihood to improve developing sustainability competences.

The updated framework (Figure 6) shows that there is a perception that the pedagogical approaches, in general, may develop the sustainability competences, with some particular exceptions, such as case studies, supply chain/life-cycle analysis, and lecturing. The way lecturing is being carried out, it is not likely to develop sustainability competences. This does not imply that lecturing should not be done anymore, but that it should be adjusted to better develop the competences, or that it should be complemented with other pedagogical approaches that would help develop sustainability competences.

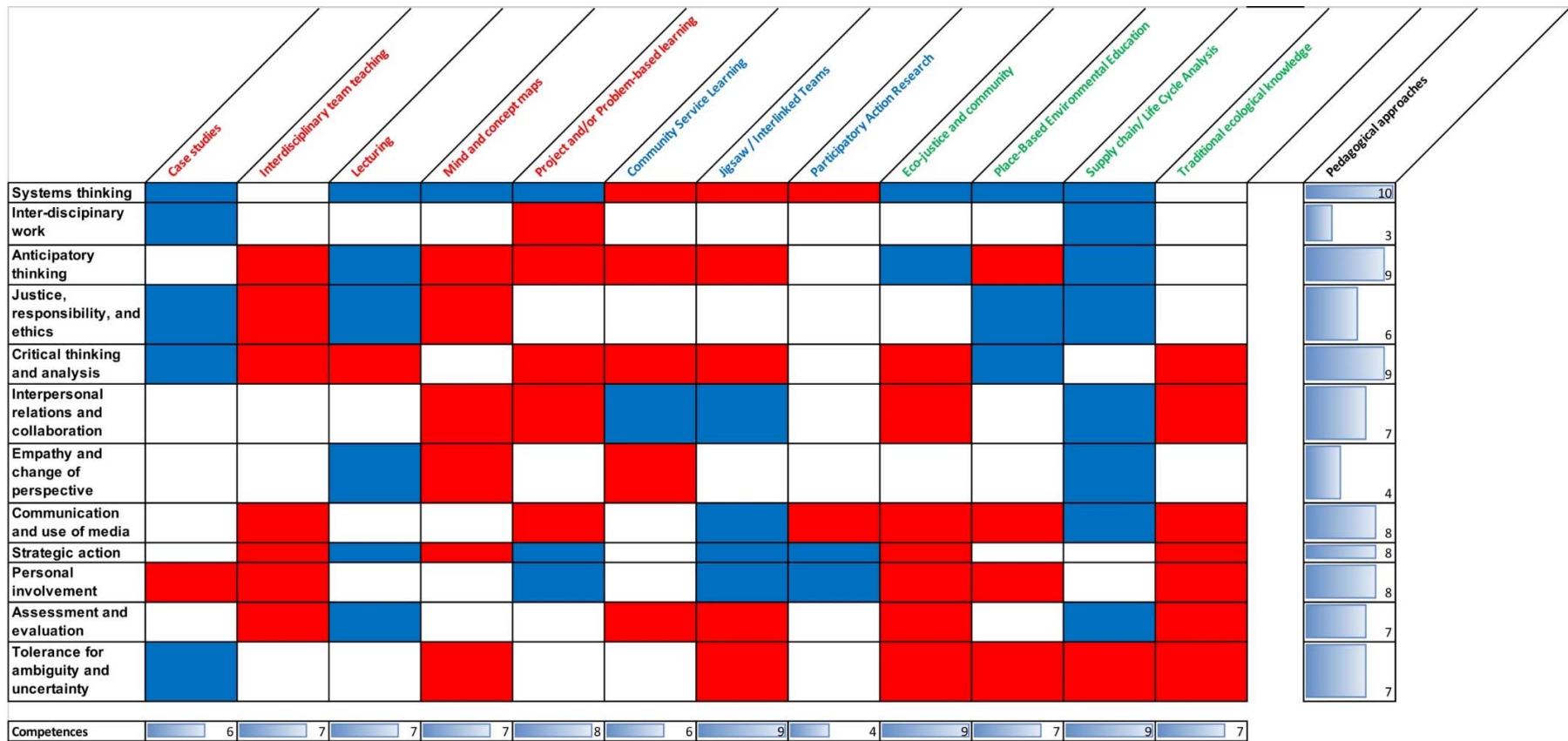


Figure 7. Differences between the theoretical framework and the updated one from the survey results. The blue cells indicate a higher result in the theoretical framework, the red cells indicate a higher result in the updated one, and a white cell indicates that the result was the same in both.

4. Conclusions

Although there has been considerable progress in the incorporation of SD into the curricula of higher education institutions (HEIs) in Europe, particularly on competences for sustainable development and on pedagogical approaches, there has been limited research on the connection between how courses are delivered (pedagogical approaches) and how they may affect sustainability competences. This paper presents the results from a survey answered by 390 European educators on sustainability, competences, and pedagogical approaches that tested the “framework connecting sustainable development pedagogical approaches to competences”. The paper analyzes the results through descriptive statistics, Friedman ranking, and Spearman correlations. The research underlines the relations between: (1) The competences and sustainability; and (2) the pedagogical approaches and the competences.

The paper empirically tested and updated the framework to provide a much more ‘real’ picture on how the pedagogical approaches are being used to develop sustainability competences. This paper demonstrates that, to achieve sustainability, it is necessary to cover the competences ‘Full Monty’ through a combination of pedagogical approaches. Traditional pedagogical approaches (such as lecturing and case studies) need to be rethought and redesigned to be able to better develop the competences and, ultimately, sustainability education. Another approach would be to generate capacity building to connect the pedagogical approaches having a better potential with the proper competences.

Further research should be carried out that assesses the level of sustainability contribution, the competences covered and developed, and the pedagogical approaches used in one or more HEIs throughout all levels of education regardless of whether sustainability is being taught. A cross-country comparison could also be carried out. Follow-up research, using interviews or focus groups, could provide insights on how to better use, rethink, redesign, and combine pedagogical approaches to provide a more sustainability-oriented education.

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