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QUANTITATIVE ASSESSMENT OF THE IMPACT OF STEAM-BASED CURRICULUM INNOVATION AT CAHUL STATE UNIVERSITY

Irina Todos[1], Ludmila Roșca-Sadurschi[2]

[1,2]*Cahul State University, Cahul, Republic of Moldova*

Abstract. The study explores the outcomes of curriculum modernization carried out within the SKILLS4FUTURE project at Cahul State University “Bogdan Petriceicu Hasdeu.” The research examined students’ perceptions of the redesigned courses that integrate STEAM principles within the Business and Administration program. Five disciplines were analyzed: Quality Management, Production Management, Human Resources Management, Innovation Management, and Foundations of Entrepreneurship. The investigation relied on a structured questionnaire addressing several dimensions of academic satisfaction, including course organization, teaching materials, practical components, and learning outcomes. The overall results indicate a consistently high degree of satisfaction, particularly with the inclusion of themes related to sustainability, innovation, and applied problem-solving. The evidence suggests that interdisciplinary and skills-oriented approaches contribute to stronger student engagement and a more relevant learning experience in the context of contemporary educational and labor market requirements.

Keywords: *STEAM education; curriculum innovation; student satisfaction; higher education*.

JEL code: *I25*

Introduction

This article continues the research initiated in the previous study entitled *“The impact of the activities carried out within the SKILLS4FUTURE Project on the satisfaction of the academic community within Cahul State University “Bogdan Petriceicu Hasdeu”*. While the initial paper outlined the conceptual and methodological framework of the project, emphasizing its theoretical underpinnings and the organization of activities, the present work focuses on the empirical analysis of students’ responses.

The study examines the quantitative data collected from students who participated in the SKILLS4FUTURE project, aiming to assess their level of satisfaction, perceived benefits, and the extent to which the integration of STEAM-related competencies has influenced their academic experience. The analysis concentrates on the modernized curricula of five disciplines within the *Business and Administration* study program, redesigned to promote interdisciplinary learning and innovation.

Integrating STEAM into higher education is increasingly recognized as a catalyst for developing 21st-century skills, including creativity, collaboration, critical thinking, and problem-solving [1]. Within this framework, the SKILLS4FUTURE project serves as a practical model for aligning curriculum modernization with the principles of Education 4.0 and Industry 4.0, preparing students for the evolving demands of the labor market [2][3].

Through this continuation, the research deepens the understanding of how curriculum innovation and STEAM integration influence academic engagement and satisfaction. The findings are expected to offer practical insights for improving teaching strategies, refining curricular content, and strengthening the connection between university education and the dynamic needs of the knowledge economy . Furthermore, the perspectives of academic staff provide valuable insight into professional development needs and the practical implementation of STEAM-based teaching.

Metodology

The present research uses a quantitative approach with descriptive and explanatory dimensions, aiming to analyze the perceptions and satisfaction levels of students who attended courses modernized under the *SKILLS4FUTURE* project. Unlike the previous study, which focused on the overall impact of the project on the academic community, this paper emphasizes the empirical evaluation of students' feedback regarding the integration of STEAM principles into specific disciplines.

The target group consisted of 58 undergraduate students enrolled in the *Business and Administration* study program at Cahul State University "Bogdan Petriceicu Hasdeu," who participated in the teaching and learning activities of the modernized courses. The study covered five disciplines: *Production Management*, *Quality Management*, *Human Resources Management*, *Innovation Management*, and *Fundamentals of Entrepreneurship*.

Data collection was carried out between May 2024 and March 2025 through an online questionnaire distributed via Google Forms. Participation was voluntary and anonymous, ensuring adherence to the ethical principles of scientific research.

The questionnaire used for this stage of the study was adapted from the initial version applied during the project, being focused exclusively on the student perspective. It included two main sections:

- the first section gathered demographic information (study year, program, and form of education);
- the second section assessed students' satisfaction concerning organizational aspects of the courses, the quality of teaching and learning materials, the relevance of new theoretical and practical components, and the perceived achievement of STEAM-related knowledge and skills.

Responses were recorded on a five-point Likert scale ranging from *1 – very low* to *5 – very high*, enabling a quantitative assessment of satisfaction levels and perceived learning outcomes. The data were processed using descriptive statistics to identify dominant tendencies and correlations between satisfaction indicators and learning achievements.

This methodological approach ensured a consistent and comparable evaluation across the five modernized disciplines, providing a clear perspective on how curricular innovation and STEAM integration influence students' engagement and academic experience.

The following section presents the empirical results derived from the surveys, structured by each of the five modernized disciplines. This approach allows for a detailed understanding of how the integration of STEAM principles has influenced students' learning experiences and satisfaction levels across different subjects.

Results and discussion

Building on the methodological framework described above, this section presents the main empirical findings derived from the questionnaire administered to students who attended the modernized disciplines under the *SKILLS4FUTURE* project. The results reflect students' perceptions regarding organizational aspects of the courses, the relevance and quality of the newly introduced theoretical and practical topics, and the extent to which the intended STEAM-related knowledge and skills were achieved. Through comparative interpretation of satisfaction indicators and learning outcomes, the study aims to highlight patterns of consistency, areas of improvement, and the overall pedagogical impact of curriculum modernization.

To illustrate these findings in a structured manner, the results are presented separately for each of the five modernized disciplines. The first case analyzed refers to the discipline *Production Management*, which exemplifies the integration of STEAM concepts into managerial and operational contexts.

The *Production Management* discipline was evaluated by 14 students from the Business and Administration study program, 2nd year of studies, full-time education. As a result of the surve:

- *The student's´ degree of satisfaction concerning organizational aspects related to the discipline.*

According to the data presented in Figure 1, we observe that the general opinion of the respondents regarding the degree of satisfaction with the organizational aspects of the discipline is good. Thus, the degree of usefulness of the course content, the quality of the course and the material learned, the ability of the teaching staff to ask questions is rated excellent (37.5%) and good (37.5%), while the structure of the course, the explanations given by the teacher during the course, the degree of difficulty of the course, the relationships and group work, the volume of information and the workload during the course are rated excellent (25%) and good (50%), another aspect appreciated is the teacher's ability to increase interest in the topic, the attractiveness and usefulness of the practical subjects (good - 62.5% and excellent - 12.5%).

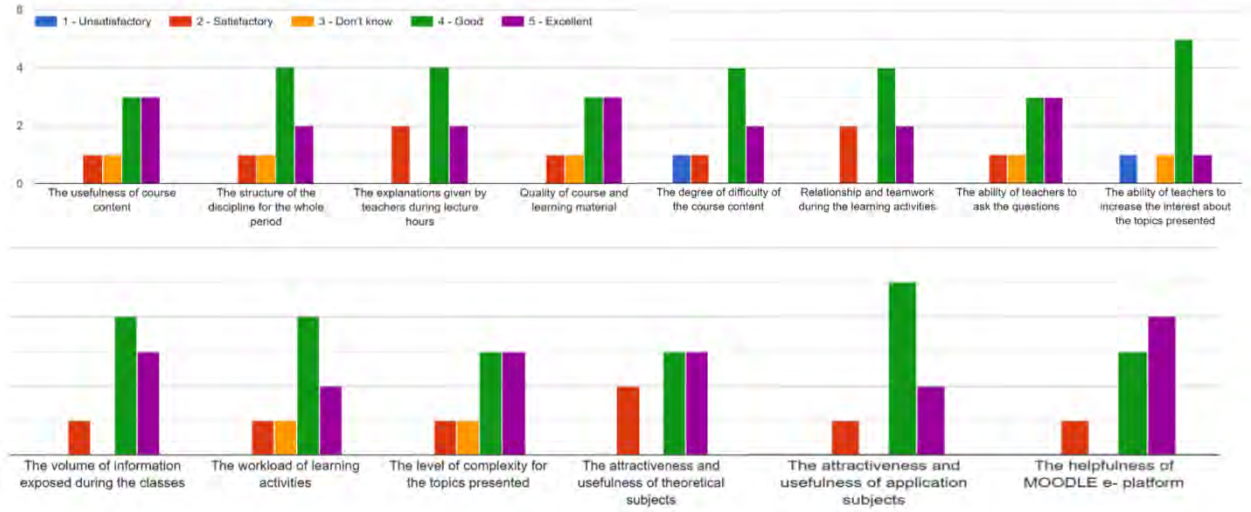


Figure 1. The distribution of the students' satisfaction

Source: Authors' own research results/contribution

- *The student's' degree of satisfaction concerning the teaching material and learning resources and practical exercises and applications for newly added theoretical lessons.*



Figure 2. The distribution of the students' satisfaction with newly added theoretical and practical subjects for STEAM knowledge

Source: Authors' own research results/contribution

According to the data presented in Figure 2, 50% of the students rated the improved themes proposed for the study as “good”, and 37.5% rated them as “excellent”. In the case of themes integrating the principles of sustainable development and circular economy, the level of satisfaction was even higher: 87.5% of the respondents considered them “good”, and 25% rated them as “excellent”. Overall, it can be deduced that between 50% and 75% of the students perceived the improved themes as suitable for application in seminars and laboratories.

- *The overall student's appreciation concerning the learning outcomes of the discipline.*

The results in Figure 3. show that 87% of students significantly developed both their theoretical knowledge and practical skills by integrating STEAM elements into the Production Management discipline. This confirms the effectiveness of curricular modernization and the relevance of interdisciplinary approaches, which stimulate engagement and strengthen transversal skills.

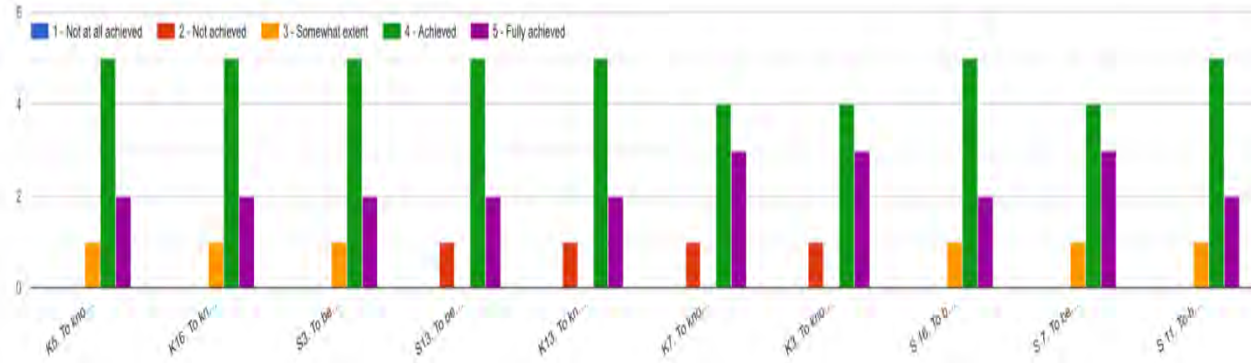


Figure 3. The degree of fulfilment for learning outcomes linked to targeted STEAM knowledge (K) and skills (S)

Source: Authors' own research results/contribution

The second discipline analyzed, *Quality Management*, offers valuable insights into how the introduction of STEAM-oriented topics enhances students' understanding of quality systems, sustainability standards, and social responsibility principles within modern business frameworks.

The *Quality Management* discipline was evaluated by 8 students from the Business and Administration study program, 3rd year of studies, full-time education. Following the survey, we obtained the following results:

- *The student's´ degree of satisfaction concerning organizational aspects related to the discipline.*

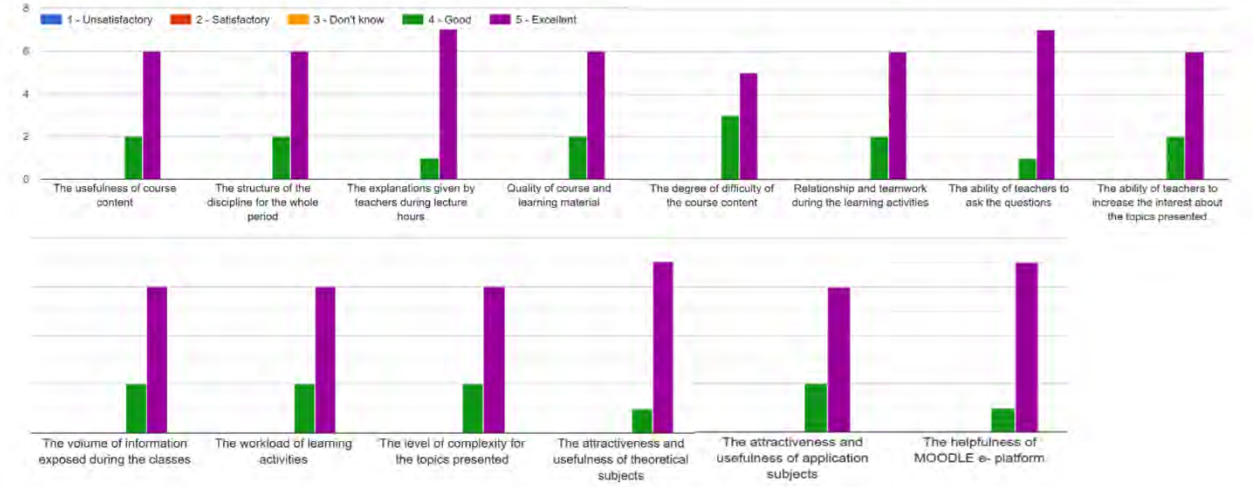


Figure 4. The distribution of the students' satisfaction

Source: Authors' own research results/contribution

Indicators of student satisfaction with the organizational aspects of the course are generally rated positively. The predominant ratio of "excellent" (between 75% and 100%) and "good" (between 12.5% and 25%) responses suggests that students perceived the organization of the course (such as its structure, teaching method, available resources, communication, etc.) favorably. A specific point mentioned is the degree of difficulty of the course content, where 62.5% of students considered it "excellent" in the sense of well-balanced and appropriate.

- *The student's´ degree of satisfaction concerning the teaching material and learning resources and practical exercises and applications for newly added theoretical lessons.*

The graph indicates a high level of satisfaction with the selected lessons. For example, the lessons on Quality Management System and Social Responsibility and Environmental Protection Standards were rated as "excellent" by 75% of the students, and the rest considered them "good". The lessons on Correlation between Quality and Competitiveness, Assessment of Sustainable Business Development and Integrated Management Systems received 62.5% "excellent" and 37.5% "good" ratings. These results show a high overall level of satisfaction with the theoretical content, although the topics with practical applicability were perceived as more challenging, probably due to the limited practical experience of the students.



Figure 5. The distribution of the students' satisfaction with newly added theoretical and practical subjects for STEAM knowledge

Source: Authors' own research results/contribution

Regarding the applied components, exercises such as the presentation of a quality policy (Lesson 1) or the case study on STEAM topics (Lesson 8) were rated as "excellent" by 62.5% of the students and "good" by 37.5%. The activities related to competitiveness in the EU market and social and environmental responsibility (Lesson 3 and Lesson 5) generated high interest, being appreciated by 75% of respondents. Other activities, such as the topics on the implementation of social and environmental standards or the additional tasks (Lesson 10), received balanced evaluations: 50% "excellent" and 50% "good". Overall, students appreciated the value of the practical exercises, but some of them encountered difficulties due to the lack of applied experience, which suggests the need to integrate additional examples and clearer guidance.

- *The overall student's appreciation concerning the learning outcomes of the discipline.*

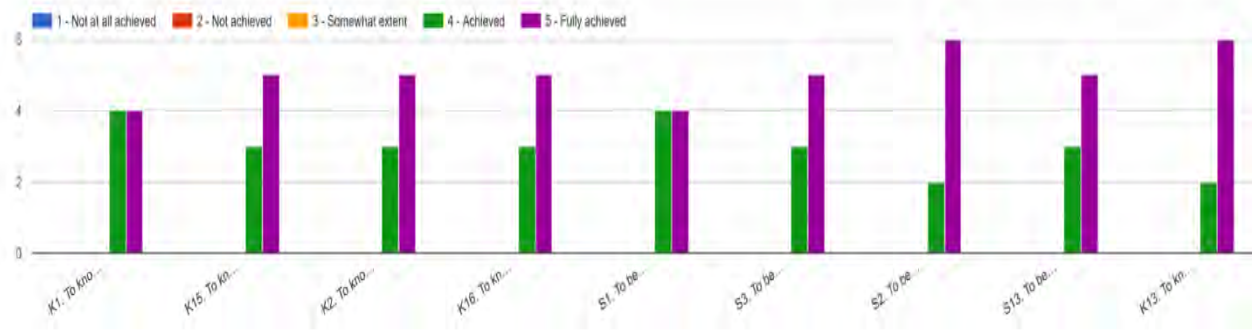


Figure 6. The degree of fulfilment for learning outcomes linked to targeted STEAM knowledge (K) and skills (S)

Source: Authors' own research results/contribution

Figure 6 illustrates the extent to which the intended learning outcomes, particularly those targeting STEAM-related knowledge (K) and skills (S), were achieved from the students' perspective. Students reported that the development of STEAM theoretical knowledge was achieved at a moderate to high level, with the majority of respondents indicating a completion rate between 50% and 75%. This suggests that the course content effectively contributed to improving students' conceptual understanding in areas such as quality management, sustainability and the integration of STEAM-related frameworks. Similarly, students perceived their STEAM skills – such as analytical thinking, interdisciplinary application and problem solving in real-world contexts – as being developed in the same range of 50% to 75%. While this indicates a satisfactory level of skill acquisition, it also indicates potential areas for improvement in terms of practical learning and practical engagement.

The discipline *Basics of Entrepreneurship* provides an essential perspective on how the inclusion of sustainability and innovation-oriented topics can strengthen entrepreneurial competencies and foster a mindset aligned with the principles of the green and circular economy. For this discipline, the demographic profile of respondents was as follows:

- 47.05% were students from the Bachelor's program in *Business and Administration,* and 52.95% from *Engineering and Management* programs.
- 47.05% were in their first year of study, and 52.95% in their second year.

All respondents (100%) were enrolled in full-time bachelor’s programs.

- 70.6% were women, and 29.4% were men.

➢ *The student's´ degree of satisfaction concerning organizational aspects related to the discipline.*

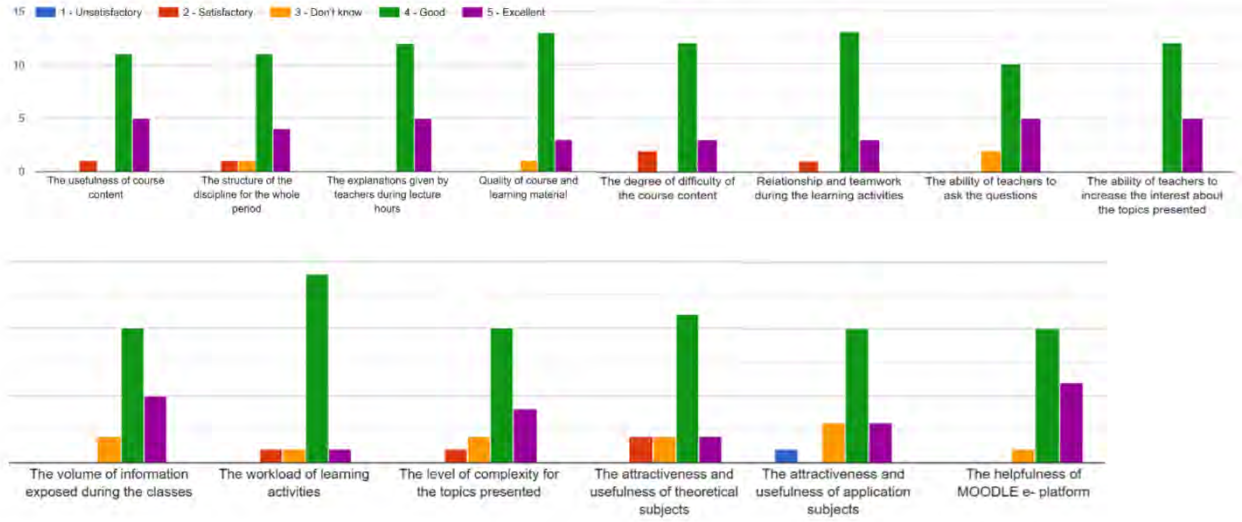


Figure 7. The distribution of the students' satisfaction

Source: Authors’ own research results/contribution

Analysis of Figure 7 highlights a consistently high level of student satisfaction with the organizational aspects of the course – structure, scheduling, communication and clarity of requirements – with values ranging from 88.23% to 100%. These results suggest that the organization of the course was appreciated and contributed significantly to supporting the learning process.

➢ *The student's´ degree of satisfaction concerning the teaching material and learning resources and practical exercises and applications for newly added theoretical lessons.*

The data in figure 8 show a very high level of satisfaction among students for the new theoretical topics:

Lesson 1: Green Business - positively rated by 94.11% of students.

Lesson 2: Sustainable Development Goals in SMEs: Achieved a 100% satisfaction rate, indicating a unanimous appreciation.

Lesson 3: Resource efficiency through the collaborative economy (e.g. coworking spaces, crowdfunding, freelancers): Captured the interest of 94.11% of respondents.

These results suggest that the new theoretical content was highly relevant and well aligned with students’ expectations and interests, especially in the context of modern, sustainability-oriented business practices.

For the applied content students demonstrated a strong involvement in solving the proposed tasks:

Topic 1: Practical exercise: generated the interest of 88.23% of students.

Topic 2: Proposed task: it attracted the interest of 82.35% of the respondents.

Topic 3: Practical task: it attracted the interest of 88.23% of the students.

These results indicate that the majority of the students found the practical applications engaging and valuable. However, although the interest levels are high, there is still room for improvement especially in Topic 2 by refining the task design, providing clearer instructions or increasing the relevance to the students’ real-world contexts.

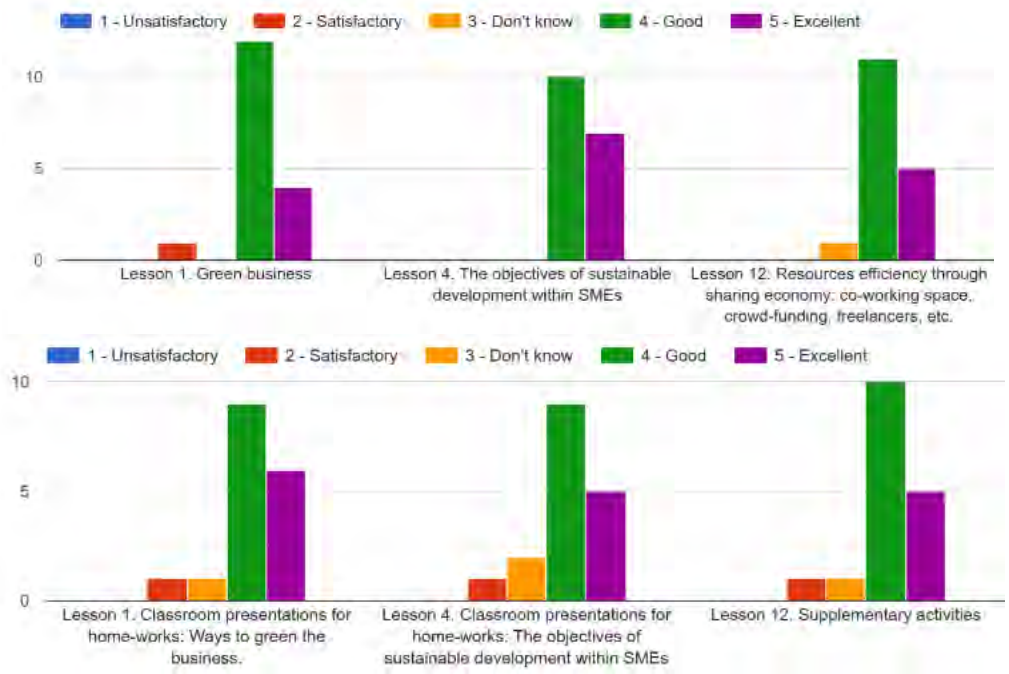


Figure 8: The distribution of the students' satisfaction with newly added theoretical(a) and practical subjects(b) for STEAM knowledge

Source: Authors' own research results/contribution

In both the theoretical and practical components, students reported very high levels of satisfaction, especially regarding topics related to sustainability and the green economy. The results confirm that integrating STEAM content - when relevant and applied - can encourage student engagement and support learning outcomes. Continued emphasis on real-world applicability and interactive learning strategies is recommended to maintain and further improve these satisfaction levels.

➢ *The overall student's appreciation concerning the learning outcomes of the discipline.*

The results show that the level of knowledge acquisition ranged between 70.58% and 94.11%, indicating a good understanding of key concepts such as sustainability, green business models and innovation in the STEAM context. Regarding practical skills, the development of STEAM competencies – problem solving, critical thinking, collaboration and applying theory to practice – ranged between 70.58% and 88.23%. The lower values compared to the theoretical part suggest that some students encountered difficulties in applying knowledge in real/practical contexts.

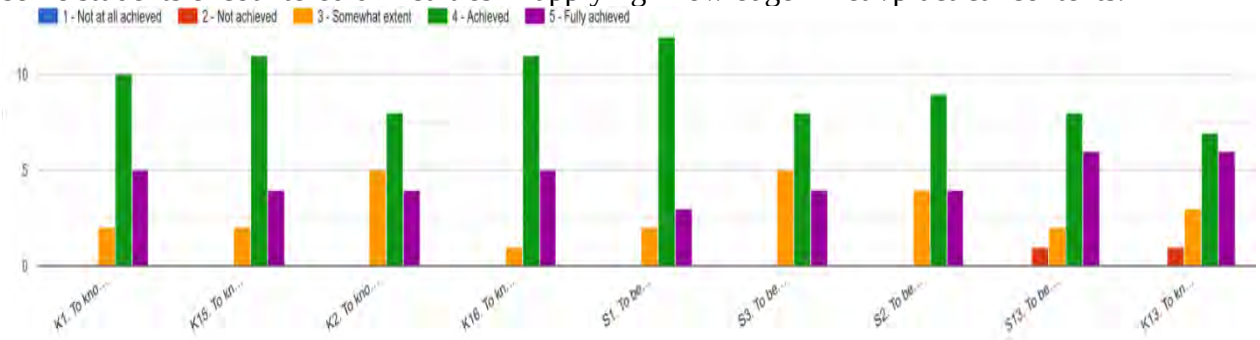


Figure 9. The degree of fulfilment for learning outcomes linked to targeted STEAM knowledge (K) and skills (S)

Source: Authors' own research results/contribution

Overall, students reported a high level of satisfaction with their learning outcomes, with both knowledge and practical skills recording development rates above 70%. These findings confirm the effectiveness of the discipline in facilitating the acquisition of relevant STEAM skills. However, the gap observed between the degree of theoretical knowledge acquisition and the development of applied skills highlights the need to strengthen experiential learning methods – such as applied projects,

contextualized case studies and collaborative activities – to increase the transferability and practical applicability of the acquired knowledge.

The fourth modernized discipline is *Human Resources Management*, which was evaluated by 10 students, of which 40% were students from bachelor programme in *Business & Administration* and 60% were students from bachelor programme in *Engineering and Manageent in Food Industry*, and 100% of bachelor students were enrolled in full-time programme whereas.

- *The student's' degree of satisfaction concerning organizational aspects related to the discipline*

From the data presented in the figure 10, we notice that the students, for the most part, are satisfied with the course taught, the subject offered, and the teacher's training and teaching method.

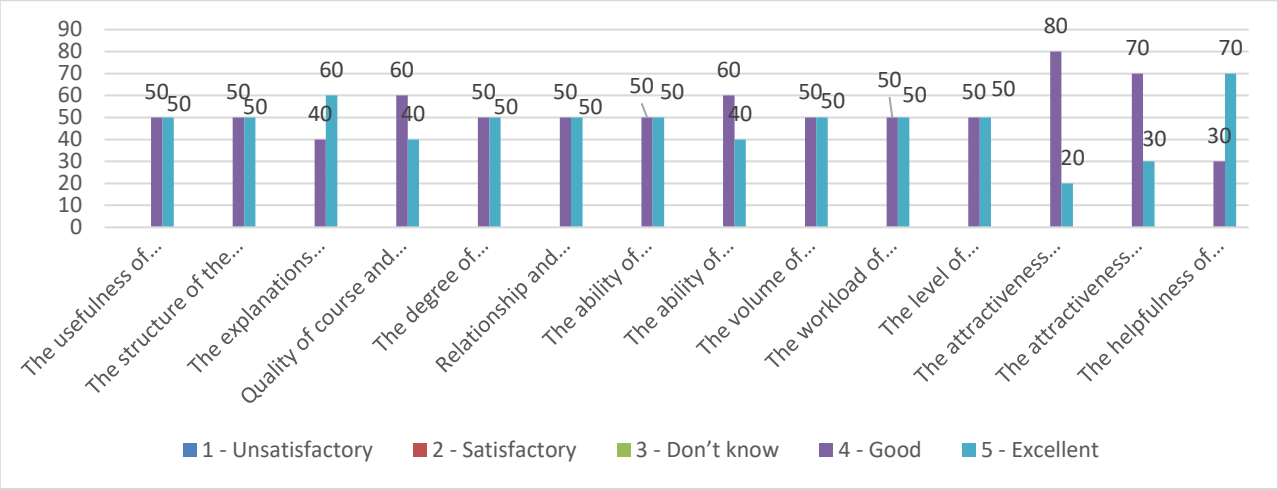


Figure 10.The distribution of the students' satisfaction

Source: Authors' own research results/contribution

Several students appreciated the quality and accessibility of the contents, the quality of the teaching of the course by the teacher, but also the accessibility of the course on the e-learning platform. In general, only two types of response "Good" and "Excellent" predominate.

- *The student's' degree of satisfaction concerning the teaching material and learning resources for newly added theoretical lessons.*

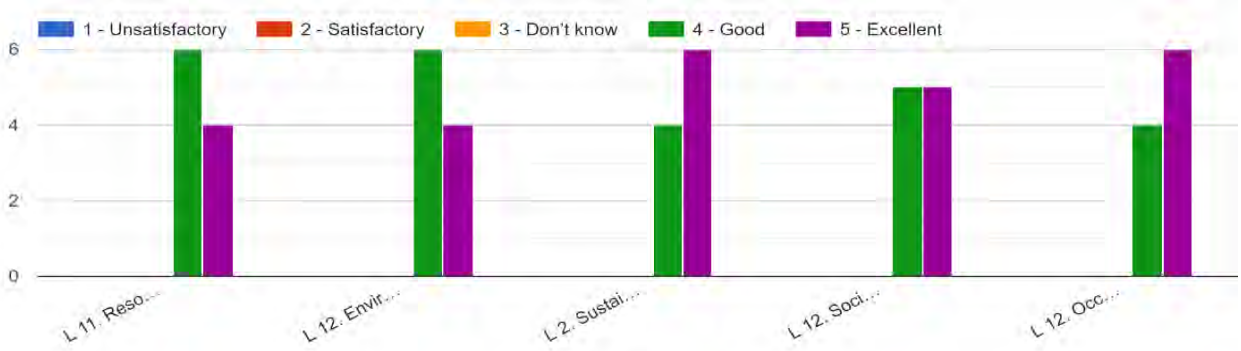


Figure 11. The distribution of the students' satisfaction with newly added theoretical subjects for STEAM knowledge

Source: Authors' own research results/contribution

Regarding the theoretical materials developed according to the improved curriculum, the students were satisfied. In general, only two types of response "Good" and "Excellent" predominate. For the topics formulated for the theme: about 60% rated the theoretical topics elaborated in topics: Resources efficiency through sharing economy: coworking space, crowd-funding, freelancers, etc.(L11) and Environmental compliance (L12) as "good", and the topics in topics Sustainable employments (L2) and Occupational health and safety (L12) as "excellent" . But, regarding the Social and labour protection (L12) subject, the respondents expressed themselves equally with "good" and "excellent".

➢ *The student's' degree of satisfaction concerning the practical exercises and applications for newly added subjects?*

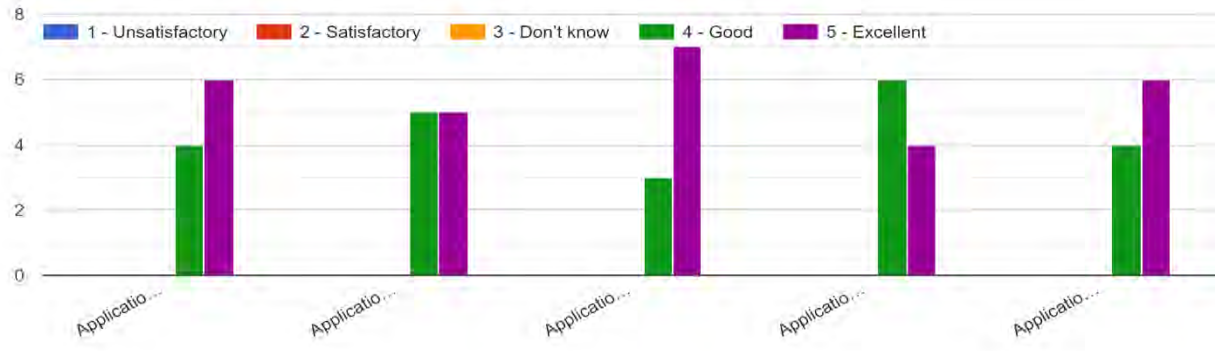


Figure 12. The distribution of the students' satisfaction with newly added practical subjects for STEAM skills

Source: Authors' own research results/contribution

Here we can say that all students rated the practical work presented in all three topics as "excellent", which were improved in the project. Accordingly, we have the following assessment of the students with "excellent": Sustainable employments (A12) – 70%; Resources efficiency through sharing economy: coworking space, crowd-funding, freelancers, etc. (A11) and Occupational health and safety(A12) – 60%; Environmental compliance (A2) – 50%; Social and labour protection (A12) – 40%.

➢ *The overall student's appreciation concerning the learning outcomes of the discipline*

With reference to the knowledge acquired by students in the process of studying new materials, developed according to the modernized curriculum, we mostly have the appreciation of "achieved" and "full achieved". Student appreciation was distributed as follows:

K20. To know the importance of empowering individuals and organizations to work collaboratively: achieved – 60%, fully achieved – 40%.

K21. To know that preventive action should be taken when certain action/inaction may damage human health and all life forms (precautionary principle): achieved – 70%, fully achieved – 30%.

K19. To know the main sustainability stakeholders in the community and how to contact them: achieved – 60%, fully achieved – 40%.

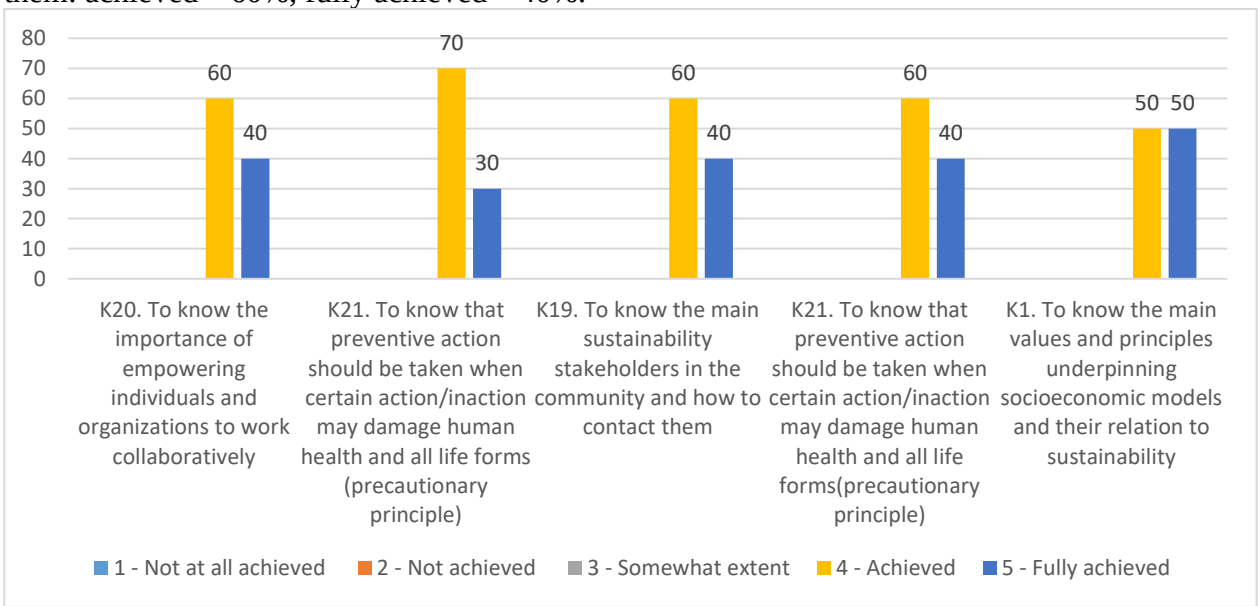


Figure 13. The degree of fulfilment for learning outcomes linked to targeted STEAM knowledge (K)

Source: Authors' own research results/contribution

K21. To know that preventive action should be taken when certain action/inaction may damage human health and all life forms (precautionary principle): achieved – 60%, fully achieved – 40%.

K1. To know the main values and principles underpinning socioeconomic models and their relation to sustainability: achieved – 50%, fully achieved – 50%.

The data in Figure 14 shows that, after studying the theoretical materials and practical exercises from the improved curriculum, the students' knowledge and skills were assessed at the "Achieved" and "Fully achieved" levels. In terms of skills, the results are as follows:

S14: adapting to local circumstances in sustainability issues – 70% achieved, 30% fully achieved;

S15: synthesizing interdisciplinary information on sustainability – 60% achieved, 40% fully achieved;

S17: analyzing the influence of power structures and political systems – 70% achieved, 30% fully achieved;

S22: acting promptly in conditions of uncertainty, respecting the precautionary principle – 50% achieved, 50% fully achieved;

S4: careful evaluation and management of resources for long-term objectives – 60% achieved, 40% fully achieved.

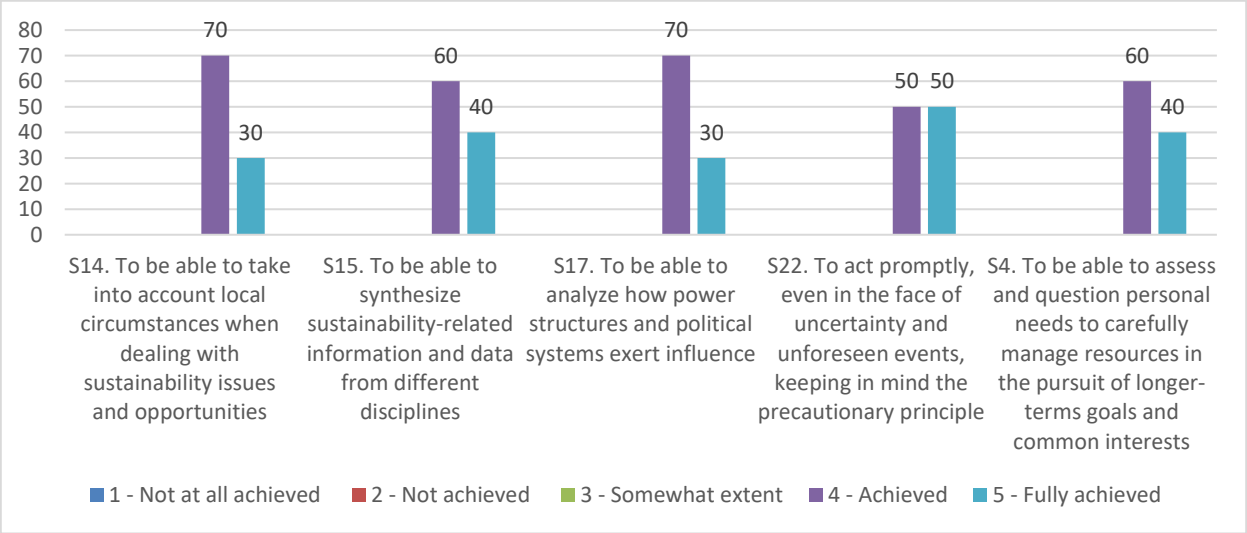


Figure 14. The degree of fulfilment for learning outcomes linked to targeted STEAM skills (S)
Source: Authors' own research results/contribution

Finally, the discipline *Innovation Management* completes the analysis by emphasizing the role of creativity, environmental responsibility, and systemic thinking in fostering sustainable innovation. The results highlight students' appreciation for the relevance and applicability of STEAM-based approaches to real-world managerial challenges. *The Innovation Management* discipline is the 5th discipline included in this project and was evaluated by 9 students from the Business and Administration study program, 3rd year of studies, full-time education. The following results were obtained from the survey:

- *The student's´ degree of satisfaction concerning organizational aspects related to the discipline.*

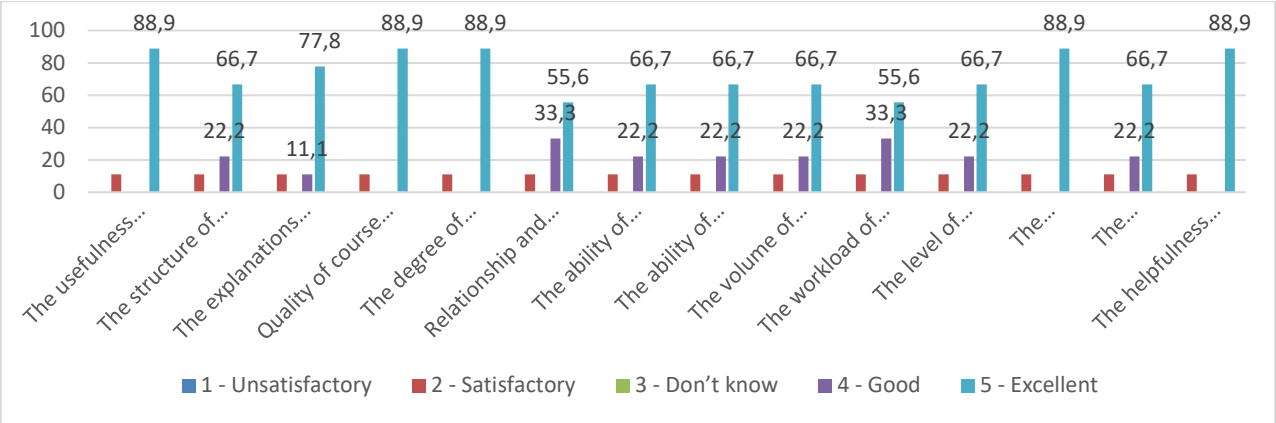


Figure 15. The distribution of the students' satisfaction

Source: Authors’ own research results/contribution

The data presented in the figure above indicate that the majority of students are generally satisfied with the course, the subject content, and the teacher’s instructional methods and qualifications. Many students specifically appreciated the clarity and accessibility of the course materials, the quality of the teaching, and the ease of access to the course through the e-learning platform.

- *The student's′ degree of satisfaction concerning the teaching material and learning resources and practical exercises and applications for newly added theoretical lessons.*

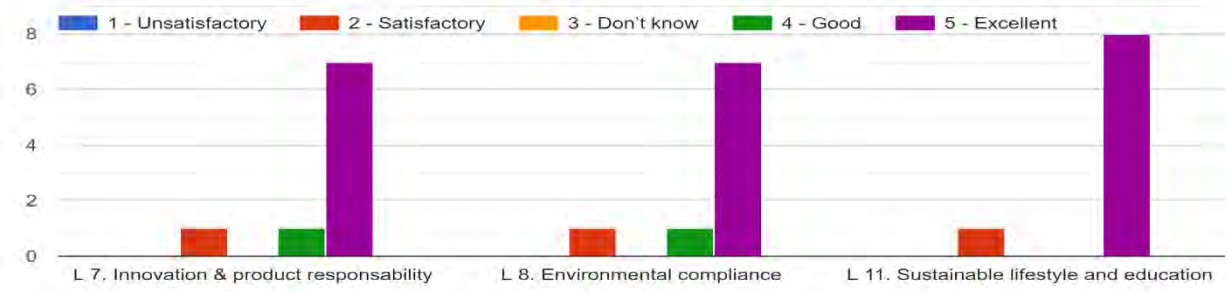


Figure 16. The distribution of the students' satisfaction with newly added theoretical subjects for STEAM knowledge

Source: Authors’ own research results/contribution

Regarding the theoretical materials developed under the improved curriculum, students expressed a high level of satisfaction. For the topics covered under Theme 7: “Innovation & Product Responsibility” and Theme 8: “Environmental Compliance,” seven students (77.8%) rated the content as excellent. Notably, the topic “Sustainable Lifestyle and Education” (Theme 11) received the highest appreciation, being rated as excellent by eight students, representing 88.9% of the total responses.

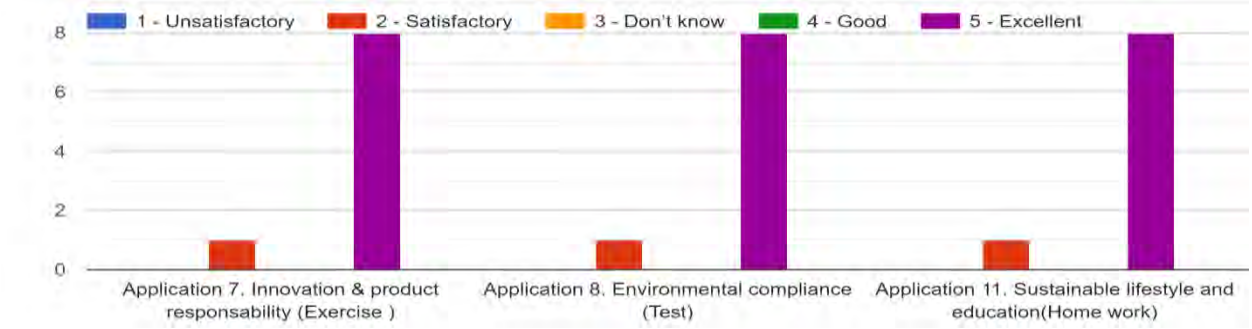


Figure 17. The distribution of the students' satisfaction with newly added practical subjects for STEAM skills

Source: Authors’ own research results/contribution

It is worth noting that the practical work presented across all three improved topics was rated as “excellent” by the vast majority of students. Out of nine total respondents, eight students (88.9%)

rated the practical components as excellent, while only one student (11.1%) provided a “satisfactory” evaluation for all three practical or applied subjects. These results highlight a strong positive perception of the practical elements introduced through the project.

➢ *The overall student’s appreciation concerning the learning outcomes of the discipline.*

From the data presented in the graphs above regarding the knowledge and skills acquired by students following the study of theoretical materials and practical exercises, developed according to the improved curriculum, we note that only one student exposed himself to "somewhat extent".

Regarding the "knowledge" dimension, the students' level of appreciation can be ordered in descending order as follows: 88.9% "fully achieved" for K13 (understanding that complex socio-economic problems do not have a unique solution, but time- and context-dependent alternatives); 66.7% for K12 (recognition of the dynamic nature of sustainability problems, which require periodic redefinition and reframing); respectively 55.6% for K16 (knowledge of the concept of sustainability, its origins and developments, the main actors and the implications for society and the environment, including environmental protection, restoration and regeneration).

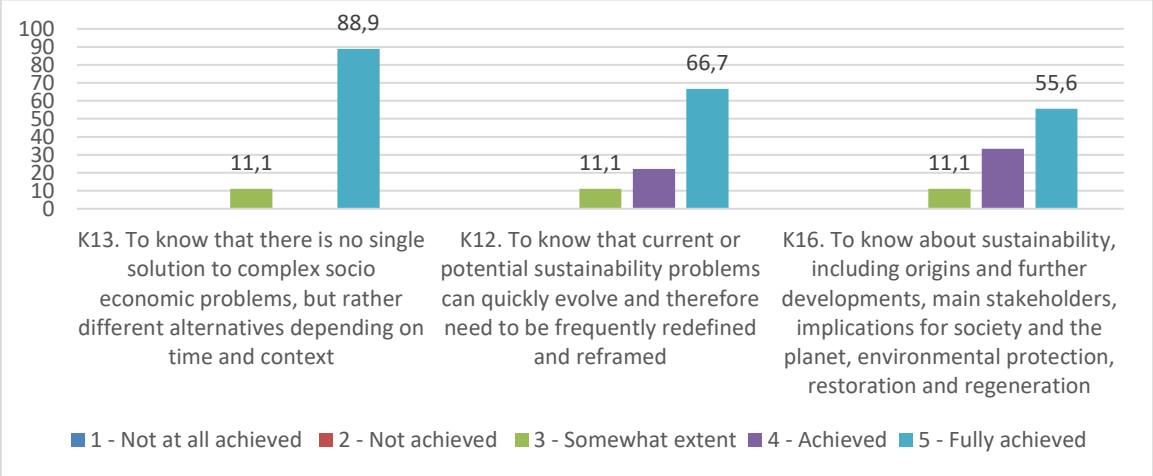


Figure 18. The degree of fulfilment for learning outcomes linked to targeted STEAM knowledge (K)

Source: Authors’ own research results/contribution

Regarding "skills", the results are as follows:

S6 (ability to identify processes or actions that reduce the consumption of natural resources) – 66.7% "fully achieved", 22.2% "achieved" and 11.1% "somewhat extent";

S13 (ability to identify and adapt to different contexts) – 33.3% "achieved" and 11.1% "somewhat extent"; and

S1 (evaluating problems and actions through the lens of sustainability values and principles) – 66.7% "fully achieved", 22.2% "achieved" and 11.1% "somewhat extent".

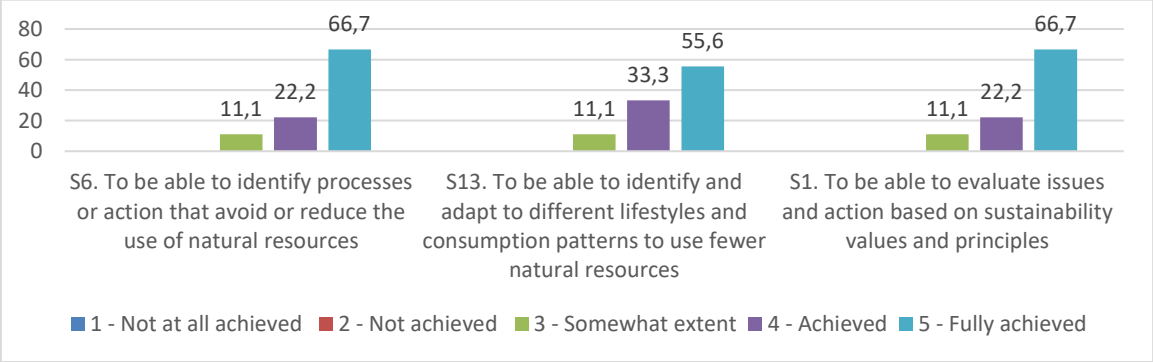


Figure 19. The degree of fulfilment for learning outcomes linked to targeted STEAM skills (S)

Source: Authors’ own research results/contribution

These results suggest that the improved curriculum succeeded in conveying key sustainability-related knowledge and fostering essential skills. However, the slight variation in ratings across certain

outcomes indicates the need for further support in reinforcing less accessible concepts and expanding students' ability to translate theory into actionable understanding.

Conclusions

The results of this study highlight the significant contribution of the SKILLS4FUTURE project to enhancing students' satisfaction and academic engagement at Cahul State University "Bogdan Petriceicu Hasdeu." The integration of STEAM-based methodologies into the curriculum of the Business and Administration program has proven effective in stimulating active learning, creativity, and the development of transversal competencies essential for the modern labor market.
Analysis of student feedback across the modernized disciplines - Production Management, Quality Management, Innovation Management, Basics of Entrepreneurship and Human Resources Management - demonstrates that the applied pedagogical model, grounded in interdisciplinary learning and project-based methods, led to a high degree of perceived usefulness and satisfaction. Students valued both the relevance of course content and the opportunity to connect theoretical knowledge with real-life economic and managerial contexts.

The findings also confirm that educational innovation must be accompanied by continuous professional development for teaching staff and institutional support mechanisms that encourage experimentation and reflective practice.

In conclusion, the SKILLS4FUTURE initiative represents a valuable step toward aligning higher education in Moldova with the principles of Education 4.0, promoting an integrative, student-centered, and competence-oriented learning culture. Future research should extend the analysis to longitudinal outcomes - including employability, entrepreneurial intention, and professional self-efficacy - to better capture the long-term impact of STEAM-based curriculum innovation on both learners and educators.

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