

Education 4.0 and the skills demanded by employers in the labour market for higher education graduates

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Abstract

Global scientific progress requires a fundamental change in the education system regarding students' roles in learning and the methods of knowledge transfer and skill development. Education 4.0 stresses the importance of developing and nurturing STEAM skills to keep graduates competitive in the job market.

This study examined how employers and economic agents perceive the level of STEAM skills among students and graduates, in light of ongoing changes in Education 4.0 requirements, based on survey data from Cahul State University "B.P. Hasdeu". The findings will be used to update the university curriculum and educational content, ensuring graduates are prepared for the labour market.

Keywords: Education 4.0, STEAM skills, sustainable development, SDGs, digital technologies

Introduction

In recent years, humanity has experienced significant economic, industrial, environmental, and social changes. These changes are affecting and reshaping labour markets, job demand, and the skills needed for the future on a global scale, resulting in diverse economic paths across and within countries, both in developing and developed economies [1, p.8].

The exponential growth of the industry drives the modernisation of education, which is also experiencing radical changes - Education 4.0, focused on cultivating and developing skills aimed at using digital technologies, as well as "developing the individual potential of the student to be prepared with the necessary skills to build his future through innovation supported by technology" [2, p.146].

Additionally, Education 4.0 aims to foster flexibility and adaptability to new requirements, enhance critical skills for evaluating available information, and promote creativity. These qualities will help students and graduates find solutions to new challenges and the needs of emerging markets, and address problems in real-world environments, both individually and collaboratively.

Therefore, we contend that Education 4.0 underscores the importance of developing STEAM skills in students, which will benefit them in the workplace and set them apart from other personnel. This is due to workforce reconfiguration and increased demand for new occupations and skills, leading to a shift in the typical profile of the modern worker/employee.

Therefore, higher education institutions need to work closely with employers to evaluate the level of developed STEAM skills and propose new solutions to enhance them. In this context, to gather the opinions of employers and economic agents on the development of STEAM skills in students, a study was conducted with a sample of economic agents from Cahul district, during April-May, as part of project No. 101081787 – “Developing and improving the STEAM skills of students and teachers for curriculum innovation and sustainable development of higher education institutions and local businesses” (Skills4future) 2023.

This study aimed to identify and examine deficiencies in students’ development of STEAM skills from employers’ perspectives, as well as the presence of other skills currently needed in students, such as entrepreneurship, creativity, and innovation.

Materials and methods

The research was conducted on a sample of 12 practitioners and local employers/economic agents from the southern region of the Republic of Moldova. Data collection took place during April and May 2023, using a digital questionnaire administered via Google Forms. The questionnaire was structured into three parts:

1. Attitude, perception, and knowledge of sustainable development.
2. Practitioners and their level of STEAM skills.
3. Learning needs and expectations for developing STEAM skills.

Sample characteristics:

- The company profiles included: a local enterprise (SME) – 58.3%; a professional association – 8.3%; a civil society organisation – 16.7%; a government entity – 16.7%.
- Services represented the company's sector of activity – 33.3%; trade – 8.35%; water, sanitation and waste management – 8.35%; agriculture, fisheries and farming – 25%; industry/production – 25%.
- The company’s size was represented by: < 10 – 41.7%; 11-50 – 25%; 51-250 – 25%; > 250 – 8.3%.
- The functions of respondents/practitioners were represented by: Execution with technical responsibilities – 16.7%; management with decision-making responsibilities – 83.3%.
- Several question types were used in the research, including Likert-scale and closed-ended questions, to collect both quantitative and qualitative data.

Results and discussion

In this study, the first part aimed to explore and analyse the attitude, perception, and knowledge of sustainable development among employers, covering the following aspects:

- Practitioners' values are related to sustainable development.
- Practitioners' awareness of the 17 SDGs.
- The degree of adoption of behaviour to become more sustainable.
- Perceived share of responsibility for implementing the SDGs.
- The main contribution of the company/employer to the SDGs.
- Practitioners' awareness of key digital technologies.
- The company's/employer's goal is to invest in digital technologies.
- The company's/employer's challenges in implementing digital technologies.

The initial aspect analysed was practitioners' values related to sustainable development, and the results are presented in Figure 1 below.

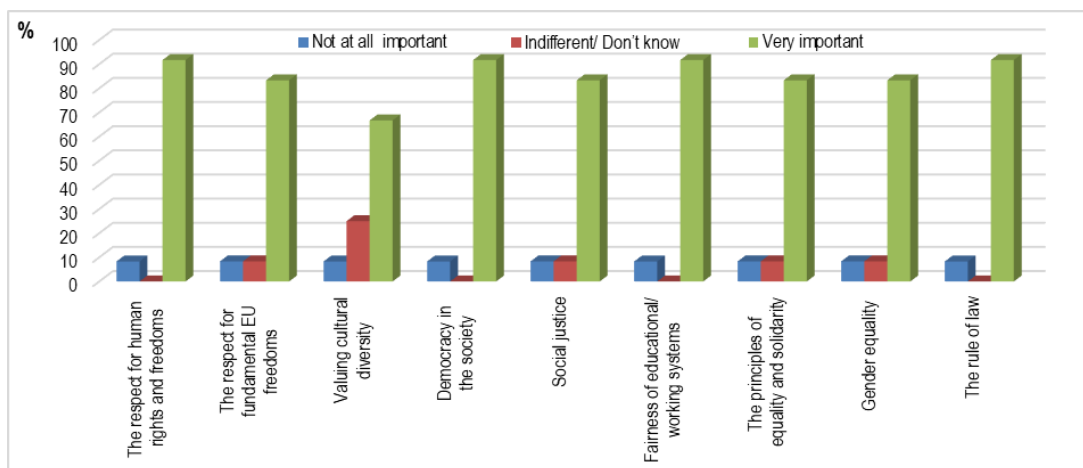


Figure 1. The distribution of practitioners' values related to sustainable development

From Figure 1, it can be observed that 91.7% of respondents consider it very important to “respect human rights and freedoms” (i.e., dignity, equality, solidarity, justice, citizens' rights, etc.). However, for one of the respondents (8.3%), respect for these values is not at all important. A similar result was obtained for “Democracy in society, fairness of educational/working systems” and “The rule of law,” which 91% of the surveyed considered very important, and for 8.3% of the interviewed practitioners, these values are not at all important. The majority of respondents (83.3%) consider “respect for fundamental EU freedoms” (i.e., free movement of goods, capital, services, and labour), “Social justice”, “the principles of equality and solidarity”, and “gender equality” to be fundamental, and only 8.35% believe they are not at all important or are indifferent. Fewer interviewed practitioners (only 66.7%) consider “Valuing cultural diversity” very important.

The analysis of practitioners' awareness of the 17 Sustainable Development Goals (SDGs) is presented in Figure 2.

Analyzing the responses of the interviewed practitioners, it becomes evident that most of them are familiar with the 17 objectives of sustainable development and their implications.

Therefore, out of the total respondents, 83,3% understand what the objectives represent: SDG5. Gender equality (achieve gender equality and empower all women and girls), SDG6. Clean water and sanitation (ensure the availability and sustainable management of water and sanitation for all), SDG 8. Decent work and economic growth (sustainable economic growth, full and productive employment, and decent work for all), SDG13.

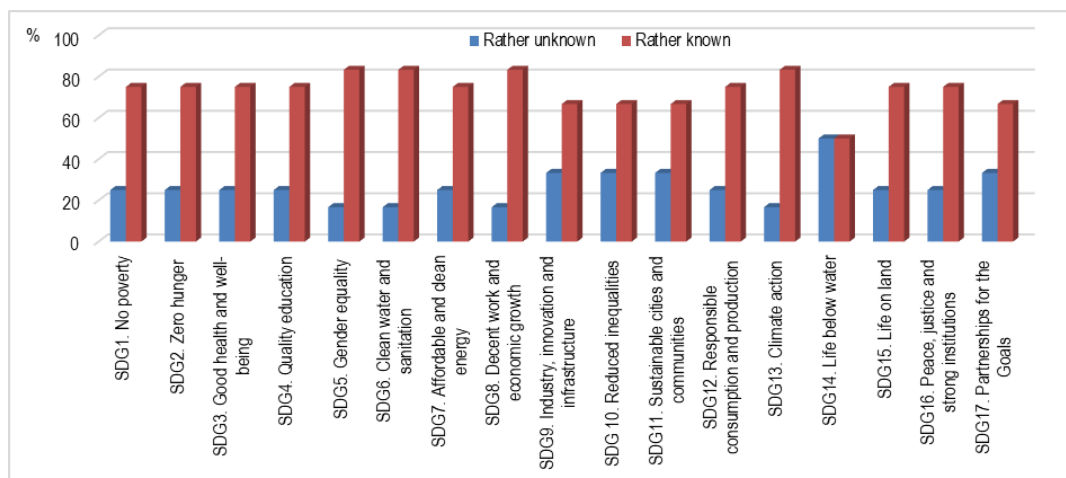


Figure 2. The distribution of practitioners' awareness related to 17 SDGs

Climate action involves taking urgent steps to combat climate change and its impacts. 75% of surveyed practitioners are aware of what each of the SDGs- SDG1, SDG2, SDG3, SDG4, SDG7, SDG12, SDG15, and SDG16- represent. Of the 12 respondents, 66.7% understand the meaning of SDG9. Industry, innovation and infrastructure aim to build resilient infrastructure, promote sustainable industrialisation and foster innovation, in line with SDG 10. Reduced inequalities (SDG 10) focus on reducing disparities within and among countries. Sustainable cities and communities (SDG 11) strive to make urban areas and human settlements inclusive, safe, resilient, and sustainable. SDG 17 emphasises partnerships for the goals, aiming to strengthen means of implementation and revitalise the global partnership for sustainable development. Less clear is the goal of SDG 14- Life Below Water- which involves conserving and sustainably using the oceans, seas, and marine resources; only 50 % of the surveyed practitioners perceive this goal.

The third aspect examined is the extent of adopting behaviour for more sustainable departure, and the results are shown in Figure 3.

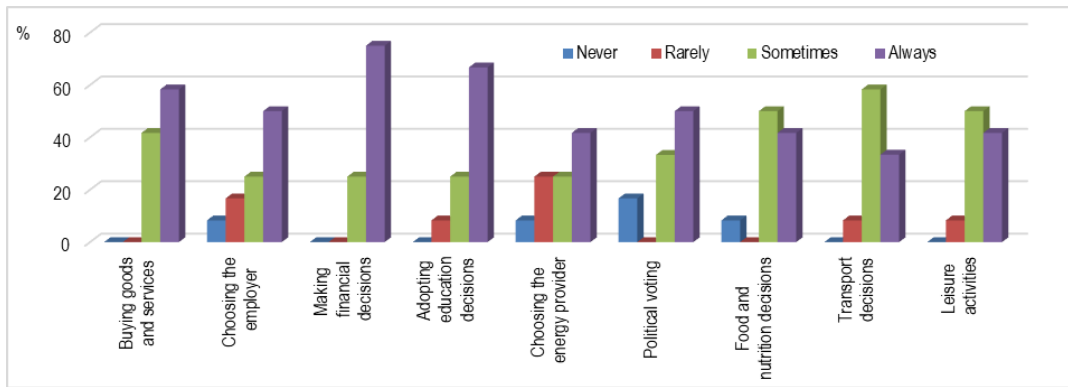


Figure 3. The degree of adoption of responsible behaviour

From the results presented in Figure 3, it was observed that much attention is paid to sustainability issues in financial decisions (75.0% - always and 25.0% - sometimes). Sustainability issues are also considered when making educational decisions (66.7% - always, 25.0% – sometimes, and 8.3% - rarely). On the other hand, for political voting, respondents consider sustainability issues less frequently (50.0%- always, 33.3% – sometimes, and 16.7%- never).

The next aspect examined concerns the Perceived Share of Responsibility for Implementing the SDGs and is shown in Figure 4. Socially responsible economic and public entities will adopt policies that promote societal and environmental well-being, while reducing the negative impacts of their activities; they will act responsibly for several reasons: they will focus their efforts on ensuring good working conditions, promote volunteering, monitor gender balance, and invest in social projects [3, p.11].

According to all respondents, “Government organisations/*the state*” are the leading and most important institutions responsible for implementing SDGs. 91% of respondents consider that “Organisations from the business environment” are equally important in implementing the SDGs, followed by “Higher Education Institutions” (75% of surveyed practitioners). Only 58,3% of practitioners believe that Civil society is also responsible for implementing the SDGs.

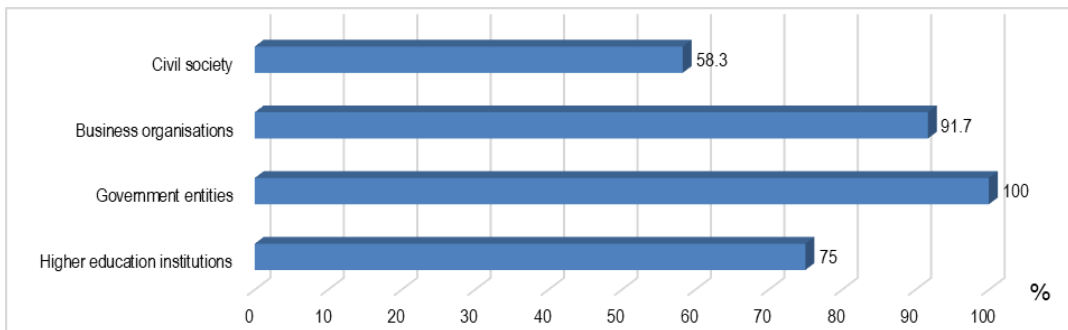


Figure 4. The share of responsibility for implementing SDGs

The company/employer’s main contribution to the SDGs is presented in Figure 5.

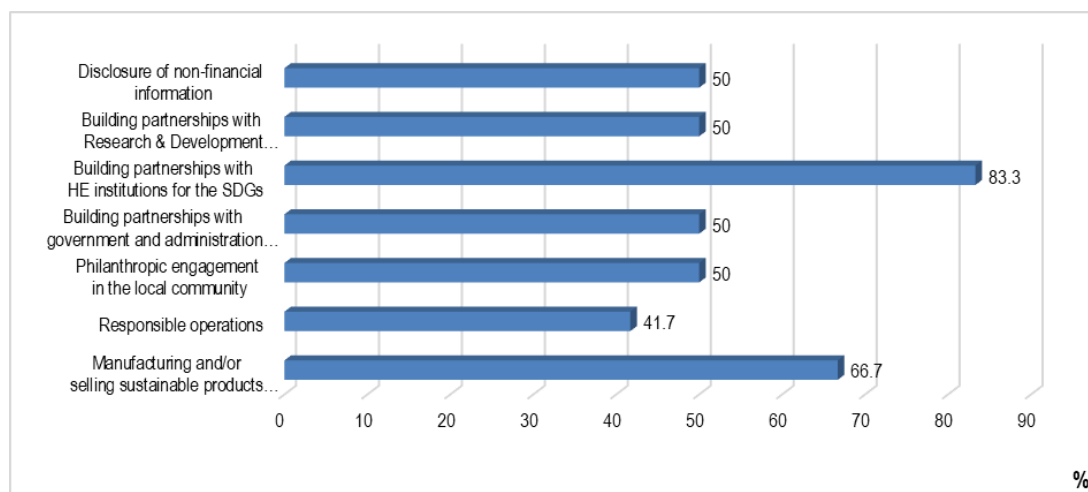


Figure 5. The main contribution of the company/employer to the SDGs

From the obtained results, it can be observed that most contributions of companies/employers to the SDGs (83.3%) are directed towards “Building partnerships with HE institutions for the SDGs”, followed by manufacturing and/or selling sustainable products and/or services (66.7%). Only 50% of practitioners indicated their company's/employer's contribution to SDGs for “Philanthropic engagement in the local community”, “Building partnerships with government and administration for the SDGs”, “Building partnerships with Research & Development institutions for the SDGs”, and disclosure of non-financial information (i.e., sustainability reporting). The smallest contribution (41.7%) is for “Responsible operations.”

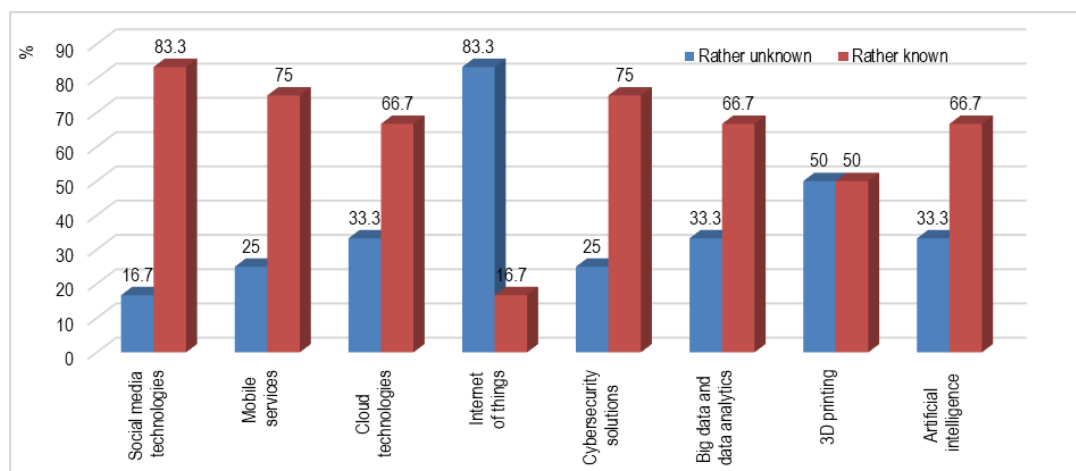


Figure 6. Awareness related to key digital technologies

Another aspect examined is practitioners' awareness of key digital technologies. Currently, business processes are undergoing digitalisation, which enhances operational efficiency within the company. The results are displayed in Figure 6.

Practitioners are highly familiar with the methods and guidelines for using key digital technologies to transform business operations, mainly social media technologies (83.3%), mobile services (75.0%), and cybersecurity solutions (75.0%). However, some areas remain less well understood, including 3D printing (50.0%) and cloud technologies, big data, data analytics, and artificial intelligence (66.7%).

It is interesting to know the company/employer's purpose of investing in digital technologies; this aspect is presented in Figure 7.

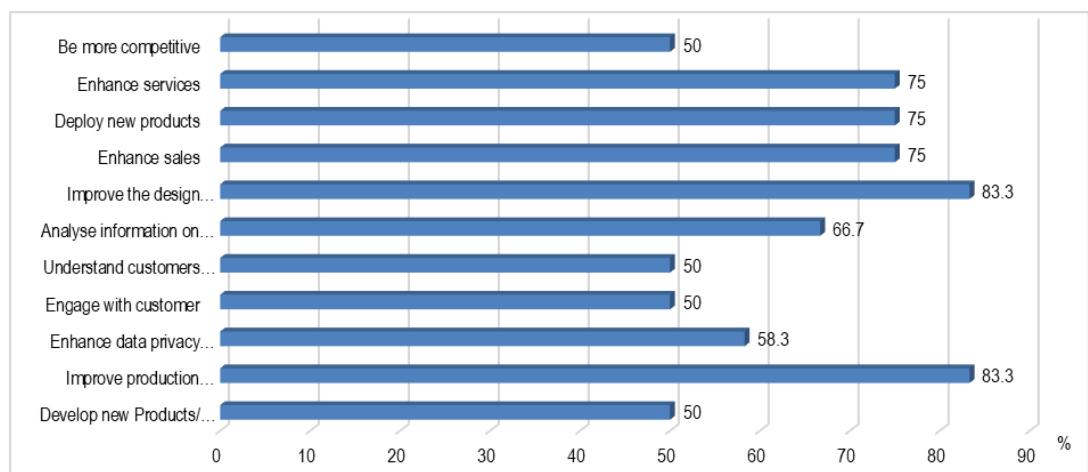


Figure 7. The objectives of investments in digital technologies

According to practitioners (83.3% of respondents), the purpose of investing in digital technologies is to improve production processes and design. 75% of the surveyed practitioners believe that the aim of investing in digital technologies could be to increase sales, boost the company's competitiveness, and enhance services. Fewer practitioners (50%) agree that the purpose of investing in digital technologies should include retraining the workforce, understanding customer behaviours, engaging with customers, and developing new products or services generated by digital technologies. Of the 12 people surveyed, 7 (58.3%) think the aim of investing in digital technologies is to ensure data confidentiality and protect customer data.

Respondents also mentioned the challenges the company/employer faces in implementing digital technologies, as shown in Figure 8.

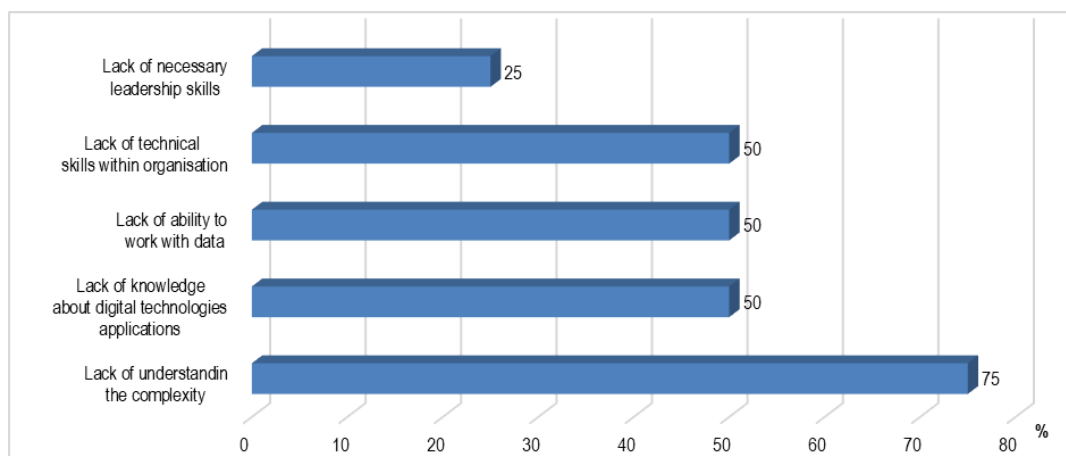


Figure 8. The challenges of using digital technologies

For 75% of respondents, the challenges in implementing digital technologies are due to the difficulties in understanding the complexity generated by digital technologies, and for 50% — because of Lack of knowledge about digital technologies applications, Lack of ability to work with data, and Lack of technical skills within organisations. The challenges in implementing digital technologies are less related to Lack of necessary leadership skills (25% of respondents).

The second part of the questionnaire relates to Practitioners and their level of STEAM skills. The primary focus is on the company or employer's perception of the STEAM skills possessed by young graduates in relation to the company's internal needs, as shown in Figures 9 and 10.

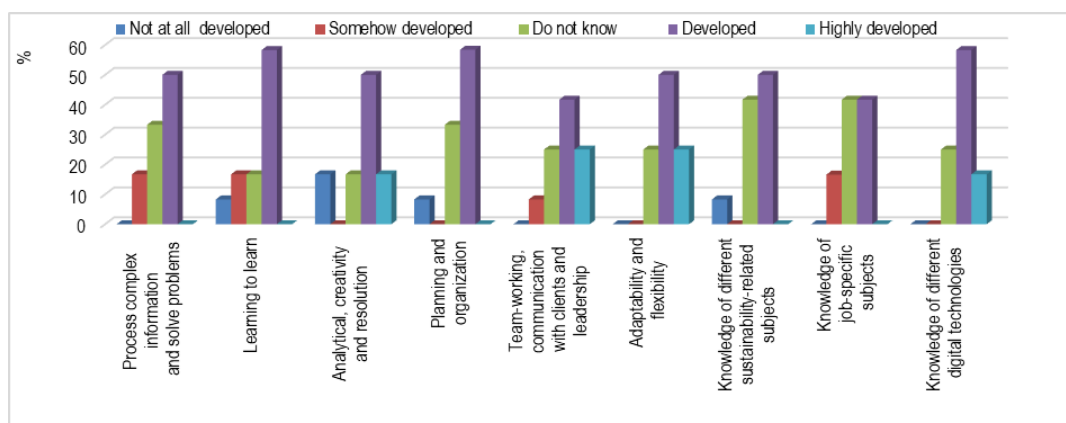


Figure 9. The level of cognitive skills possessed by young HE graduates

Practitioners assess that higher education graduates possess varying levels of non-digital skills, ranging from advanced to satisfactory. However, there are also unsatisfactory ratings in specific areas:

- learning to learn – 8.3%.
- analytical, creativity, and resolution – 16.7%.
- planning and organisation – 8.3%.
- knowledge of different sustainability-related subjects (e.g., economic, environmental, and social issues) – 8.3%.

From the results, it can be concluded that technical skills are generally more developed than intellectual and socio-emotional skills.

The responses indicate that digital skills are usually well developed, although some areas are less advanced:

- evaluating and managing data, information, and digital content (8.3% – not at all developed).
- integrating and re-elaborating digital content (8.3% - somewhat developed).

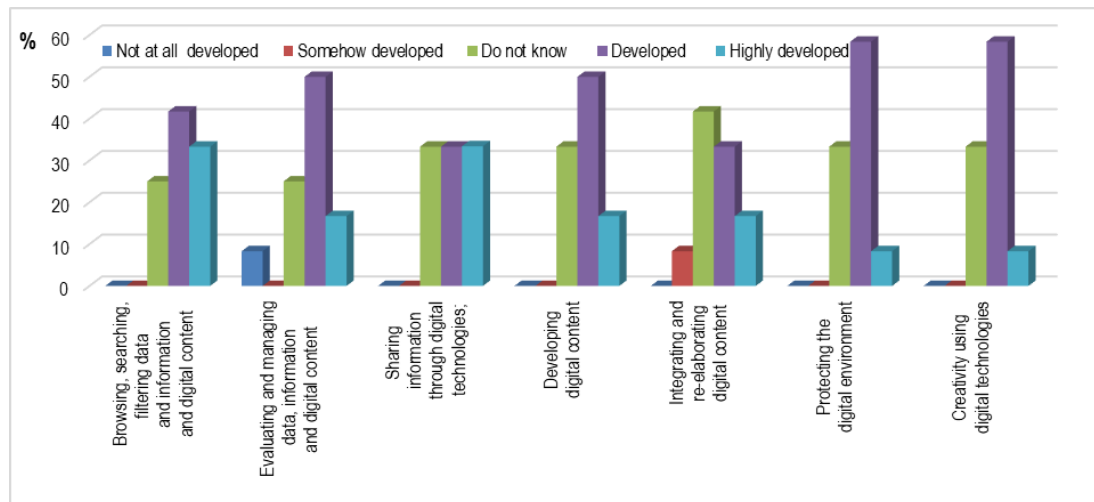


Figure 10. The digital skills level among young HE graduates

The third part of the survey aimed to investigate Learning Needs and Expectations for STEAM skills development. This section also considered the following research directions: the company's/employer's learning expectations regarding subjects that are useful for young graduates to understand sustainability-related topics, and the company's/employer's learning expectations regarding STEAM knowledge and skills. The company's/employer's learning expectations concerning subjects that help young graduates understand sustainability-related directions are shown in Table 1.

Table 1. Employers' expectations for subjects to be taught

	Not useful	Useful	Very useful
ECONOMIC subjects			
Sustainable Procurement Practices	0%	58.3%	41.7%
Competition, fair-trade regulations and practices	0%	41.7%	58.3%
Green business, green finance and investments	0%	50%	50%
Resource efficiency through sharing economy: co-working space, crowdfunding, freelancers, etc.;	8.3%	33.3%	58.3%
Sustainable consumption and production: circular economy and EU action plan for circular economy;	0%	58.3%	41.7%
Innovation & product responsibility	0%	33.3%	66.7%
Corporate social responsibility	0%	58.3%	41.7%
Social entrepreneurship	0%	58.3%	41.7%
ENVIRONMENTAL subjects			
Environmental compliance	0%	41.7%	58.3%
Supplier environmental assessment	0%	41.7%	58.3%
Circular economy – green productions and consumption, waste to resources – secondary raw materials and water reuse, etc.	0%	41.7%	58.3%
SOCIAL subjects			
Green jobs and local community engagement.	0%	50%	50%
Sustainable employments	0%	41.7%	58.3%
Social and labour protection	0%	58.3%	41.7%
Occupational health and safety	0%	50%	50%
Diversity, equal opportunities, and human rights	0%	50%	50%
Sustainable lifestyle and education	0%	33.3%	66.7%

According to practitioners, all the subjects presented in Table 1 are useful for young graduates to understand sustainability-related directions. The cumulative frequency of the 'sustainability' parameters for the qualifiers 'useful' and 'very useful' sums to 100% for all indicators, except Resources Efficiency through Sharing Economy: co-working spaces, crowd-funding, freelancers, etc. (Economic subject), which accounts for 91.7%.

The company/employer learning expectations concerning STEAM knowledge & skills:
The data analysis shows the learning expectations for STEAM knowledge as presented in Table 2:

Table 2. Employers' expectations for STEAM knowledge

STEAM knowledge	Not useful	Somewhat extent	Useful	Very useful
K1. To know the main values and principles underpinning socio-economic models and their relation to sustainability	0	8.33	58.33	33.33
K2. To know that when human demand for resources is driven by greed, indifference and unfettered individualism, this has negative consequences for the environment	0	0	33.33	66.67
K3. To know that ethical concepts and justice for current and future generations are related to protecting nature	0	0	41.67	58.33
K4. To know about environmental justice, namely, considering the interests and capabilities of other species and environmental ecosystems	0	0	25	75
K5. To know that humans shape ecosystems and that human activities can rapidly and irreversibly damage ecosystems	0	0	25	75
K6. To know about the need to decouple production from natural resources and wellbeing from consumption	0	0	50	50
K7. To know the main concepts and aspects of complex systems (synthesis, emergence, interconnectedness, feedback loops and cascade effects) and their implications for sustainability	0	8.33	66.67	25
K8. They know the UN SDGs and are aware of interconnections and possible tensions between individual goals	0	8.33	58.33	33.33
K9. To know that sustainability claims without robust evidence are often mere communication strategies (e.g. green washing)	0	8.33	75.00	16.67
K10. To know that tackling sustainability patterns requires challenging the status quo, at the individual and collective levels, by organisations and politics	0	8.33	75.00	16.67

STEAM knowledge	Not useful	Somewhat extent	Useful	Very useful
K11. To know that sustainability problems are often complex and that some cannot be solved entirely	0	8.33	41.67	50.00
K12. To know that current or potential sustainability problems can quickly evolve and therefore need to be frequently redefined and reframed	0	0	50.00	50.00
K13. To know that there is no single solution to complex socio-economic problems, but rather different alternatives depending on time and context	0	0	58.33	41.67
K14. To know which aspects of personal lifestyle have higher impacts on sustainability and require adaptation (e.g. air travel, car usage, meat consumption, fast fashion)	0	8.33	41.67	50.00
K15. To know that sustainability problems must be tackled by combining different disciplines, knowledge cultures and divergent views to initiate systematic change	0	0	50.00	50.00
K16. To know about sustainability, including origins and further developments, main stakeholders, implications for society and the planet, environmental protection, restoration and regeneration	0	8.33	50.00	41.67
K17. To know how political systems, including their components, should work for sustainability	0	8.33	66.67	25.00
K18. To know the policies that assign responsibility for environmental damage.	0	0	50.00	50.00
K19. To know the main sustainability stakeholders in the community and how to contact them	0	0	58.33	41.67
K20. To know the importance of empowering individuals and organisations to work collaboratively	0	0	66.67	33.33
K21. To know that preventive action should be taken when certain action/inaction may damage human health and all life forms (precautionary principle)	0	0	58.33	41.67
K22. To know that every action has an impact, even if not immediate	0	0	58.33	41.67

The data analysis shows the learning expectations for STEAM skills as presented in Table 3:

Table 3. Employers' expectations for STEAM skills

STEAM skills	Not useful	Somewhat extent	Useful	Very useful
S1. To be able to evaluate issues and actions based on sustainability values and principles	0	0	41.67%	58.33
S2. To be able to bring personal choices and actions in line with sustainability values and principles	0	0	4	66.67
S3. To be able to apply equity and justice for current and future generations as criteria for environmental preservation and the use of natural resources	0	0	4	66.67
S4. To be able to assess and question personal needs to carefully manage resources in the pursuit of longer-term goals and common interests	0	0	25	75
S5. To be able to assess one's own impact on nature and consider the protection of nature as an essential task for every individual	0	0	50	50
S6. To be able to identify processes or actions that avoid or reduce the use of natural resources	0	0	41.67	58.33
S7. To be able to assess interactions between environmental, economic, social, and cultural aspects of sustainability action, events and crises (e.g. migration caused by resource scarcity)	0	0	41.67	58.33
S8. To be able to use life cycle thinking to analyse the risks and benefits of human action	0	0	75	25
S9. To be able to apply personal reasoning to address criticism and arguments on sustainability matters	0	0	58.33	41.67
S10. To be able to look at various sources of evidence and assess their reliability to form opinions about sustainability	0	0	4	8
S11. To be able to apply a flexible, systemic, life-cycle and adaptive approach when framing current and potential sustainability challenges	0	0	41.67	58.33
S12. To be able to continuously explore the problem of a sustainability issue to broaden the range of alternatives and solutions	0	0	41.67	58.33
S13. To be able to identify and adapt to different lifestyles and consumption patterns, to use fewer natural resources	0	0	50.00	50.00

STEAM skills	Not useful	Somewhat extent	Useful	Very useful
S14. To be able to take into account local circumstances when dealing with sustainability issues and opportunities	0	0	58.33	41.67
S15. To be able to synthesise sustainability-related information and data from different disciplines	0	8.33	50.00	41.67
S16. To be able to apply circular economic concepts, such as valuing quality over quantity and reusing and repairing	0	0	8	4
S17. To be able to analyse how power structures and political systems exert influence	0	8.33	58.33	4
S18. To identify relevant social, political and economic stakeholders in the community and region to address a sustainability problem	0	8.33	50.00	41.67
S19. To be able to create opportunities for joint action across communities, sectors, and regions	0	0	58.33	41.67
S20. To be able to work collectively in sustainability change processes	0	8.33	58.33	4
S21. To apply the principle of using fewer resources, doing better with fewer resources, and reusing the same resources	0	0	41.67	58.33
S22. To act promptly, even in the face of uncertainty and unforeseen events, keeping in mind the precautionary principle	0	0	50.00	50.00

According to the respondent entrepreneurs, graduates of higher education who are prepared in sustainable business development or sustainability should possess all parameters analysed through STEAM knowledge, which collectively have a cumulative frequency of over 80%. Most of these parameters reached a cumulative frequency of 100% - K2, K3, K4, K5, K6, K12, K13, K15, K18, K19, K20, K21, and K22.

However, some respondents believe that some STEAM knowledge is only somewhat useful (8.33% of respondents), such as:

- K1. To understand the main values and principles underpinning socio-economic models and their relation to sustainability
- K7. To grasp the main concepts and aspects of complex systems (synthesis, emergence, interconnectedness, feedback loops, and cascade effects) and their implications for sustainability
- K8. To know the UN SDGs and be aware of the interconnections and possible tensions between individual goals

- K9. To understand that sustainability claims without robust evidence are often mere communication strategies (e.g., greenwashing)
- K10. To recognise that addressing sustainability patterns requires challenging the status quo, at both individual and collective levels, by organisations and policymakers
- K11. To acknowledge that sustainability problems are often complex and that some cannot be entirely solved
- K14. To identify which aspects of personal lifestyle have higher impacts on sustainability and require modification (e.g., air travel, car usage, meat consumption, fast fashion)
- K16. To understand sustainability, including its origins and future developments, key stakeholders, implications for society and the planet, as well as environmental protection, restoration, and regeneration
- K17. To comprehend how political systems, including their components, should function to promote sustainability.

Similar results were observed for STEAM skills. Therefore, according to the respondents, higher education graduates specialising in sustainable business development and sustainability should possess all the parameters assessed by STEAM skills, with a collective frequency exceeding 80%. Most of these parameters reached a cumulative frequency of 100% for S1 – S14, S16, S19, S21, and S22.

However, some respondents believe that specific STEAM skills are only somewhat useful (8.33% of respondents), such as:

- S15. The ability to synthesise sustainability-related information and data from different disciplines
- S17. The ability to analyse how power structures and political systems exert influence
- S18. The ability to identify relevant social, political, and economic stakeholders in the community and region to address a sustainability problem
- S20. The ability to work collectively in sustainability change processes.

Conclusions

Based on the study results, we observe that entrepreneurs are knowledgeable about the United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs), with values linked to sustainable development being highly significant. Furthermore, respondents are concerned about integrating digital technologies within companies and their utilisation across various levels and operations, and are open to their ongoing development. Consequently, we can anticipate that industry transformations will continue, mainly focusing on the human workforce and on developing skills to apply the knowledge and abilities they have gained.

Therefore, the university must serve as the pillar that oversees these changes and prepares qualified specialists for the necessary jobs by offering modern educational content that encourages learning, through the assimilation of knowledge and the development of skills.

Finally, Cahul State University “B.P. Hasdeu” is a driving force in southern Moldova, promoting, supporting, and facilitating students' access to quality educational services at the regional level, centred on the development of STEAM skills and knowledge. We will strengthen collaborative relationships with the business sector and regional organisations,

which are the leading employers, and work together to shape competent and adaptable young people prepared for future economic shifts and industrial trends.

Acknowledgments

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