School-Enterprise-University Cooperation for the Effective Implementation of Natural Science Education Goals

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Abstract: Georgia's education system encompasses primary, basic, and higher education. Strong, continuous interconnections between these levels are crucial, with open communication between schools and universities. Integrating industry partners enhances the practical application of classroom knowledge through real-world experiences, refining skills in university settings. A multi-stage lesson module was developed, involving collaboration among students, schoolteachers, industry professionals, and university students. The participating schools were: Batumi Public School No. 7 and the Public School of Charnali village. The industrial partner is "Batumi Brewery." Batumi State University professors organised the research. The instructional sequence began with an engaging exploration of the digestive system, employing interactive role-playing and situational learning strategies. Subsequent phases delved into the socio-economic importance of beer within local communities, involving 165 participants in a carefully crafted questionnaire-based research initiative. High school students conducted a detailed market analysis of beer brands, uncovering that "Batumi Beer" enjoyed significant consumer preference, alongside strong market penetration by international brands such as the Dutch "Heineken" and the German "Löwenbräu." A specialized scientific lesson on "Glucose and Alcoholic Fermentation" offered in-depth theoretical insights into biochemical processes, enriched by an experiential site visit to the Batumi Brewery. The project concluded with a university-hosted event titled "We Choose a Healthy Lifestyle," reinforcing the program's holistic educational objectives. This interdisciplinary collaboration between educational institutions and industrial entities exemplifies an advanced pedagogical model that transcends traditional learning paradigms. By integrating theoretical instruction with hands-on experiences, the approach not only enhances educational engagement but also serves as a powerful motivational tool for students and educators alike.

Key-Words: - Sustainable development, health, enterprise, lesson, education, brewery.

Received: August 11, 2024. Revised: December 12, 2024. Accepted: December 27, 2024. Published: December 31, 2024.

1 Introduction

In September 2015, achieving the Sustainable Development Goals by 2030 was defined as the world's agenda. The states implementing this framework adapted it to their national context [1], [2], [3]. All countries of the world have shifted the

issues of sustainable development to the national Perspective, [4], [5], [6], [7], [8], [9], [10], [11], [12].

Education is significantly responsible for realizing the Sustainable Development Goals. Enhancing consciousness is the most effective pathway for young people to develop transformative values. Instruction at all educational levels must invariably incorporate the principles of sustainable development. Young people should learn with an orientation towards future developments or progress. They must be afforded opportunities to engage in reassessing existing systems.

'Education for Sustainable Development' integrates the principles of sustainable development into education to transform the concept of sustainability into reality. This approach empowers individuals to cultivate sustainable expertise and adaptive skills, enabling them to thrive professionally while maintaining ecological consciousness. It fosters and empowers individuals, organizations, and nations to assess events and processes, enabling them to make informed choices that contribute to the assurance of sustainable development", [13], [14], [15, [16].

It is crucial to recognize that each individual has the power and responsibility to drive positive change and innovative ideas on a global scale. The future of humanity depends on our actions today. Hope for a better future emerges through values-based education, which nurtures a generation grounded in sound principles, creating a secure environment and safeguarding humanity's future, [17], [18].

Implementing a unified, systemic approach to sustainability in education enables students to discover interconnections within and across academic disciplines, particularly in the natural sciences. This approach facilitates more effective knowledge and skill transfer to new contexts and real-life scenarios. A unified institutional approach bridges educational concepts with dynamic surrounding processes and events by aligning with the Sustainable Development Goals.

Teaching styles and assignment design significantly impact learning outcomes. Effective methods include research-based, field-based, problem-based, project-based, and theme-based learning approaches. Encouraging discussions and debates promotes critical information analysis and fosters students' moral and value development. Students must be prepared to engage in diverse cognitive tasks, enabling them to navigate and resolve complex issues effectively. This requires accurately identifying problems, recognizing when to seek additional resources, and knowing how to take appropriate action, [19], [20].

Collaboration with partner organizations is also crucial for the implementation of school activities. As is known, Georgia's education system includes several levels: primary, basic, and higher education. Notably, there should be close interconnections among these levels, with schools and universities maintaining constant communication, [21], [22]. Additionally, integrating partner organizations from the industry is of great interest. The practical application of knowledge acquired during the classroom process can take place within industrial settings, and this knowledge can be effectively utilized within the university environment, [23], [24], [25].

Project Objective: By introducing students to the operational features of the Batumi Brewery and observing beer brewing technologies, we aim to stimulate their interest in biochemical processes. Our goal is to enhance students' motivation in natural sciences by demonstrating the relevance of these subjects in understanding and managing processes within our environment and bodies. Additionally, the study seeks to promote healthy lifestyle practices among students.

General Research Question: What fundamental theoretical and practical skills do students need to develop to be successful in the natural sciences (particularly biology and chemistry)?

This research aligns with the following Sustainable Development Goals (SDGs): Goal 3, which aims to ensure healthy lives and promote well-being for all people of all ages, and Goal 12, which aims to ensure sustainable consumption and production patterns.

2 Research Materials and Methods

In this study, we employed a mixed-methods approach to gather comprehensive data. The primary methods utilized included questionnaires and open-ended questions, which provided valuable insights into participants' perspectives and experiences. Several pedagogical methods were employed, including lectures, classroom instruction, structured discussions, laboratory activities, scientific research projects, project-based learning, role-playing, discussion, presentations, excursions, and organized events to facilitate experiential learning. Observational techniques were also employed to capture real-time interactions and behaviors during these sessions. Combining qualitative and quantitative methods allowed a holistic understanding of the research topic. At the

research's outset, Batumi State University professors from natural sciences and healthcare developed a multi-stage lesson module comprising six key phases. The module's implementation involved public school students from grades VIII to XI, school teachers, industry professionals, university students, and professors. Participating schools included Batumi Public School No. 7 (10 students with a biology-specializing lead teacher) and the Public School of Charnali village in Khelvachauri Municipality (10 students with a chemistry-specializing lead teacher). The schools' involvement originated from the university's existing collaboration memorandum, with VIII and XI grade classes purposefully selected. Under Georgia's National Education Plan, these classes study digestive systems, enzymatic reactions, alcoholic fermentation, and related topics in detail. Students at this age demonstrate enhanced capabilities in project preparation and causal-consequential analysis. The "Batumi Brewery" served as the industrial partner. Four professors from the Biology Department at Batumi State University organized the research, with six first- and second-year biology bachelor-level students participating.

Our lesson module was designed by the professor-educators from the leading organization (Batumi Shota Rustaveli State University) and was coordinated with partner organizations. The partner organizations were public schools and industry. The final structure of the lesson module was established through an exchange of ideas and collaboration among the involved parties.

The structure of the lesson module is outlined as follows:

Stage 1: Lesson - Topic “Digestive System“

Stage 2: Activity - "What Role Does Beer Play in the Lives of Our Community?" This involves a survey of the population using a specialized questionnaire and its subsequent analysis. Students conducted the analysis and interview.

Stage 3: Activity—"Researching the Beer Market." This activity examines the sales of local and imported beers based on data from several supermarkets in Batumi.

Stage 4: Lesson – Topic: "Glucose and Fermentation."

Stage 5: Activity - "How is Beer Produced in Batumi?" This includes a visit to the Batumi Brewery by schools and university students.

Stage 6: University event - "Choosing a Healthy Lifestyle."

In the first phase of the research, a first lesson was conducted for the school students. The instructional process focused on the digestive system, during which alcoholic and non-alcoholic beverages and their effects on the growth and development of the body were discussed. This educational process involved Batumi Public School No. 7 students and their biology teacher.

In the subsequent phase of the research, students assessed the population's level of awareness regarding beer. They investigated the popularity of the beer among fellow citizens, as well as their understanding of the brewing technology specific to Batumi beer and the general positive and negative aspects associated with beer consumption. A specialized questionnaire was developed by the university professors for this phase, targeting volunteers aged 16 to 50. The questionnaire comprised closed and open-ended questions. A total of 165 respondents participated in the study. Later students performed a biostatistical analysis and a comprehensive evaluation of the results.

In the next stage, students examined the beer brands in the Georgian market. To facilitate this, they selected two major supermarkets in Batumi city („Agrohub“, and „Carrefour“) and explored the beer sections within these establishments. They identified both local and imported beer brands in the Georgian market. Consultations with store representatives distinguished the most popular and in-demand brands.

In the subsequent phase of the research stage, a teacher conducted a lesson on the topic: "Glucose and fermentation reactions." This instructional process involved students from the Public School of Charnali and their chemistry teacher.

In the next phase of the research, Students visited the „Batumi Brewery“ where they conducted interviews with the director and employees of the brewery. The activity aimed to familiarize students with the operation of the Batumi Brewery and to promote the selection of natural science fields as their future profession. This initiative aimed to enhance their motivation and to illustrate potential employment opportunities in these fields.

The brewery employees provided students with insights into the history of the Batumi brewery's establishment, its significance for the region, and its potential for future development, both within the specific context of the Adjara region (Western part of Georgia Republic) and at the national level (Republic of Georgia). Students were also introduced to the laboratory equipment used in the mentioned brewery and the technological processes underlying beer production. Their observation of the

brewing process significantly enhanced their motivation to explore the concepts of fermentation and alcoholic fermentation.

The final activity involved both school and university students. During the culminating event titled "Choosing a Healthy Lifestyle," the BSU students presented some posters and video clips on healthy living.

Statistical methods were employed to process the research questionnaire. We used the general formula for calculating chi-square. This test assesses the difference between observed (O) and expected (E) values. We used an on-variable chi-square as in some cases a variable chi-square criterion.

3 Results and Discussion

Before the commencement of the study, the students participated in a lesson focused on the digestive system. During the lesson, they were introduced to the structural characteristics of the organs within the digestive system, and the details of their specific functioning. Additionally, the mentioned lesson covered both alcoholic and non-alcoholic beverages and their effects on the growth and development of the human body. This lesson was conducted for 8th-grade students at Batumi Public School No. 7 as part of the biology national curriculum. The lesson spanned two academic hours (45-45 minutes) which was engaging, enjoyable, and filled with various teaching activities. All participating school students were equally involved in the learning process. To enhance students' understanding of the topic, the lead teacher utilized illustrative materials, including different models of the relevant system. Role-playing and situational games were also employed effectively during the lesson. The students wore white T-shirts displaying the digestive organ they represented, and they took turns describing the characteristics of their assigned organ. They explained their specific functions. The students discussed the liver's role in the detoxification process of both low-alcohol and alcoholic beverages. The students also effectively simulated the processes of digestion, specifically demonstrating how organic compounds (carbohydrates, proteins, and lipids) are broken down into simpler organic substances and ultimately into monomers and how these monomers are used by the cell. Students effectively identified specific enzymes involved in the digestion of carbohydrates, proteins, and lipids. By the end of the lesson, the students had a comprehensive understanding of the digestive system, including the structural characteristics, location, and specific functions of its organs. This was evidenced by a quiz (MCQ) activity conducted at the end of the lesson, which assessed their knowledge. Most of them completed the quiz with excellent and high scores (Figure 1, Appendix).

The next activity involved students determining the role beer plays in the lives of residents (city of Batumi, West part of Georgia Republic). A specially designed questionnaire was developed to carry out this task. People of various ages (16-50 years) participated in completing the questionnaire, with a total of 165 participants. The age group selection was primarily based on the observation that individuals within this specific age range tend to exhibit relatively higher levels of beer consumption. The students then statistically analyzed the data and created corresponding tables for each question. Analysis of each research question is presented in Appendix in the Table 1, Table 2, Table 3, Table 4 and Table 5).

The first question was: "What role does beer play in your life?" According to the responses, 29% of respondents are frequent beer consumers, while a substantial portion (26%) indicated that they do not consume beer. Additionally, 40% reported that they drink beer only occasionally, and for only 5% of respondents, beer is a part of their daily routine, with near-daily consumption (Table 1, Appendix). χ^2 value is equivalent to 25.68, The P-value is .000011. The result is significant at $p < .05$.

To the second Question: "Which brand of beer do you prefer?" the majority of respondents (43%) do not highlight their preferences for locally produced or imported beer. However, a significant portion (41%) prefers locally produced beer, while a smaller group (16%) favors imported beer (Table 2, Appendix). χ^2 value is equivalent to 13.56. The P-value is .001136. The result is significant at $p < .05$.

Table 3 (Appendix) indicates that most respondents (52%) have a positive opinion of Batumi beer. A notable portion (23%) has never tried it, while 21% are unsure or find it difficult to express an opinion. Only a small percentage (4%) dislike Batumi beer (Table 3, Appendix). χ^2 value is equivalent to 47.6. The P-value is < .00001. The result is significant at $p < .05$.

Table 4 (Appendix) reveals that a significant number of respondents (88%) correctly recognize that beer can be made from all the listed ingredients. However, only a small percentage identified barley malt (5%), wheat (3%), rye (2%), and rice (2%) as specific ingredients used in beer production (Table 4). χ^2 value is equivalent to 289.3. The P-value is < .00001. The result is significant at $p < .05$.

Table 5 (Appendix) illustrates the respondents' perceptions of safe beer consumption levels. A notable percentage believes one can per week (28%) is not harmful, while 22% feel it is acceptable. Additionally, 14% consider one to three cans per day safe, and 13% believe one can per month poses no health risk. For 23% of respondents, it is difficult to say (Table 5, Appendix). χ^2 value is equivalent to 8.1. The P-value is .087983. The result shows no significance at $p < .05$. The results don't regret the 0 hypothesis in this current case.

Respondents were also asked to answer two open-ended questions: "What benefits does drinking beer bring?" and "What harm does drinking beer cause?" The students gathered the responses and categorized the data into several groups. Below are some of the respondents' perspectives on the benefits of beer consumption.

In response to the question, "What benefits does drinking beer bring?" respondents can be categorized into four groups:

- Group One: This group strongly favors beer and notes its various health benefits, presenting a general perspective that includes statements such as: "Beer lowers cholesterol levels"; "It prevents the formation of stones in the kidneys"; "It aids in digestion"; "It reduces the risk of cardiovascular diseases"; "It is a refreshing beverage"; "It strengthens the immune system"; "It prevents the formation of blood clots"; "It contains essential nutrients and vitamins"; "It improves blood circulation"; "It contains B vitamins"; "It is important for bone and overall body health"; "Moderate beer consumption generates B1, B6, and B12 vitamins in the body, which help in the production of hemoglobin".
- Group two: The second category of respondents indicates that beer is good for "entertainment," stating that it is "pleasant to drink," "quenching thirst," "puts you in a good mood," and "enjoyable for spending time with friends."
- Group three: Some respondents believe there are no benefits to drinking beer, while one noted, "It's just a human whim, like smoking."
- Group four: A portion of respondents find it difficult to answer this question due to a lack of relevant information or knowledge about the effects of beer consumption. They state: „No Ideas ", or „It is difficult for me to say something regarding this. "

In response to the question, "What harm does drinking beer cause?" a variety of opinions emerged:

- Group one: Some respondents noted that beer can lead to intoxication, hormonal imbalances, and weight gain. They also mentioned that it could damage the human body's organs, especially kidneys, and liver, and that consuming more than one litre frequently can harm the cardiovascular system, and the stomach, and impede normal brain function, potentially leading to intoxication. Others expressed concerns about dependency and its negative effects on the nervous system.
- Group two: Due to a lack of relevant information or awareness about the potential harms of beer consumption, some respondents struggled to answer this question
- Group three: A limited number of respondents claimed that beer consumption has no negative effects.

For the next phase of the study, high school students were tasked with researching the beer brands available in the Georgian market. They aimed to identify the main local and imported brands that dominate the Georgian market and determine which brands have higher sales. To achieve this goal, the project leadership team selected two primary supermarkets that are particularly popular in Batumi and are frequented by a significant portion of the local population for various purchases. These supermarkets are "Agrohub" and "Carrefour." Batumi is a small city, however, it features a variety of supermarket chains. A notable limitation of the study is the selection of only two supermarkets for the research.

High school students worked in groups, with four students assigned to each supermarket, where they explored and examined the beer section. The research conducted by both groups yielded relatively similar findings; specifically, the students observed that the supermarkets featured both local and foreign beers. They noted qualitative differences among the brands and variations in pricing. Among the Georgian beer-producing companies selling their beer in the local supermarkets are: 1. Georgian Brewery Company (Sakartvelos Ludi Kompania), 2. Global Beer Georgia, 3. Argo Brewery, 4. Batumi Beer (Ludi Batumuri), and 5. Lomisi Brewery (SS Lomisi). The students observed that Batumi Beer enjoys significant popularity among consumers in Batumi.

The supermarkets also prominently feature foreign beer brands, with a segment of the

population preferring these imports. Notable examples include German, Dutch, and Czech beers. During interviews with the students Agrohub supermarket consultants emphasized that Dutch beer, particularly Heineken, is in high demand. In contrast, at the supermarket Carrefour, the German beer Löwenbräu was identified as the most popular imported beer (Figure 2, Appendix).

The students analyzed the nutritional value and composition of the listed beers and presented their findings in a subsequent presentation to their classmates. The presentation showcased the beneficial properties of beer while emphasizing the adverse effects of excessive consumption.

In the next phase of the study, a lesson on "Glucose and Alcoholic Fermentation" was conducted for 10th to 12th-grade students by the chemistry teacher. The lesson was allotted two academic hours (45-45 minutes) and involved students from the Public School of Charnali, guided by a lead chemistry teacher. Before the lesson, the educator prepared a detailed lesson plan outlining the objectives and expected outcomes of the session.

The lesson objectives aimed at familiarising students with the diversity of carbohydrates, determining the physical properties and chemical composition of glucose, studying the process of alcoholic fermentation, and examining the relationship between fermentation and temperature.

The lesson comprised several activities:

Organizational Part of the Lesson - 5 minutes: The teacher introduced the topic and objectives of the lesson, assessment methods, and rubrics that would be used during the session.

Activation of Prior Knowledge - 10 minutes: The teacher engaged the students with a brainstorming session to mobilize their thinking and stimulate their interest in the new material. The teacher employed a question-and-answer format, prompting students to recall previously studied classes of oxygen-containing organic compounds, and encouraged them to apply this knowledge to discover a completely new substance composition and research its properties.

Mini-Lecture - 10 minutes: The teacher informed the class about the diversity of carbohydrates using a PowerPoint presentation. Students were shown the classification of carbohydrates through slides which helped them to express their thoughts on the distribution of the monosaccharide glucose and its importance to the human body, drawing on experiences from previous biology and life sciences lessons.

Experiments to Determine the Physical Properties and Composition of Glucose - 20 minutes: This activity was conducted in groups. Students learned about the physical properties and composition of glucose. In the experiment, students observed glucose powder and conducted tests to identify its physical properties, and recorded data in a table. Using materials on the table, they experimented to determine which functional groups were present in glucose molecules (alcohol, aldehyde, or acid). At the end of the task students worked on an oral presentation, collaboratively with the teacher deriving the formula for glucose.

Investigation of the Fermentation Process during Alcoholic Fermentation of Glucose - 30 minutes: This group activity aimed to develop students' research skills. They were tasked with formulating a research question, hypothesizing, planning, conducting, and evaluating their experiments, and drawing conclusions based on their findings. Students set up an experiment to observe the alcoholic fermentation of glucose with yeast, manipulating temperature as the independent variable (observing fermentation at cold, warm, and hot conditions). The dependent variable was the amount of carbon dioxide produced, indicated by the generated foam and the inflation of a balloon over the flask. They recorded their data in tables and created graphs to illustrate the relationship between the variables, ultimately presenting their findings through a demonstration poster.

Interactive Mini-Lecture - 15 minutes: To optimize time, this mini-lecture was conducted simultaneously with the fifth activity while glucose fermentation was underway. The teacher introduced students to the chemical properties of glucose and reviewed photosynthesis and respiration reactions from biology, as well as the role of enzymes. Using slides, the teacher presented the reaction of glucose in silver mirror formation, its reduction to hexanol, and the process of alcoholic and lactic acid fermentation, highlighting the differences between photosynthesis and respiration. Students recalled the concept of catalysts (enzymes) and their significance in digestion and the production of wine and beer.

Presentation of Results from the Investigation of Alcoholic Fermentation - 7 minutes: This group activity involved analyzing and summarising the conducted research, and drawing appropriate conclusions. Groups presented their research findings using posters.

Assessment - 6 minutes: This activity encouraged students to reflect on their strengths and weaknesses. The teacher provided evaluative feedback on several students' performances using a rubric, offering constructive comments on their

participation in the lesson. Students then engaged in self-assessment with the rubric.

Assignment of Homework - 2 minutes: To connect the lesson content to real-life situations, the teacher asked students to investigate and record how their families prepare wine, paying attention to the conditions that facilitate effective fermentation (Figure 3, Appendix).

As stated in the lesson module, the next activity focused on answering the question: "How is beer produced in Batumi?" To achieve this, a visit to the Batumi brewery was organized for the students. Following discussions with the brewery employees, the students observed that the majority of the workforce at the facility is primarily composed of individuals with backgrounds in natural sciences. Many of them are professionals in biology and chemistry. The students recognized the potential for employment opportunities in this field.

The brewery management conducted a comprehensive tour of the entire facility for the students. Employees explained the significance of each area within the brewery and the sequence of their layout. During their visit, the students examined the machinery and the procedure of the beer production process. This hands-on experience familiarized students with the beer production process and the fundamental principles of brewing technology. Direct observation of these processes enabled the students to grasp the essence of applying their theoretical knowledge practically (Figure 4, Appendix). At the end of the tour, all the students were satisfied and found the activity engaging.

The students also assessed the importance of this enterprise for the city, region, and the country as a whole. Additionally, one student (Mariela Partenadze From Charnaly Public School) involved in the project created a video documenting each stage of the project, which has been uploaded to the YouTube platform.

These one-minute video clips provide an introduction to the interesting activities conducted by the students. The idea of the video was to show the way from school student to business lady.

At the end of the project, the leadership group organized a university event called "We Choose a Healthy Lifestyle." First and second-year biology bachelor students prepared interesting presentations, video clips, and posters on a healthy lifestyle. They also answered questions from the audience (Figure 5, Figure 6 and Figure 7 in Appendix).

At the event, issues related to traditional healthy lifestyles were discussed, and students presented topics such as "Resorts and Healthy Lifestyles," "Fashion and Healthy Lifestyles," and "City vs. Village," among others. What made the event interesting and enjoyable for the attendees was the inclusion of various fun activities, in which both the students participating in the project and the invited community took part. Additionally, the most active students and teachers were awarded certificates. They shared their experiences with other students and teachers, expressing a strong desire to participate in similar projects in the future.

The posters created by the students were quite engaging (Figure 6 and Figure 7 in Appendix). Figure 6 (Appendix) features sports activities that promote a healthy lifestyle. The students expressed the belief that while every student doesn't need to pursue a career in sports, incorporating physical activities into daily life is essential. This approach can help reduce mobile addiction among teenagers (Figure 6, Appendix).

The poster in Figure 7 (Appendix) illustrates two contrasting lifestyles: on the right, a healthy lifestyle, and on the left, an unhealthy one. The healthy lifestyle section outlines fundamental principles and characteristics of proper nutrition, emphasizing the importance of balanced eating habits and physical activity. In contrast, the unhealthy lifestyle section highlights detrimental habits that can lead to addictions and significantly hinder the body's growth, development, and overall physiological function. To enhance visual clarity, the poster uses color coding: the healthy lifestyle is represented in green, symbolizing vitality and well-being, while the unhealthy lifestyle is depicted in red, indicating caution and negative consequences (Figure 7, Appendix).

This clear visual distinction effectively communicates the stark differences between the two lifestyles, encouraging viewers to make informed decisions about their health.

The discussion of this activity will be integrated into various educational processes in the natural sciences, as outlined in the National Curriculum of Georgia. Incorporating such activities helps students explore multiple perspectives of the same process. Specifically, this activity can be applied across several subjects, including chemistry, biology, and geography.

Below are the main learning issues related to this approach:

1. The study of carbohydrate hydrolysis in chemistry classes.
2. The study of chemical technologies in chemistry classes.

3. The study of production and business in economics classes.
4. The study of healthy lifestyles in biology classes.
5. The study of light industry enterprises in geography classes.

This integrated teaching approach enhances student motivation and supports the learning process. It helps students understand and appreciate the complexities of natural science and recognize the practical applications of their studies in the future.

Future perspective: In the future, we plan to expand discussions of similar activities in collaboration with enterprises involved in bread baking, dairy products, and wine production. We also aim to involve kindergarten children, providing them with information about these topics at an appropriate level. This approach will strengthen the connections between different stages of the educational system (kindergarten, school, and university). Implementing such a cohesive strategy will eliminate barriers between these stages, creating a seamless upward pathway that every child can easily navigate.

4 Conclusion

To achieve the Sustainable Development Goals, the transformation of the educational system is essential, as the current system fails to ensure a sustainable development model where individuals take responsibility for their lives and the choices they make every day. Additionally, a transformation of educators is necessary, which involves experiential learning that creates new opportunities for creativity and innovation, paving alternative paths in life. Such practices will encourage students to align their daily actions with the Sustainable Development Goals. Collaboration between schools, industries, and universities is effective for education. This kind of collaboration enhances interest in learning and motivates students and pupils.

Acknowledgement:
We would like to extend our sincere gratitude to the teachers, students, and pupils who contributed to this project. Their original and creative approach not only enhanced collaboration but also made the experience enjoyable and engaging. This work has been accomplished within the scope of the grant project Erasmus+ "Promoting relevant education in science for sustainability (PRESS). 2023-2025.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work the authors used Grammarly, Claude and chat GPT in order to improve the readability and language of manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

References:

[1] C. Meschede, «The Sustainable Development Goals in Scientific Literature: A Bibliometric Overview at the Meta-Level», *Sustainability,* Vol. 12, Issue 11, pp. 4461, 2020, doi: 10.3390/su12114461.

[2] E. Halisçelik and M. A. Soytas, «Sustainable development from millennium 2015 to Sustainable Development Goals 2030», *Sustain. Dev.,* Vol. 27, Issue 4, pp.545–572, 2019, doi: 10.1002/sd.1921.

[3] G. Halkos и E.-C. Gkampoura, «Where do we stand on the 17 Sustainable Development Goals? An overview on progress», *Econ. Anal. Policy,* Vol. 70, pp.94–122, 2021, doi: 10.1016/j.eap.2021.02.001.

[4] N. Kizilaslan, A. Z. Gürler, и H. Kizilaslan, «An analytical approach to sustainable development in Turkey», *Sustain. Dev.,* Vol. 15, Issue 4, pp.254–266, 2007, doi: 10.1002/sd.316.

[5] A. Patuelli и F. Saracco, «Sustainable development goals as unifying narratives in large UK firms' Twitter discussions», *Sci. Rep.,* Vol. 13, Issue. 1, pp.7017, 2023, doi: 10.1038/s41598-023-34024-y.

[6] A. Boto-Álvarez и R. García-Fernández, «Implementation of the 2030 Agenda Sustainable Development Goals in Spain», *Sustainability,* Vol. 12, Issue. 6, pp.2546, 2020, doi: 10.3390/su12062546.

[7] A. Dello Strologo, E. D'Andrassi, N. Paoloni, and G. Mattei, «Italy versus Other European Countries: Sustainable Development Goals, Policies and Future Hypothetical Results», *Sustainability,* Vol. 13, Issue. 6, pp.3417, 2021, doi: 10.3390/su13063417.

[8] R. P. Pradhan, M. B. Arvin, M. S. Nair, J. H. Hall, and S. E. Bennett, «Sustainable economic development in India: The dynamics between financial inclusion, ICT development, and economic growth», Technol. *Forecast. Soc. Change,* Vol. 169,

pp.120758, 2021, doi: 10.1016/j.techfore.2021.120758.

[9] A. DeWit, R. Shaw, and R. Djalante, «An integrated approach to sustainable development, National Resilience, and COVID-19 responses: The case of Japan», *Int. J. Disaster Risk Reduct.*, Vol. 51, pp. 101808, 2020, doi: 10.1016/j.ijdrr.2020.101808.

[10] D. Wang, F. Ding, J. Fu, and D. Jiang, «China's sustainable development evolution and its driving mechanism», *Ecol. Indic.*, Vol. 143, pp.109390, 2022, doi: 10.1016/j.ecolind.2022.109390.

[11] A. Silvestri и M. D'apuzzo, «Critical Resilience and Sustainability Function Deployment», *WSEAS Transactions on Business and Economics*, Vol. 21, pp.1001–1011, 2024, https://doi.org/10.37394/23207.2024.21.83.

[12] T. Kulinich, N. Yakimenko-Tereschenko, A. Melnyk, A. Vasina, and V. Adamyk, «Challenges and Prospects of Applying the Paradigm of Sustainable Development to the Eastern Europe Economy», *WSEAS Transactions on Environment and Development*, Vol. 17, pp.929–940, 2021, https://doi.org/10.37394/232015.2021.17.86.

[13] A. Draghici, «Education for sustainable development», *MATEC Web Conf.*, Vol. 290, Page 13004, 2019, doi: 10.1051/matecconf/201929013004.

[14] A.E.J. Wals *«Education for Sustainable Development»,* Education, Oxford University Press, 2021. doi: 10.1093/obo/9780199756810-0280.

[15] G. Grosseck, L. G. Țîru, and R. A. Bran, «Education for Sustainable Development: Evolution and Perspectives: A Bibliometric Review of Research, 1992–2018», *Sustainability*, Vol. 11, Issue 21, pp.6136, 2019, doi: 10.3390/su11216136.

[16] D. Olsson, N. Gericke, and J. Boeve-de Pauw, «The effectiveness of education for sustainable development revisited – a longitudinal study on secondary students' action competence for sustainability», *Environ. Educ. Res.*, Vol. 28, Issue 3, pp. 405–429, 2022, doi: 10.1080/13504622.2022.2033170.

[17] A. W. Little and A. Green, «Successful globalisation, education and sustainable development», *Int. J. Educ. Dev.*, Vol. 29, Issue. 2, pp.166–174, 2009, doi: 10.1016/j.ijedudev.2008.09.011.

[18] A. V. Agbedahin, «Sustainable development, Education for Sustainable Development, and the 2030 Agenda for Sustainable Development : Emergence, efficacy, eminence, and future», *Sustain. Dev.*, V. 27, Issue 4, pp.669–680, 2019, doi: 10.1002/sd.1931.

[19] F. Rauch, «The Potential of Education for Sustainable Development for Reform in Schools», *Environ. Educ. Res.*, Vol. 8, Issue 1, pp.43–51, 2002, doi: 10.1080/13504620120109646.

[20] X. Yuan and J. Zuo, «A critical assessment of the Higher Education For Sustainable Development from students' perspectives – a Chinese study», *J. Clean. Prod.*, Vol. 48, pp.108–115, 2013, doi: 10.1016/j.jclepro.2012.10.041.

[21] E. Chaleta, M. Saraiva, F. Leal, I. Fialho, and A. Borralho, «Higher Education and Sustainable Development Goals (SDG)—Potential Contribution of the Undergraduate Courses of the School of Social Sciences of the University of Évora», *Sustainability,* Vol. 13, Issue 4, pp.1828, 2021, doi: 10.3390/su13041828.

[22] S. Sedlacek, «The role of universities in fostering sustainable development at the regional level», *J. Clean. Prod.*, Vol. 48, pp.74–84, 2013, doi: 10.1016/j.jclepro.2013.01.029.

[23] P. Glavič, «Identifying Key Issues of Education for Sustainable Development», *Sustainability,* Vol. 12, Issue. 16, pp.6500, 2020, doi: 10.3390/su12166500.

[24] B. Karatzoglou, «An in-depth literature review of the evolving roles and contributions of universities to Education for Sustainable Development», *J. Clean. Prod.*, Vol. 49, Page 44–53, 2013, doi: 10.1016/j.jclepro.2012.07.043.

[25] R. Lozano, F. J. Lozano, K. Mulder, D. Huisingh, and T. Waas, «Advancing Higher Education for Sustainable Development: international insights and critical reflections», *J. Clean. Prod*., Vol. 48, pp. 3–9, 2013, doi: 10.1016/j.jclepro.2013.03.034.

APPENDIX

(a)

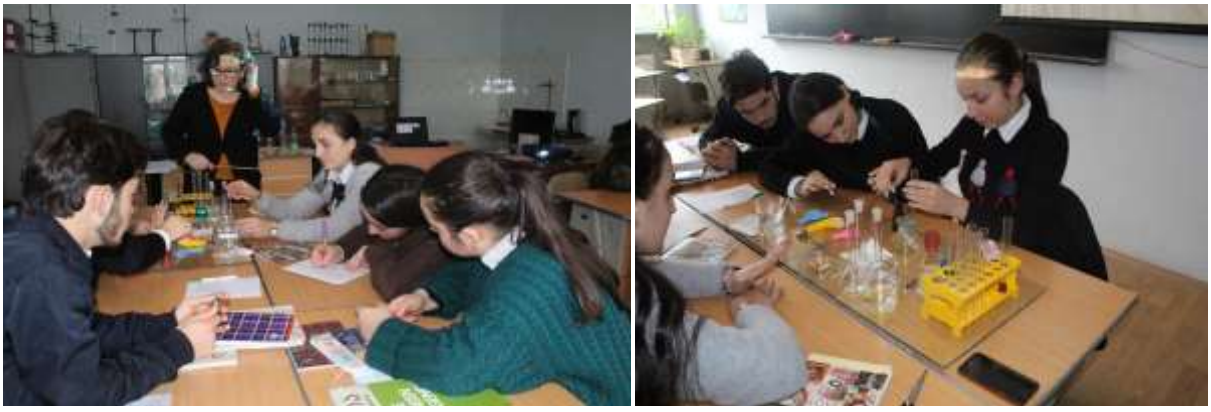
(b)

(c)

Fig. 1: The 1st lesson of the teaching module. The topic of the lesson was: "The Digestive System." Biology teacher: Irine Tsintsadze. School: Public School No. 7. Class: 8th Grade. The number of students in the class is 20. A) First step of the lesson. The teacher is introducing the digestive system to the students. B) The pupils demonstrate the functions of digestive system organs. C) The last stage of the lesson. Assessment by using MCQ

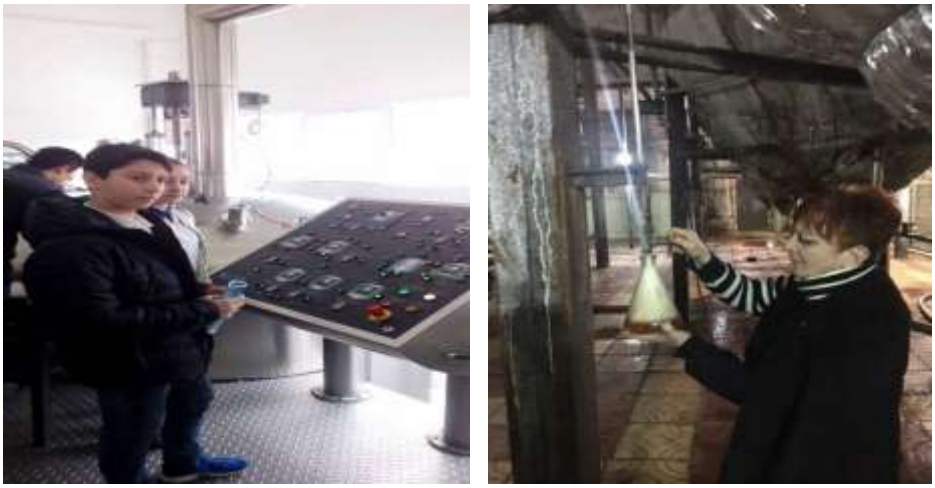
(a) (b)

Fig. 2: Beer Market Research: Students from Batumi Public School N7 Participating in the Study. A. Beer Market Research in the "Agrohub" B. Beer Market Research in the "Carrefour"



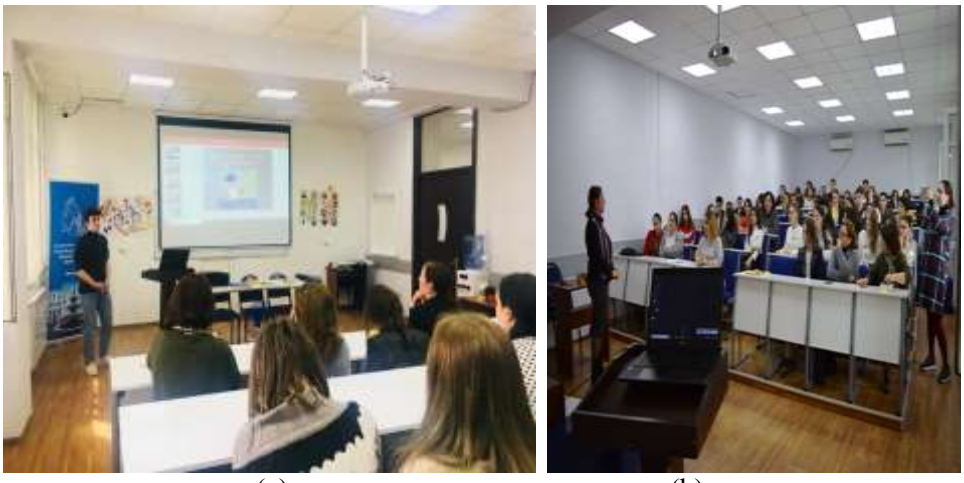
(a) (b)

Fig. 3: Lesson 2 of the teaching module. Topic: "Alcoholic fermentation. Enzymes and Fermentation Reactions". Teacher: Naira Jackeli. School: Village of Khelvachauri municipality. Charnal school. Class: IX. Number of students: 18. A. The teacher explains the procedure of the experiment. B. Students are doing experiments based on teacher instruction



(a) (b)

Fig. 4: Students and pupils Visit the brewery. Schools: public school N7 of Batumi and village of Khelvachauri municipality. Students and teachers of VIII-IX school of Charnal public school. A. The students are introducing the technology of bear preparation; B. The teacher is demonstrating to students the technology of brewery



(a) (b)

Fig. 5: University Event „We Choose a Healthy Lifestyle,". Batumi Shota Rustaveli State University. Organizator: professor, PhD Marina Nagervadze. A. The participant of the project is speaking about his experience. B. The organizer introduces the audience to the Healthy lifestyle categories

Fig. 6: Poster prepared by first-year students of the faculty of Natural Sciences and Health care. The authors of the poster are: Natia Mikeladze, Tea Mikeladze, Marika Broladze, and Mariam Darsavelidze

Fig. 7: Poster prepared by first-year students of the faculty of Natural Sciences and Health care. The authors of the poster are: Elene Kurtanidze, Mari Goradze, and Mari Dolidze

Table 1. Percentage distribution of respondents' answers to the question: "What role does beer play in your life?"

Response	%	χ^2	P-Value
Daily beer consumer	5	25.68	The P-value is .000011. The result is significant at $p < .05$.
Frequent beer consumer	29		
Occasional beer consumer	40		
Do not consume beer	26		
Total	100		

Table 2. Percentage distribution of respondents' answers to the question: "Which brand of beer do you prefer?"

Responses	%	χ^2	P-Value
Preference for local beer	41	13.56	The P-value is .001136. The result is significant at $p < .05$.
Preference for imported beer	16		
No preference (local or imported)	43		
Total	100		

Table 3. Percentage distribution of respondents' answers to the question: "What is your opinion on Batumi beer?"

Responses	%	χ^2	P-Value
Very fond of Batumi beer	52	47.6	The P-value is < .00001. The result is significant at $p < .05$.
Do not like Batumi beer	4		
Have never tried Butumi beer	23		
Unsure/ difficult to say	21		
Total	100		

Table 4. Percentage distribution of respondents' answers to the question: "What is beer made from?"

Responses	%	χ^2	P-Value
Barely malt	5	289.3	The P-value is < .00001. The result is significant at $p < .05$.
Wheat	3		
Rice	2		
Rye	2		
All listed ingredients	88		
Total	100		

Table 5. Percentage distribution of respondents' answers to the question: "In your opinion, what amount of beer consumption is safe for health?"

Responses	%	χ^2	P-Value
One can of beer per day is considered safe	22	8.1	The P-value is .087983. The result is not significant at p < .05.
One to three cans of beer per day is considered safe	14		
One can of beer per week is considered safe	28		
One can of beer per month is considered safe.	13		
Can not say	23		
Total	100		

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- M. Nagervadzewas leading the research process and preparation of the Georgian version of the manuscript.
- R. Khukhunaishvili has organized the events.
- T. Nakashidze-Makharadze was responsible for the modification of teaching methods and preparation English version of the manuscript
- I. Tsintsadze organized pupils' enrolments in the research.
- N. Jakeli organized pupil enrolments in the research.
- K.Dolidze - was responsible for the Statistics.
- M. Koridze was prepared the online questionnaire.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

This work has been accomplished within the scope of the grant project Erasmus+ “Promoting relevant education in science for sustainability (PRESS). 2023-2025.

Conflict of Interest

The authors have no conflicts of interest to declare.