Using Secondary Materials for the Creation of Biological Teaching Models

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Abstract—The article discusses creating educational thematic models from second-hand items in collaboration with the students. Our research aimed to assess the main aspects of knowledge of sustainable development among students. To show them the possibility and impact of reusing things in the teaching process. A questionnaire was designed using the Google platform, with 400 volunteers participating in the study. To develop the biological teaching methods, we utilized second-hand materials. The majority (70.25±2.29%) of respondents were female, and 29.75±2.29% were male. χ2 - Chi-square equals to 65.5; The P-Value is < .00001. The result is significant at p < .05. One of the questionnaires was formulated as follows: "Have you ever used second-hand items?" 84.75%±1.80 of the total number of respondents use second-hand items, and the remaining 15.25%±1.79 do not. χ2 - Chi-square equals to 192; The P-Value is < .00001. 39,5±2,91% used second-hand materials as appliances, 39,5±2,91% used them as clothes, 1,5±0,73% used them as shoes, 5,75±1,39% used them as accessories, and 30±2,73% used them as teaching materials. Additionally, 1,25±0,66% of the respondents did not use second-hand items as utensils, while 8,25±1,64% indicated using them for other purposes. χ2 - Chi-square equals to 335.34; The P-Value is < .00001. When respondents were asked whether the second-hand items could be utilized as a learning resource, the majority 88,25%±1,92, believed it was possible, while 11,75%±1,92 expressed the view that second-hand items cannot serve as learning resources. χ2 - Chi-square equals to 231. For the next stage, students and pupils were given a proposal to collect unnecessary, second-hand items and bring them to Batumi Shota Rustaveli University. Using the mentioned items, students and pupils created biological thematic models. At least 25 biological models were created following the provided instructions and were exhibited at the Scientific Picnic.

Keywords—Reuse, Science Education, Second-hand materials, Sustainable development, Teaching models "School-University" Cooperation network, students projects, biology, exhibition.

I. INTRODUCTION

In the modern era, biology is one of the rapidly developing fields of science, in the process of teaching biology many classical and modern methods can be used [1], [2], [3], [4]. Biology is the science of understanding the surrounding world and, primarily ourselves. Curiosity and our inner exclamation - "Know thyself" makes us observe the events, objects, and life processes occurring within and around us, [5] .

Science is not an unfamiliar concept for students. In the very first lesson of biology, we make sure that the students already have preconceived views on a number of scientific issues, which may not necessarily correspond to the truth, but it shows their obvious interest in studying the delicate structure of life. Therefore, our main mission as teachers is to deepen the scientific spirit in young people, and the desire to learn about the world should not be outweighed by routine homework and boring monologues. Applying diverse methods in the teaching process enhances the quality of interaction, and with a high probability, transfers the acquired knowledge to students' long-term memory. Currently, there is a list of about 50 methods, considered as innovative methods of teaching science, [5]. These include role play and situational play, sports-based learning, science flashcards, virtual science lab, brainstorming, word cloud, science museum visit, project, video clip, science promotion grant competition, documentary problem solving, use of science kits, science films, Games, Science Songs, Mobile Apps in Science, Science Quizzes, Hands in Teaching, Visual References, Learning Conversations, Using Social Networks, Word Wall, Mini Presenter Charts, Arguing with Scientist, Computational and Remote Thinking, Science Picnic, Field Trips, Interactive Science Journal and many others. It stimulates students' and pupils' ability to learn and understand more, [6], [7], [8], [9], [10], [11]. Creating a model is a challenging yet enjoyable task assigned to students and/or pupils, which constitutes one of the crucial components of acquiring a scientific education. A teaching model serves as a fundamental of science, employed to explain many aspects of the real world. A student creates a model based on his/her own scientific knowledge. It is also an interesting approach to

deciding what materials should be used to create the model, [12].

Alongside the growth of the Earth's population and its growing needs the production and consumption of products and services are constantly increasing, [6]. As a result, a huge amount of waste was generated on our planet, which caused a "waste crisis" in many countries, [13], [14], [15]. Today, every country in the world faces problems related to waste. Some of the issues are common to all countries, while others are special and specific only to a specific area. Nowadays, tons of garbage are dumped in landfills.

The Sustainable Development Goals (SDGs) also known as The World Global Goals, which were adopted by the United Nations in 2015, address this issue. The goals serve as an appeal to eliminate poverty, protect the environment, and guarantee that by 2030 everyone will live in peace and prosperity. Education for Sustainable Development helps individuals gain knowledge, skills, attitudes, and values important for a sustainable future by teaching about issues like climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption, [16]. The 17 Sustainable Development Goals (SDGs) are interconnected. This means that making progress in one area can influence results in another. For true development, a balance should be found between improving society, growing the economy, and protecting the environment at the same time, [17]. Our research focuses on Goal 12, which promotes responsible consumption and production . Studies show that discarded items can often be reused. Sustainable Waste Management Solutions highlights six key actions: prevent, Reduce, Reuse, recycle, recover, and dispose, [18].

Reuse refers to the secondary utilization of consumed items. It can be using things for the same or different purposes. Exchanging or reusing items that are still useful and in good condition, without technological recycling, saves time, money, energy, and resources. Classic examples of reuse include: returning glass bottles to a factory where they are reused, reusing cars and their parts, utilizing second-hand clothing, and so on. Currently, there are various alternative ways for utilizing secondary materials, including reuse, repair, and repurposing to give them new life. Today, the widespread utilization of second-hand items for various purposes is a global phenomenon. For instance, the use of second-hand materials in landscape is a leading trend in the world. Specialists in this field advocate for a common-sense approach, suggesting that waste generated from repair or construction works should not be discarded. Instead, it should be used in yards and gardens to create unique elements, thereby transforming the space into something distinctive. It is crucial to consider the advice of the specialists in landscape particularly those that align with nature.

It is very interesting to create innovative and creative models using such second-hand and low-budget materials. One of the relevant methods of teaching natural sciences is practical teaching. If the student has the opportunity to create a visual (in the form of a model or a poster), he will be able to better comprehend the issue theoretically. When second-hand or low-budget items are approached creatively, it definitely gives you inspiring ideas. You can create a unique element from it, which will be creative, individual, and distinctive. Therefore, such an approach is very interesting - the new life of an object seen in its own prism, which already acquires a different meaning and load. Students will be creative in designing models and at the same time using and assessing their own work. This is the right approach to finding the scientist in a student.

It is generally acknowledged that students absorb and remember material better with posters, pictures, or animations, but what happens when students make them themselves? We can assume that creating models with their own hands in a lesson can be an unforgettable experience for both students and pupils. We live in an advanced scientific world, and advanced teaching strategies help students discover and explore science every day. Strategies like these can help young people better understand the beauty of science.

Learning models play a crucial role in the teaching and learning process. A model serves as a simulated representation of an important process or structure, allowing the student to see and interact with it. By engaging multiple senses – seeing, touching, and sometimes manipulating – the learner can better understand and retain the material. This experiential approach enhances comprehension. Learning models become even more valuable when the student creates them personally, as this active involvement deepens undertanding and reinforces the learning process.

If we look at the market price of the model, we will find that they are both quite expensive and standardized. For instance, on the widely-used online marketplace www.amazon.com, the mitosis model is priced at $253.96 (equivalent to 672 GEL), the chromosome simulation set is priced at $210.00 (equivalent to 558 GEL), and the anatomical model of a plant cell is priced at $43.60 (the equivalent of 114 GEL), etc. The models created by us will be original, distinctive, and cheap. Judging only by the market price of these three models, their total amount is 1344 GEL, while the models with similar style and content are much cheaper. According to our initial calculations, if we use second-hand or low-budget materials for the creation of models, the mentioned amount will be sufficient to cover the material costs incurred for the creation of at least ten models (that is, it is possible to create three times more models). In addition to the above-mentioned, the crucial aspect is that the creation process is not templated. Students are fully engaged in the process and have complete freedom for innovative and creative expression. We believe that this direction offers the most valuable inspiration for students' professional growth. By adopting this approach, any school can be equipped with similar creative exhibits allowing them to display those exhibits in the corresponding classrooms.

II. Aim and Research Questions

Research question: Is it possible for a student to create a learning resource using secondary materials? The purpose of our research was to evaluate students' understanding of sustainable development. We aimed to raise environmental awareness and equip them with relevant knowledge about the benefits of reusing materials in the learning and teaching process. Additionally, we sought to teach them how to construct models from second-hand materials. Our goal was to create biological models and posters using inexpensive and recycled material, which would then be exhibited in various

public schools to promote science.

The practical value of this research lies in motivating and sparkling the students' interest to explore and learn more about their surrounding environment. It also helps them to gain a deeper understanding of sustainable development issues, both globally and locally. We have the enthusiasm to impart knowledge on these issues to students, on the other hand, students who will later become teachers will pass environmental protection issues to students. This will eventually increase awareness and each person will see their contribution to solving global problems.

The objectives of the work are:

A. Selecting a partner school for future collaboration;

B. Delivering a public lecture for pupils and students;

C. Evaluating students' and pupils' environmental awareness and understanding through a special questionnaire;

D. Creating thematic models and posters by pupils and students;

E. Developing instructional materials and creating models (Is planned to create special video tutorials in the future);

F. Hosting an exhibition, and presentation of the completed models and posters.

G. conducting a survey on the satisfaction of students and pupils participating in the project.

III. Research Materials and Methods

To address the research objectives, we utilized various materials and methods. Sustainable development topics were presented to students through lecture seminars, which primarily took the form of discussions. During these sessions, specific examples of sustainable development were examined, and participants exchanged ideas and insights on the subject.

During the research we also employed both open and closed questionnaires, which were completed by students and pupils. They assessed the use of second-hand items in both everyday life and the school environment.

The research also incorporated project-based teaching and demonstration methods. Through the project-based approach, students collaboratively developed and presented learning models related to various biological themes. A key aspect of the project's implementation was that students were required to use only second-hand materials or low-cost consumables to create their models. During the demonstration phase, specially organized sessions allowed students to present their models to the audience, describing their design process and the concepts behind their creation. These presentations took place both within the university setting and at science fairs organized across the country.

At the end of the research, one more questionnaire was used to evaluate student satisfaction. All students involved in the project participated, providing valuable feedback on their experiences.

IV. Results

Phased activities were planned to accomplish the above-mentioned tasks. We have divided the process into several stages, each with corresponding activities. Below, the specific descriptions of the activities and their outcomes are provided.

Stage I - Selecting a Partner School. "School-University" Cooperation network

Professors and teachers of the Biology Department of the Faculty of Natural Sciences and Health of Batumi Shota Rustaveli State University participated in the project. Additionally, ten students from the undergraduate biology program were involved in the project. The first task assigned to them was the selection of a partner public school for further cooperation. Batumi Shota Rustaveli State University has memorandums with the public schools in Batumi. Two schools were selected from them: the 2nd and 7th public schools of Batumi. Teachers from the Department of Biology and students from the ninth and tenth grades (a total of 15 students) were involved in the implementation of the mentioned activities.

At the mentioned stage, regular meetings were held among the staff, experts, students, and pupils participating in the project. Comprehensive information regarding the tasks to be performed was provided to the participating team members. At the meetings, the responsibilities and obligations were assigned and future plans were outlined. (Figure 1).

Fig. 1. The project team: students, pupils, teachers, and professors

Stage II - Delivering Public Lectures by Professors

A group of project leaders (BSU professors) delivered public lectures to teachers, students, and pupils covering the following topics:

a) Sustainable development and its outcomes

b) Waste management and recycling, including practical activities (Figure 2).

Fig. 2. Public lecture

Stage III. Research on the use of second-hand items

A questionnaire was prepared by the project group and distributed to students and pupils above 8th grade for completion. A questionnaire was prepared on the Google platform using Google Forms. The corresponding link of the questionnaire was sent to the participants (students and pupils) willing to participate in the research. The questionnaire was straightforward and could be completed in just a few minutes. It contained questions with multiple possible answers. The students/pupils could choose either one or several answers. Also, two questions had an additional open field intended for the respondent to express his opinion on a specific issue. 400 volunteers participated in the study, and the results of the questionnaire were analyzed in the tables below. Data processing was carried out according to gender differentiation. The majority (70.25±2.29%) of respondents were female (n=281), and 29.75±2.29% were male (n=119) (Table I). $\chi 2$ - Chi-square equals to 65.5; df= 1; CV=3,841. The P-value is < .00001. The result is significant at $p < .05$.

Table I. Number of interviewed respondents according to gender

	Number (n)	Percent %
Female	281	70.25±2.29%
Male	119	29.75±2.29
Total	400	100

According to the status (student or pupil), the data was distributed as follows, among the respondents, 42.5±2.47% were students (n=170), and 57.5±2.47% were pupils of different public schools of the Adjara region (Georgia Republic) (n=230) (Table II). $\chi 2$ - Chi-square equals to 9; df= 1; CV=3,841. The P-Value is < .0027. The result is significant at $p < .05$ (Table II).

Table II. Number of surveyed respondents by status

	Number (n)	Percent %
Students	170	42.5±2.47%
Pupils	239	57.5±2.47%
Total	400	100

The age range of the respondents is from 13 to 30 years. The average age is 21 years. Age categories are distributed in Table III. In particular, 4.5%±1.04 of the respondents were 13 years old (18), 14.5%±1.76 were 14 years old (n=58), 11.75%±1.61 were 15 years old (n=47), 10.5 %±1.53 were 16 years old (n=42), 14%±1.73 were 17 years old (n=56), 9.5%±1.47 were 18 years old (n=38), 10.25%±1.51 were 19 years old (n=41), 8%±1.36 were 20 years old (n=32), 5%±1.09 were 21 years old (n=20), 3.75%±0.95 were 22 years old (n=15), 3.5% ±0.92 was 23 years old (n=14), 1.5%±0.61 was 24 years old (n=6), 1%±0.49 was 25 years old (n=4), 0.75%±0.43 was 26 years old (n=3), 0.25%±0.24 were 27 and 28 years old (n=1), and 0.5%±0.35 were 29 and 30 years old n=(2).

Table III. Distribution of Respondents by Age Group.

Age	Number (n)	Percent %
13-year-olds	18	4,5±1,04
14-year-olds	58	14,5±1,76
15-year-olds	47	11,75±1,61
16-year-olds	42	10,5±1,53
17-year-olds	56	14±1,73
18-year-olds	38	9,5±1,47
19-year-olds	41	10,25±1,51
20-year-olds	32	8±1,36
21-year-olds	20	5±1,09
22-year-olds	15	3,75±0,95
23-year-olds	14	3,5±0,92
24-year-olds	6	1,5±0,61
25-year-olds	4	1±0,49
26-year-olds	3	0,75±0,43
27-year-olds	1	0,25±0,24
28-year-olds	1	0,25±0,24

One of the questions was formulated as follows: "Have you ever used second-hand items?" Based on the surveyed data, the data was distributed as follows: 84.75%±1.80 of the total number of respondents use second-hand items (n=339), and the remaining 15.25%±1.79 do not (n=61) (Table IV). $\chi 2$ - Chi-square equals to 192; df= 1; CV=3,841. The P-Value is < .00001. The result is significant at $p < .05$ (Table IV).

Table IV. Distribution of data according to the use of second-hand items

	Number (n)	Present (%)
Yes	339	84,75±1,8
No	61	15,27±1,8
Total	400	100

The data on the mentioned question was analyzed with respect to gender. It was found that out of the 119 male respondents, 82.35%±3.48 (n=98) reported using second-hand items, while the remaining 17.65%±3.5 (n=21) did not. Similarly, among the 281 females, 85.77%±2.08 (n=241) indicated using second-hand items, while 14.23%±2.1 did not (n=40) reported not using them (Table V). The chi-square statistic is 0.7531. The P-Value is .385499. The result is significant at $p < .05$.

Table V. Distribution of data on the Use of Second-Hand Items by Gender

Male	Number (n)	Present (%)	Female	Number (n)	%
Yes	98	82.35%±3.48	Yes	241	
No	21	17.65%±3.5	No	40	
Total	119	100	Total	281	

When respondents were asked about the purpose for which they and their family members used second-hand items, the data was distributed as follows: 39,5±2,91% used them as appliances (n=55), 39,5±2,91% used them as clothes (n=158), 1,5±0,73% used them as shoes (n=6), 5,75±1,39% used them as accessories (n=23), and 30±2,73% used them as teaching materials (n=120). Additionally, 1,25±0,66% of the respondents did not use second-hand items as utensils (n=5), while 8,25±1,64% indicated using them for other purposes (n=33) (Table VI). $\chi 2$ - Chi-square equals to 335.34; df= 6; CV=13. The P-Value is < .00001. The result is significant at $p < .05$ (Table VI).

Table VI. Various Uses of Second-Hand Items

	Number (n)	Persent (%)
Appliances	55	13,75 ±2,05
clothes	158	39,5±2,91
Shoes	6	1,5±0,73
Accessories	23	5,75±1,39
Teaching materials	120	30 ±2,73
Utensils	5	1,25±0,66
Other	33	8,25±1,64

The aforementioned data on the use of second-hand items were also analyzed taking into account gender and it was found that 24 (6%) of the total number of males (119/400) use second-hand items as appliances, 36 (9%) as clothes, 3 (0.75%) as shoes, 4 (1%) as accessories, 35 (8.75%) as study supplies, and second-hand items as tableware are used by only 0.5% (2) of men and the remaining 3.75% (n=15) state other purposes.

As for the representatives of females, data was distributed as follows, in particular, out of the total number of females (281/400), 31 (7.75%) use second-hand items as appliances, 122 (30.5%) as clothes, 3 (0.75 %) as shoes, 19 (4.75%) as accessories, 85 (21.25%) as teaching materials, and second-hand items such as tableware are used by only 0.75% (3) of females and the remaining 4.5% (n=18) state other purposes (Table VII).

Table VII. Distribution of Respondents According to the Use of Second-Hand Items, according to Gender

	Female		Male		Total	
	n	%	n	%	n	%
Appliances	31	7,75±1.34	24	6±1,19	55	13,75±2,05
Clothes	122	30,5±2.30	36	9±1,43	158	39,5±2,91
Shoes	3	0,75±0.43	3	0,75±0.43	6	1,5±0,73
Accessories	19	4,75±1.06	4	1±0,5	23	5,75±1,39
Study Supplies	85	21,25±2.05	35	8,75±1,4	120	30±2,73
Tableware	3	0,75±0.43	2	0,5±0,35	5	1,25±0,66
Other	18	4,5±1.04	15	3,75±0,95	33	8,25±1,64
Total	281	70,25 ±2.29	119	29,75±2.29	400	100

Under the category “for another purpose” respondents presented the following answers: 1. I have made different types of accessories using used bottles or dishes. Such as a flower pot, a pencil box, etc.; 2. We have used it in the form of second-hand books, as well as for various collectibles, equipment, and others. 3. Using second-hand clothes to create new garments; 4. We used to give away second-hand clothes to those who were in need, and my grandmother sewed mattresses for our house in the mountains. I personally sewed toy dolls when I was little and created clothes; 5. To decorate the yard; 6. My smartphone, which was in working condition, was used by my son; 7. I made different types of jewelry from second-hand items, I sewed different clothes; 8. We utilize recycled plastic containers as storage bins; 9. My friend gave me a laptop; 10. We made New Year's accessories from bottle caps. Pictures from the fallen tree branches; We bought a second-hand car and its accessories.

When respondents were asked whether the second-hand items could be utilized as a learning resource, the majority 88,25%±1,92, believed it was possible (n=353), while 11,75%±1,92 expressed the view that second-hand items cannot serve as learning resources (n= 47) (Table VIII). $\chi 2$ - Chi-square equals to 231; df= 1; CV=3,841. The P-Value is < .0027. The result is significant at $p < .05$.

Table VIII. Respondents' data on the use of second-hand items as learning resources

	Number (n)	Percent (%)
Yes	353	88,25±1,92
No	47	11,75±1,92
Total	400	100

The processing of respondents' data on the use of second-hand items as a learning resource was also processed taking into account gender and it was found that 99 (24.75%) of the total number of male representatives (119/400) use second-hand items as a learning resource, and the remaining 20 (5%) He notes that he does not use second-hand items as teaching resources. As for the representatives of the female sex, the data was distributed in the following direction, namely: 254 (63.5%) of the total number of female representatives (281/400) use second-hand items as educational resources, while the remaining 27 (6.75%) indicate that second-hand He does not use things as teaching resources. $\chi 2$ - Chi-square equals to 4.1772; df= 1; CV=3,841. The P-Value is < .040971. The result is significant at $p < .05$ (Table IX).

Table IX. Respondents' data on the use of second-hand items as learning resources, according to gender

	Female		Male		Total	
	n	%	n	%	n	%
Yes	254	63,5±2,41	99	24,75±2,16	353	88,25±1,92
No	27	6,7±1,25	20	5±1,9	47	11,75±1, 92
Total	281	70,25±2,29	119	29,75±2,29	400	100

Regarding the question of how we can use second-hand items for educational purposes, the data was distributed as follows, in particular, among the respondents, 66.5%±2.82 think that second-hand items can be used as textbooks for educational purposes, 7.75%±1.59 believe that for educational purposes it is possible to make educational models from second-hand items, 6.75%±1.5 believe that it is correct to make posters, as for 13.75%±2.05 had no idea in this regard, the remaining 5.25%±1.33 present some different ideas, which I will introduce below (Table X). $\chi 2$ - Chi-square equals to 548.43; df= 4; CV=9,488. The P-Value is < .00001. The result is significant at $p < .05$.

Table X. Distribution of Data on the Use of Second-Hand Items for educational purposes

	Number (n)	Percent (%)
Using secondary-hand textbooks	266	66,5±2,82
Preparing learning models	31	7,75±1,59
Preparing learning posters	27	6,75±1,5

Have not thought about it	55	13.75%±2.05
Other	21	5,25± 1,33
Total	400	100

The responses categorized under 'Other' by the interviewers were interpreted as follows:

1. We can use it to make various posters, as well as items, and projects; 2. Used books make learning affordable. Secondary technology is available for vulnerable groups, this is important for them to be able to learn independently; 3. I will make posters and cut out figures and roses, and I, as a future biology teacher, will make students cut out plant and animal organoids as figures. During school, we used to cut out roses from colorful paper for the New Year and decorate our class; 4. We will learn to recycle second-hand items; 5. We can access reading materials electronically (PDF) without leaving home and paying any money; 6. Second-hand items can be utilized as work or research materials. Which on the one hand can enhance our knowledge and, on the other hand, provide financial benefits; 7. To simplify household and educational activities
8. When the school does not have enough funding to produce new books, using second-hand books is a good solution.

In response to the question regarding whether they have ever taken glass and plastic bottles to the recycling spots for recycling, the data was distributed as follows: specifically, it was found that 22,75%±2,5 (n=91) did so, while the majority, 75,25%±2,57 did not (n=309) (Table XI). $\chi 2$ - Chi-square equals to 118.80; df= 1; CV=3,841. The P-Value is < .00001. The result is significant at $p < .05$.

Table XI. Distribution of Data on the Delivery of Glass and Plastic Bottles to the Enterprise

	Number (n)	Percent %
Yes	91	22,75%±2,5
No	309	75,25%±2,57
Total	400	100

Stage III - Creating biological Thematic Models and Posters.

For the next stage, students and pupils were given a proposal to collect unnecessary, second-hand items and bring them to Batumi Shota Rustaveli University. Using the mentioned items, students and pupils created biological thematic models. Some of them are illustrated below (Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9).

Fig. 3. Model of chloroplast

Fig. 4. Model of prokaryotic cell

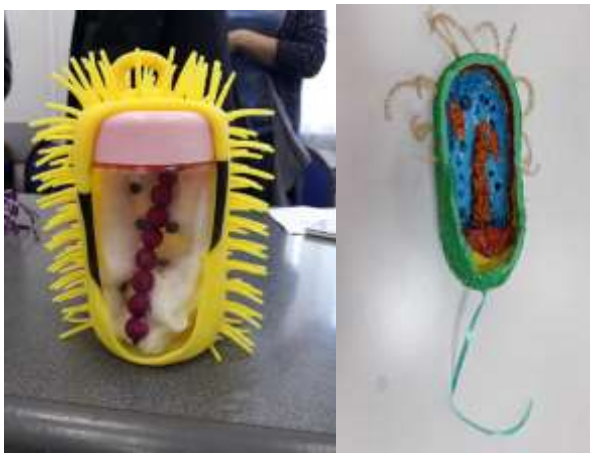

Fig. 5. Model of microorganisms

Fig. 6. Model of animal cells

Fig. 7. Model of plant cell

Fig. 8. Model of the cell membrane

Fig. 9. Models of Cell division

Stage IV - The Event Organization "Give things new life"

The hall of Batumi Shota Rustaveli State University was allocated for the event. Batumi Public School directors were invited to the event. The primary target group of the event comprised biology teachers from various public schools and students predominantly from grades IX-XII. At the event, certificates of appreciation were given to club members (Figure 10).

Fig. 10. "Give things new life"

Stage V - Exhibition of Models at a Scientific Picnic

The students' works were exhibited in the Science Picnic. Various higher universities participated in the event. Students from various schools in Batumi had the opportunity to view the displayed models and participate in the process of creating a new one. Namely, in the creation of a human karyotyping model, which was crafted from recycled paper and second-hand accessories (Figure 11).

Fig. 11. Human karyotyping model

Stage VI - Survey on the Satisfaction of Students and Pupils Participating in the Project.

At this stage, we aimed to assess students' satisfaction. To achieve our goal, we created a questionnaire using the Google platform. The corresponding link was sent to the pupils and students participating in the project. The questionnaire consisted of three closed questions and one open question. To the question "Are you satisfied with the

model you created?" Respondents unanimously stated that they were satisfied with their hand-made thematic models.

To the question "What was the outcome of the model creation in the "Introduction to Biology" and "Cytology" courses? They unanimously noted that this method of teaching has increased their academic knowledge.

To the next question: "Do you think such activities are effective in the learning/teaching process?" All respondents also provided positive answers.

The final question of the questionnaire was open-ended and participants could express their opinions in their own words. Below are some of the suggestions they made: 1. I think the combined method of teaching, which includes different types of activities, makes the students more involved and helps to absorb the material effectively; 2. Such activities help us to form diverse thinking in the relevant direction; 3. Learning by doing helps to develop visual thinking; 4. Such approaches make the teaching process interesting and fun; 5. It is effective when the teaching material is presented with more illustrations, and it is even more interesting when we are involved in the creation process; 6. It enhanced our awareness about sustainable development and showed us that it is possible to give things a new and interesting life a second time. 7. It demonstrated that each of us can make at least a small contribution to waste management.

Future Initiatives.

Our future plans involve donating models and posters to various public schools. In collaboration with the regional resource center, we will provide selected schools with models and posters, which were prepared within the project framework, addressing their lack of visual aids. Additionally, we aim to create instructional videos on model-making to further support these schools.

V. Conclusion

Creating learning resources from used and useless items stands out as a highly effective approach to Cultivating environmental education in students. We believe that this method embodies two fundamental principles:

1. Fostering environmental awareness in students and enhancing creative and innovative thinking among students and pupils.

2. Enhancing Subject Comprehension. The creation of models using recycled materials facilitates a deeper understanding of the subject matter among students. Engaging in hands-on activities promotes active learning and enables students to grasp complex concepts more effectively, having a lasting impression on students' minds.

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

Marina Nagervadze – was leading all research process and preparation the Georgian version of manuscript.
Tatia Nakashidze-Makharadze - was responsible for preparation English version of manuscript.
Marina Koridze – was prepared the online questionary.
Jilda Gobadze - organized pupils enrolments in the research.
G. Nagervadze - was responsible for the teaching models preparation.
T. Koiava - was responsible for the Statistics.
I. Tsintsadze – organized pupils enrolments in the research.
R. Khukhunaishvili - has organized the Event and scientific picnic.

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

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.

Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.