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Role of global environmental issues in Hungarian physics education

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Abstract: *The choice of topic was important to show that it is possible to do environmental physics in this few science lessons we have, while doing projects in class or outside of class. Projects that can be used and tested in secondary school's physics lessons are presented, with environmental education as one of the objectives. An important feature of the projects is that they can be integrated into the physics curriculum and support the learning and use of modern skills. Examples of such skills include collaboration, internet awareness, data analysis, research approach and interdisciplinary thinking. The main aim of this article is to present some of the projects that have been tried out in physics lessons, which have been effective in raising environmental subjects and have also been used as motivational activities. As a result of the projects, an increase in students' motivation towards both physics and specific aspects of nature conservation was detected.*

Keywords: *environmental education; physics education; project-based education; developing 21st century competences*

1. Introduction

Environmental education also found a place in the education system of post-war Hungary, in 1970, and was further elaborated in 1990. It was also included in the central law regulating the education system, the 1995 National Basic Curriculum (Lenches, 1998; Ballér, 2003). With the creation of the framework curricula in 2001 it was included in the basic curriculum and it plays an increasingly important role, primarily an attitude-shaping role, in the Hungarian education system (Kónya, 2018). This is also reflected in the teaching of physics. Examples of this are shown in the context of small group activities and school projects in grades 7-10. The combination of everyday life questions and the exact knowledge of physics helps to develop

scientific cognition, strengthen problem-solving skills and help to answer questions that often seem distant.

We begin by addressing the importance of environmental education, both in education and in understanding the problems of everyday life. Then we will analyse the place and role of environmental education in physics education, followed by a presentation of the projects and good practices we have developed. We will also look at good practice abroad.

2. Hungary's education system today

Since 2005, the country has had a two-tier school-leaving certificate system, which means that you can take either the intermediate or the advanced level. The range of subjects is expanding, including specialised subjects and foreign languages, but all students have 4 compulsory subjects, Hungarian language and literature, mathematics and history, and a foreign language. Apart from these, there is no limit to the number of subjects a student can take. There is no limit on the number of subjects that can be taken, except in the final year, in science subjects after the end of the subject, as well as in digital culture. In addition, if the school offers a foreign language as an additional subject, it is also possible to take foreign languages from year 10 onwards, after the end of the school exams.

The most typical type of school in Hungarian public education is the 8-year primary school followed by a 4-year gymnasium or 5-6-year vocational gymnasium. Admission to primary school is generally linked to the place of study, and there are few primary schools that link admission to the school to admission. However, after primary school, students have to take entrance examinations and are then admitted to the type of school of their choice. Secondary schools prepare students primarily for higher education and for the school leaving certificate, while vocational schools prepare students for the school leaving certificate, but they have already specialised their studies and take a vocational examination on leaving school. After finishing primary school, those who do not go to university can continue their studies in a vocational school, where they have to learn a specific trade (Nagy, 2018; Eurydice, 2023).

In the case of a 12-year grammar school, students stay at the same school for the rest of their studies before university, while in the case of an 8-year grammar school, they attend a single primary school for 4 years and then, after admission, they are admitted to a grammar school where they continue their studies until they graduate. There are 6-year grammar schools, where the first 6 years are a normal primary school year, after which they are admitted to a preparatory year of language study, during which they study one foreign language for a larger number of

hours, while the other subjects are levelled up. The school where I teach has 12-, 8- and 6-year high school classes. Our school is a practising school, which means that our teacher training students observe classes and do their practicum under the guidance of mentor teachers before they graduate.

The operation of these types of schools is unified by state legislation, known as the National Curriculum, currently the 2020 curriculum, which is being introduced in a progressive system. According to this legislation, physics is taught from grade 7 to grade 10 for all pupils not attending a vocational school. In the last two years of secondary school, students may choose to continue their studies in physics as an optional subject. The faculties prepare students for the upper secondary school-leaving certificate and for further study at university.

There are also alternative private schools, such as Montessori or Waldorf, which have their own rules.

~~Most countries in EU, compulsory schooling starts at the age of 6 or 7, which is also the age at which Hungarian children start school, but they are obliged to attend kindergarten from the age of 3. The tripartition of the school system (primary, secondary and upper education) is common in all European countries, but is linked to different age groups and time intervals. Where there is a significant difference is in the annual school workload, in Hungary, this is on average 600 hours per year, which is low compared to the European average, but not significantly different compared to the Central and Eastern European average. (Eurydice, 2023)~~

3. Presentation of project pedagogy and its relevance to teaching about the environment

The school activities described below are project-based, and an important part of their design is to ensure that the educational process is one in which both community and individual development are reflected. A fundamental part of the projects is the transfer of values, which, in addition to the application and practice of the lessons learned, also means raising awareness of environmental problems and possibility pf harm reduction.

As an educational strategy, project-based learning requires an activity-based model that goes beyond the school setting, where learners are responsible for their own learning. The National Curriculum of 2020 also emphasises the importance of problem-based thinking and sets as a key objective that students should not only be passive recipients of learning, but also active

participants and shapers. The curriculum combines the development of problem-solving thinking with collaborative and creative teaching styles.

The local curriculum identifies as an important task the development of students' scientific understanding, which includes critical interpretation of resources and active use of the concepts learned (K. Radnóti and F. M Adorjánné, 2013).

The main aim of the sample activities is to educate people to think and act in an environmentally aware way, and to assess their own and others' responsibility for their environment and their future. The local curricula recommend project-based methods, problem-based teaching or experimental group work to increase pupils' motivation to work on environmental problems and develop skills.

One of the main results of György Pólya's research was the development of a theory dealing with the decision making process of problem solving (Gy. Pólya, 1969). This research is the basis of the PISA assessments, so it is not surprising that one of the main areas of focus in these assessments is complex problem solving thinking itself. In his study in 2005, Benő Csapó concluded from the results of the 2003 PISA surveys that problem solving as a skill is a key teaching task for public education (B. Csapó, 2005).

In his book on the practice of environmental education, János Lehoczky (Lehoczky, 1999) emphasises that the project method, collaborative learning techniques and out-of-school activities help to develop environmental thinking. In Lehoczky's statement, it is mentioned that the effectiveness of environmental education is enhanced by the experiences gained during the learning process and that goal-oriented activities help to deepen the learning that supports the use of project methods. As Mária Kováts-Németh writes in her article (Kováts-Németh, 2011), the teacher's task is not only to transfer knowledge and point out connections, but also to transmit values, standards and help to identify and solve problems. The importance of developing responsible behaviour and the effectiveness of using the project method are also highlighted in the Forest Pedagogy Project (Kováts-Németh and Földes-Leskó, 2019).

The above considerations support the view that the projects presented below are appropriate to the 21st century learning-teaching model and support the development of the skills that are a priority today, and increase students' motivation and engagement in learning the subject.

4. The role of environmental education in our daily lives and in education

In today's world, the 'monster of pollution' is everywhere, perhaps too often (Dodds, 2011; Marks et al., 2021). Environmental disasters are often highlighted in the media, but there is also a growing emphasis on environmental protection and sustainability (Kajner et al., 2013). This should be part of our everyday lives, as it was for our ancestors living with the environment for centuries.

The accuracy of environmental ambition is demonstrated by the fact that 8 out of the 17 targets in the 2030 Agenda for Sustainable Development include sustainability and the environment. The goals include sustainable agriculture (Goal 2.), sustainable water management (Goal 6.) and sustainable and modern energy access (Goal 7.), but there are also a number of goals that include measures to protect the environment as a whole, such as Developing sustainable consumption and production (Goal 12.), Taking urgent action to fight climate change and its impacts (Goal 13.), and Sustainable development (Goal 16.). Conserve and sustainably use oceans, seas and marine resources for sustainable development (Goal 14.) and Promote the protection, restoration and sustainable use of terrestrial ecosystems, sustainable forest management, combat desertification, halt and reverse land degradation and halt biodiversity loss (Goal 15.). (General Assembly of United Nations, 2015)

Of course, today's examples are different: more and more packaging-free shops are opening or plastic-free items are appearing in stores. For example, not everyone knows why we avoid food containing palm oil and not everyone goes vegetarian to protect the environment, but fortunately, ordinary people are increasingly finding ways to protect nature (see the problem of reactive nitrogen ("Nr"): Horvath, 2010; Sutton et al., 2011; Westhoek et al., 2015). These include, to take just one example, canvas bags in supermarkets, energy-saving electrical appliances and selective waste bins in shopping malls and public areas. Several surveys by the Hungarian Central Statistical Office (KSH) show that we have become more environmentally conscious in the 2000s, for example, the reduction in electricity consumption and per capita water consumption is partly due to this, alongside technological advances (KSH Environment Picture, 2018).

Few are questioned the prominent role of environmental education and sustainability in public education. After all, change is easier to achieve with the younger generation, whether by teaching or by example. They can also educate and sensitise their own families to global environmental issues. Initially, environmental education was included in classroom teaching,

ethics and environmental studies in primary school, but now it is also included in the framework of several subjects (NAT, 2012). The current National Curriculum of 2020 (NAT, 2020) includes environmental protection and sustainability, but it still plays a minor role. The situation is better in biology, geography, ethics and science (grades 5-6). It is striking that the subjects concerned are still predominantly science, while mathematics and real sciences are not mentioned in the NAT. Moreover, it is also apparent that chemistry and physics are not given a prominent place in the context of dealing with environmental problems. In physics, environmental sustainability is most prominent in the relationship between energy and the environment in 8th grade, followed by a 12-hour block on the preservation of the integrity of our environment at the end of 10th grade, which includes noise pollution, the role of the ozone hole in our daily lives, the greenhouse effect and alternative, green energy production.

Environmental education is present in physics education but is not given a prominent role. Often the problem is the reduced number of lessons. But we have to admit that even with this, there is still a lot of potential for environmental education for students, as it does not have to be seen as a separate subject. In many cases, assignments and projects can be given to students on this topic that can be adapted to the specific subject area in the curriculum.

The key to assigning tasks and projects is to adapt them to the age and knowledge of the students. That's why we thought that the most effective way to tackle global problems was to tackle them in line with students' development. At the beginning, the younger age group will only be introduced to problems related to their own environment, but over time, by grades 10-11, they will have grown up to learn about global problems. Micro-scale is understood to mean those phenomena that can be observed and measured in the students' immediate environment, i.e. that allow direct measurements, so it takes part from 7th grade to 9th grade students teaching. The meso-scale is slightly broader, covering a wider environment, allowing the search for urban and regional problems and solutions. At the meso-scale, it is no longer necessarily expected that measurements can be made, but rather that research and data collection can be carried out on topics about which students are likely to have some knowledge. For example, the majority of students have some knowledge of the country's energy production, of large power plants, and this knowledge is expanded and refuted by acquiring scientific knowledge. This can be use on 9th and 10th grade. In older ages we can use macro-scale studies. The macro-scale part of the task involves complex systems about which they have little knowledge as a whole, so the task for this domain is already concerned with analysing more extensive data. It can be

seen that these scales not only involve spatial growth, but also the complexity of the tasks, thus tracking students' skill development.

5. Project ideas for physics lessons

The following are some of the projects and project ideas underway. We will then discuss their links to the National Curriculum.

In grades 7-8: "*In line with the age phase, the processing of the curriculum is phenomenon-oriented, i.e. it is based on some tangible, observable, experienceable phenomenon. The choice of topics is practice-oriented and the aim of each topic is always to acquire practical knowledge that is useful in everyday life*." (NAT, 2020). In line with this, students learn about environmental problems in their own local environment through measurements and experiments.

Grades 9-10: "*The aim is to strike a balance between problem-focused, practical and knowledge-based learning in order to maintain motivation and to enable all students to learn effectively, creating the opportunity for students to become logical thinkers, adults who understand the interconnectedness of the world and are ready to make responsible choices*." (NAT, 2020). In grade 9, they deal mostly with meso-scale environmental problems, and then, broadening this, they move on to some global problems in grade 10.

In grade 11: Physics is only optional, where the primary aim is to prepare for advanced level and further education. At this point, the aim is typically to understand more complex problems, so environmental problems pop up from time to time. In Hungary, the exam from any kind of science is not obligatory, but students can choose it as a final exam's subject. In Hungarian education system, students choose subjects in their 10^{th} grade, from which they will learn on an advanced level and they would like to take advanced final exam. For those who do not take science as an optional subject, the 2020 NAT will provide complex science at this level. The aim of this subject is to familiarise students with environmental problems and human responsibility in their development. The main title of the subject is Man and the Environment, within the following major units headings appear: *"Get to know the nature"; "Human activity in shaping the environment"; "Raw materials, energy sources"; "Changing climate"; "Biodiversity"; "Environment and health"; "Our cosmic environment"* and *"Visions for the future"* (NAT 2020, A-level physics exam assessments (2020)).

In the next section, we will present some of the projects that the students have done in physics class, which are age-appropriate and in any case develop competences related to research, engineering and precision measurements. The projects are open-ended in their initiation and design, as described in the 2020th American Institute of Physics Conference publication of Vörös (Vörös, 2020), so teacher reflection and academic supplementation are important parts of the project in addition to student reflections.

5.1. Example projects

Gread 7 - Measurement

The introduction to science starts with units of measurement. In physics, this means the SI system of units. So we are also introduced to temperature as a quantity. The following exercise is a good opportunity to learn about the specificity of the age group and to introduce a scientific, experimental approach. It could be a classroom measurement if the school's local conditions are suitable (there is a busy road and a large wooded park). But it could also be given as homework / homework assignment. As a homework assignment it is set for groups of two.

Task assignment: one member of the pair should take temperatures at the busy concrete road and the other at the wooded area, twice a day, at the same time, for a week. (The map of the measurement can be seen on the Figure 2.) The pairs should make a separate diagram of the measurements and evaluate the results. What similarities and differences can be observed? What could cause any differences?

Advice for the measurement: as the measurement was carried out in early autumn, the sun is already up when you arrive at school in the morning, so it is a good idea to take one measurement then and the other after school.

The aim of the project is to give students an idea of the environmental impact that the lack of green spaces can have on our daily lives. It also shows that urban sprawl and car traffic increase temperatures locally.

Experience: the difference between built-up and green areas can be measured with a simple shaded liquid thermometer. The measurement is not burdensome, takes little time and the students spent on average half an hour analysing the data. Discussing the measured results took between half an hour and an hour, depending on whether the students had included global warming in their lesson. In the discussion, it was important to focus on the preservation of green

spaces. If the group brings up car traffic as a factor, then public transport can also be targeted to reduce local temperatures.

The results of the measurements were basically shocking to the students, mainly because in autumn the difference of a few degrees is not as noticeable as in the summer heat, but several of them noted that the temperature difference between green and built-up areas is already noticeable in summer. The measurement took place between 7th and 11th of November 2022. The Figure 1. also shows the daily warming and the difference between the temperatures in the wooded (City Park Sunbathing Area – Városligeti Napozórét) and the built-up, busy (East Railway Station – Keleti Pályaudvar) areas.

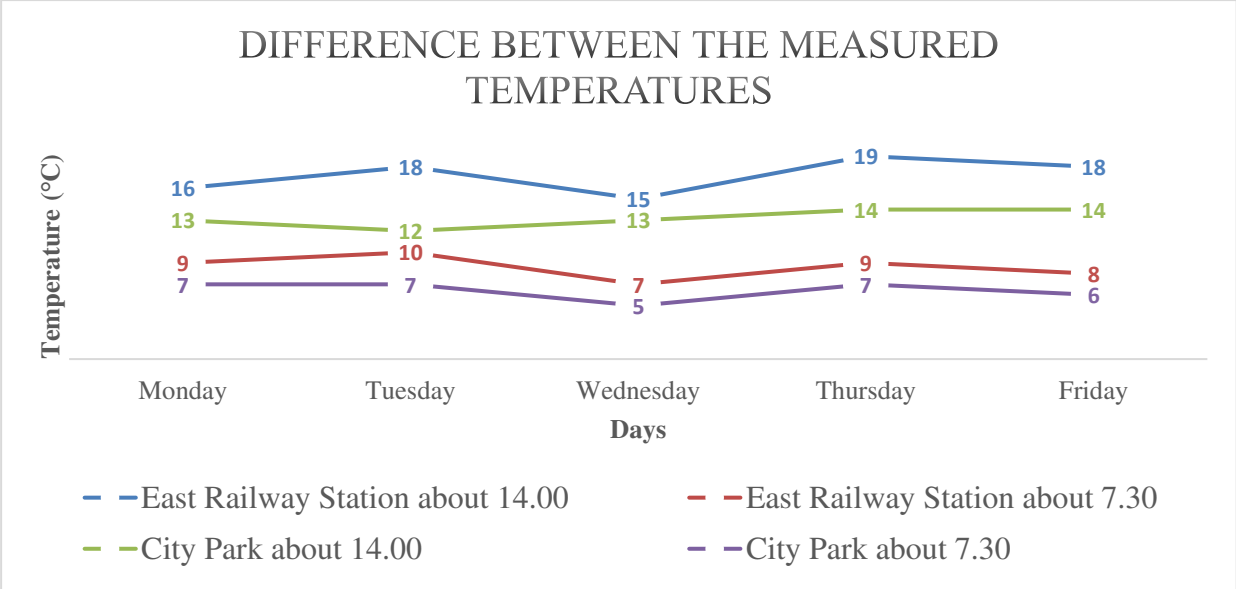

Figure 1.: Chart showing students' measurement results

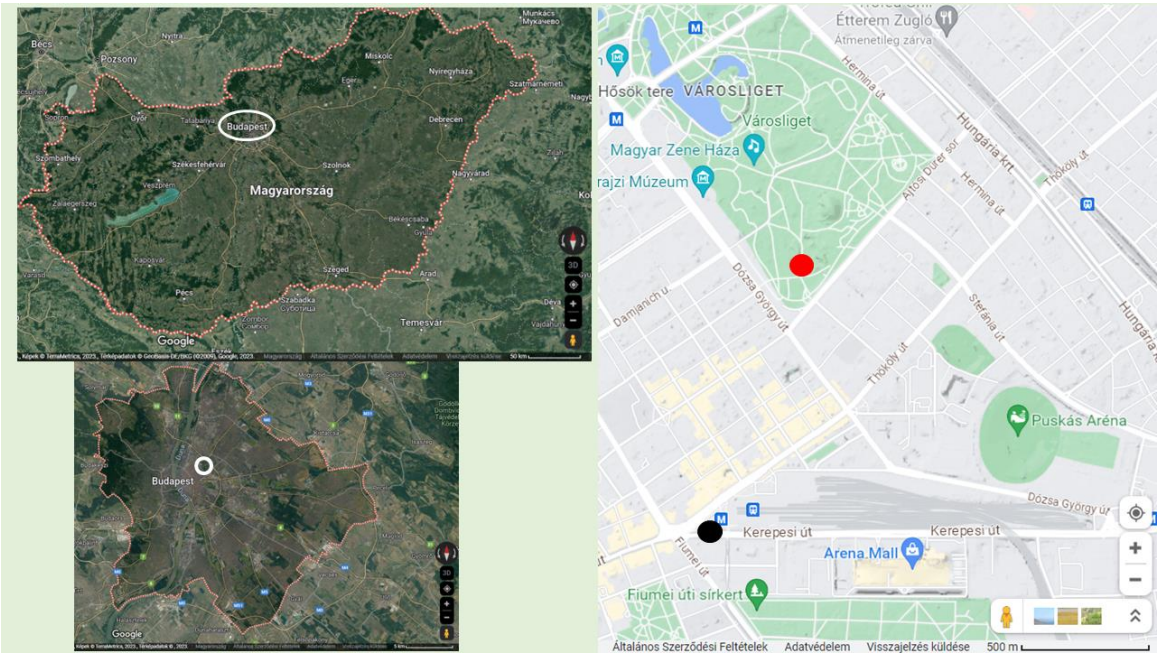

Figure 2.: Top Left: The map of Hungary; Bottom Left: The map of Budapest; The white circles point the zooming part of the map; Right: The map of school area, red dot: Central Park, black dot: East Railway Station; These maps were made by Google Maps

Grade 8 – Example for calculation

With a better foundation in mathematics, they are expected to be able to solve simple equations, so it is really from 8th grade that they are expected to solve numerical examples.

How long does it take for the dust from the volcano in Iceland to reach us? Assume that the dust spreads uniformly at a speed of 108 km/h (Richards-Thomas and McKenna-Neuman, 2020). The distance between the volcano and Budapest is about 3000 km.

The calculus example is not particularly more difficult than the general examples we solve in class. It is also advantageous because its longer wording will help you prepare for the later mathematics and physics exams, which also have a longer wording. Solving the problem did not cause any problems for the students and allowed room for discussion. We discussed why it is difficult to make such forecasts and what makes the work of meteorologists difficult. Simplifications can be a big focus at the beginning of physics studies, since we are basically talking about mass point kinematics and also mass point dynamics. We solve a lot of examples in these subjects where models and neglect are important, so they didn't encounter modelling in this exercise, so they were not particularly bothered by these approximations. The results can also be compared with real data, which shows that the models do help to describe reality The

2018 volcanic eruption resulted in the closure of Europe's entire airspace due to the dust plume, while smaller eruptions do not allow dust to reach the country's airspace, e.g. the 2011 eruption dust plume did not reach us (Eyjafjallajökull, 2010; ESA: Satellites monitor Icelandic ash plume, 2011)

Grade 9 - Think about it!

At this stage, it is possible to give slightly more complex tasks, as students have more advanced abstraction skills and two years of science knowledge. So, we dare to dive into thermodynamics, especially calorimetry and thermal expansion.

The media often claim that melting icebergs are causing ocean levels to rise. If a 1000 m^3 iceberg that has been floating on the water melts, how much will the water level rise? In our case, could it mean that melting ice alone is causing the rise in water levels? Think, what else could be causing it? Do the math! Try it on your own first, if you really can't do it, check out the help in the QR code below.

Figure 3.: QR code linked to the help

The experience of the exercise is that in the counting part of the exercise, students omit the change in volume between ice and water from the count. The completion of the counting task is also not part of the base examples, so they had to think a bit to calculate the increase in water level due to the melting of ice. And from the many data sets on the internet, not everyone found the same data on water level rise, but it became clear to everyone that it was not just melting ice that was causing the water level rise. 3 out of 18 students cleverly thought that melting land ice could have a more significant effect on water level rise than melting floating ice. Of course, we discussed, that the ice sheet floating on water has no effect to the see level, even when they melt. Finally, we also used data from the Greendex (Csaba, 2021) site to see how much sea level rise there has been in the last 50 years, and what proportion of this could have been due to rising temperatures.

Grade 10 - Look it up, write an essay.

We now give students a much freer rein. The task is less bounded than before and requires research. Its relevance for this age group is that someone who is not interested in physics may be interested in this everyday topic, which also shows how our everyday choices can influence global processes. The following complex task is inspired by the 16th assessment of the A-level physics exam (A-level physics exam assessments, 2020).

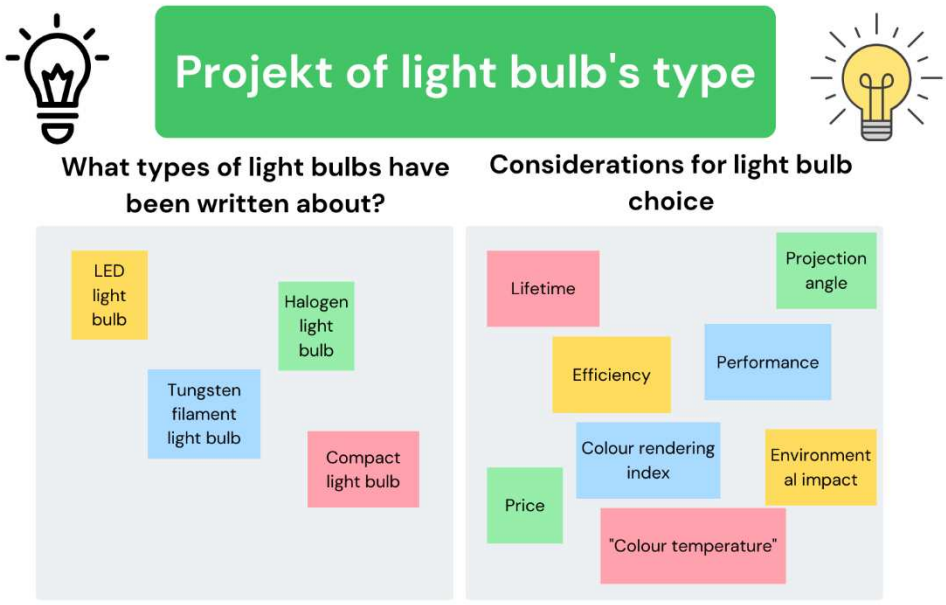

Figure 4. Summary of the light bulb project

Find out which light bulb to use in which room! Think about what might influence this? (E.g.: How often do we turn on the light?) We often hear how much energy and money we save by using an energy-saving light bulb (Kelly 2016; Obi, 2016; Lumenet, 2023,). If everyone used energy-saving light bulbs, how much energy would be saved? Write down the approximations you use and the order of magnitude of the energy thus obtained (e.g. household energy, city energy, power plant energy). Do we really save energy in all cases with energy-saving bulbs? Draw up a summary of the different types of light bulbs on the market based on the previous questions and include: Which room should I use it in? How much energy can it save per year? How much money does it cost? The expected length is at least one A4 page.

The calculations show that the energy-saving light bulb is actually better value for money than the conventional bulb. To do this, they needed to know their lifetime comparison, efficiency and wattage, which they had researched themselves. It can be seen from the submissions that

they looked at the four major types of light bulbs (Figure 4.) in general and examined at least 4 or 5 different aspects of which bulb is best for which room.

The decision can be influenced by a number of factors, as mentioned earlier.

Some examples of practicality. There are some areas where there are local light sources where there is a need for local lighting. More uniform lighting is needed in classrooms or workplaces. In the street, you need diffused light and, to minimise light pollution, you need lamps that throw little light into the sky. In the theatre, coherent, parallel, focused but bright spotlights are used. In the cinema, they aim to light only the screen. Vehicles must be clearly visible, so small but powerful light sources are used.

Incandescent lamps are not economical at all, because they produce 95% heat and only 5% light. Fluorescent lamps are more economical, but the light from conventional fluorescent lamps flickers quickly, which is not healthy. The compact (energy-saving) lamp is cheap to run, but it should only be used where it is left on for long periods of time because it is slow to reach full brightness. LED bulbs are pleasant and economical, but are more expensive than other options today. It is clear that the choice of light sources requires careful consideration.

What is the best choice depends on where you put it:

- If the operating time is low (e.g. toilet, pantry), a halogen bulb is the best because it is the cheapest. And the higher consumption is less of a problem, as it lights up less.
- If the operating time is higher (e.g. living room), a compact fluorescent or LED is recommended.
- In a room where the lamp is frequently switched on and off, a compact fluorescent lamp is not recommended because it will break down quickly. Halogen or LED lamps are recommended.
- If the light source is to be placed in a reading lamp, a halogen bulb or LED is also recommended. Not that there is anything wrong with the light from a compact fluorescent tube. It doesn't flicker, it gives a steady, excellent light. The problem is that it emits a lot of electromagnetic radiation within about half a metre.
- Pay attention to the colour temperature! For daylight, choose a warm (yellowish) light for the bedroom. Warm light improves comfort and helps you relax. Cold light is not suitable for living rooms. The situation is different in the kitchen and bathroom. Here, cold (white) light is more suitable, it increases the feeling of cleanliness. On the product box you will find a three-digit number, which is the colour code. The warmest light is

825. 825, 827 and 830 are for living rooms, 835 and 840 for kitchens and bathrooms. 865 is a cold light and should never be taken home.

This project also showed that they could be expected to analyse a wide range of data. For example: i) using and analysing data from the Hungarian Meteorological Service (HMS, in Hungarian OMSZ), or ii) extracting some regularity from data from other large databases.

Brightness is also important from another point of view, namely the radiation from the sun. Let's look at another example activity that deals with the relationship between light intensity and the amount of air pollutants.

An example activity: Use your phone to measure the light intensity (example apps: Physics Toolbox, Hukseflux Pyranometer) at least three times every day (for a week). Make sure that the measurements are taken in the open air, preferably from the same angle and from the same angle of inclination of the phone. Try to spread the measurements over 3 parts of the day (morning, early afternoon, early evening - when the sun is still shining) and take them at about the same time on different days. Compare what you find interesting between the measurements taken at different times! Then find the nearest meteorological station that measures air quality where you live and try to find a relationship between the change in air composition and the change in light intensity (Lee et al. 2010; Zhang et al. 2020; Yang et. al., 2022; Air Quality, 2023). If you find a link, also look for how the change in the air component can be linked to human activity. If you cannot find a relationship between your own measurements and the data series, try to justify why! Record your measurements and conclusions in a report. The project was inspired by measurements in heavily polluted air in major Chinese cities (Yang et al., 2022) and Seoul (Lee et al., 2010), which showed that polluted air affects light intensity.

The new types of mobile phones all have a light intensity sensor, which allows the device to automatically set the right brightness level. That's why most mobile phones have the sensor on the front-facing camera, but it's worth checking which camera's data the device uses to measure light intensity before taking a measurement. The project required students to plan the measurement themselves, allocate their time and find the right data, so a high level of autonomy was needed to complete the task. They developed their research, analytical and mathematical skills, while looking for relationships between complex and diverse data. Although the task required a lot of discourse, it was useful to get an insight into the complex processes, instruments and measurements involved in air quality measurements. The use of mobile devices for measurements in the classroom is a motivating factor for students. There are several articles

and websites that deal with the use of mobile devices in the classroom (FizziQ; Science and technology - Physics with Phones; Monteiro and Marti, 2022)

The children gave positive feedback on these activities, saying that they "took them out of physics lessons" and did not expect them to do the usual tasks. What is even more interesting is the feedback received for the grade 10 activity, where the student experienced that he "could do something about energy waste, something that did not involve a complete change of lifestyle". The 10th project, mentioned second, showed many interesting things, such as the difference in air quality between the city centre and the suburbs, although not all of them found a link between light intensity and air pollution. But there were very nice summary diagrams that we could compare and draw common conclusions. The following are the measurement results of one student (György Czvikovszky) (Figure 6.)

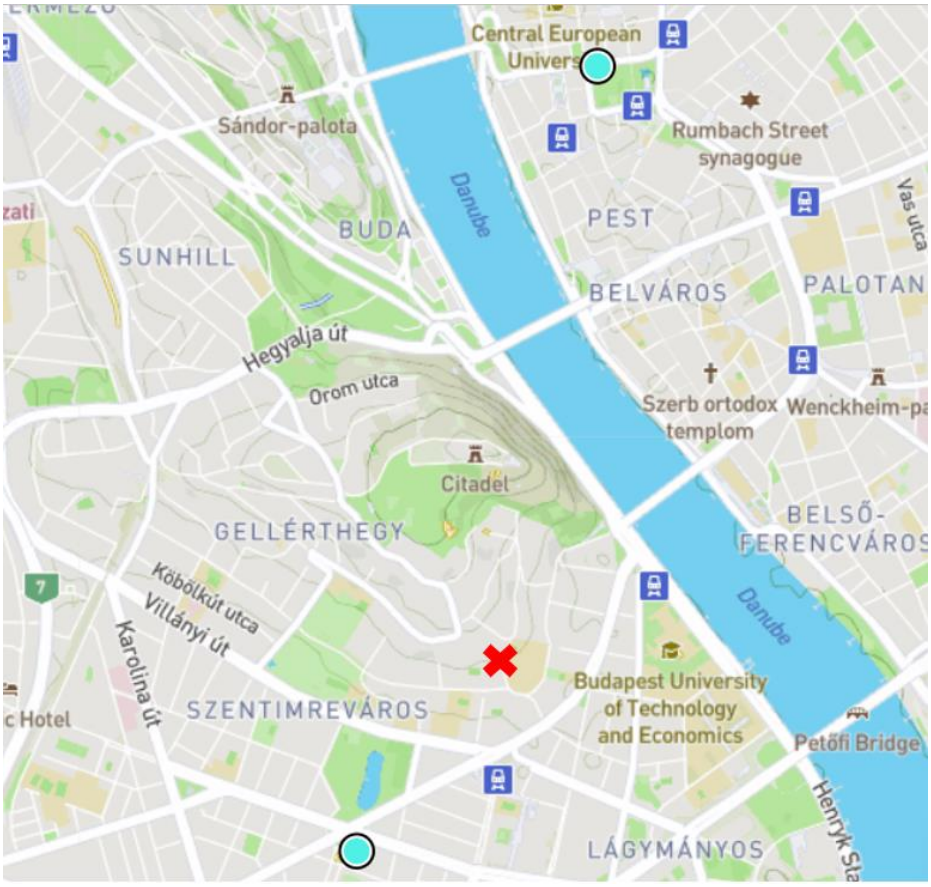

Figure 5. On the map of Budapest, turquoise dots indicate the air quality monitoring stations whose data were used for the project, red X indicates the measurement locations (The map is from Hungarian air quality: https://legszennyezettseg.met.hu/levegominoseg)

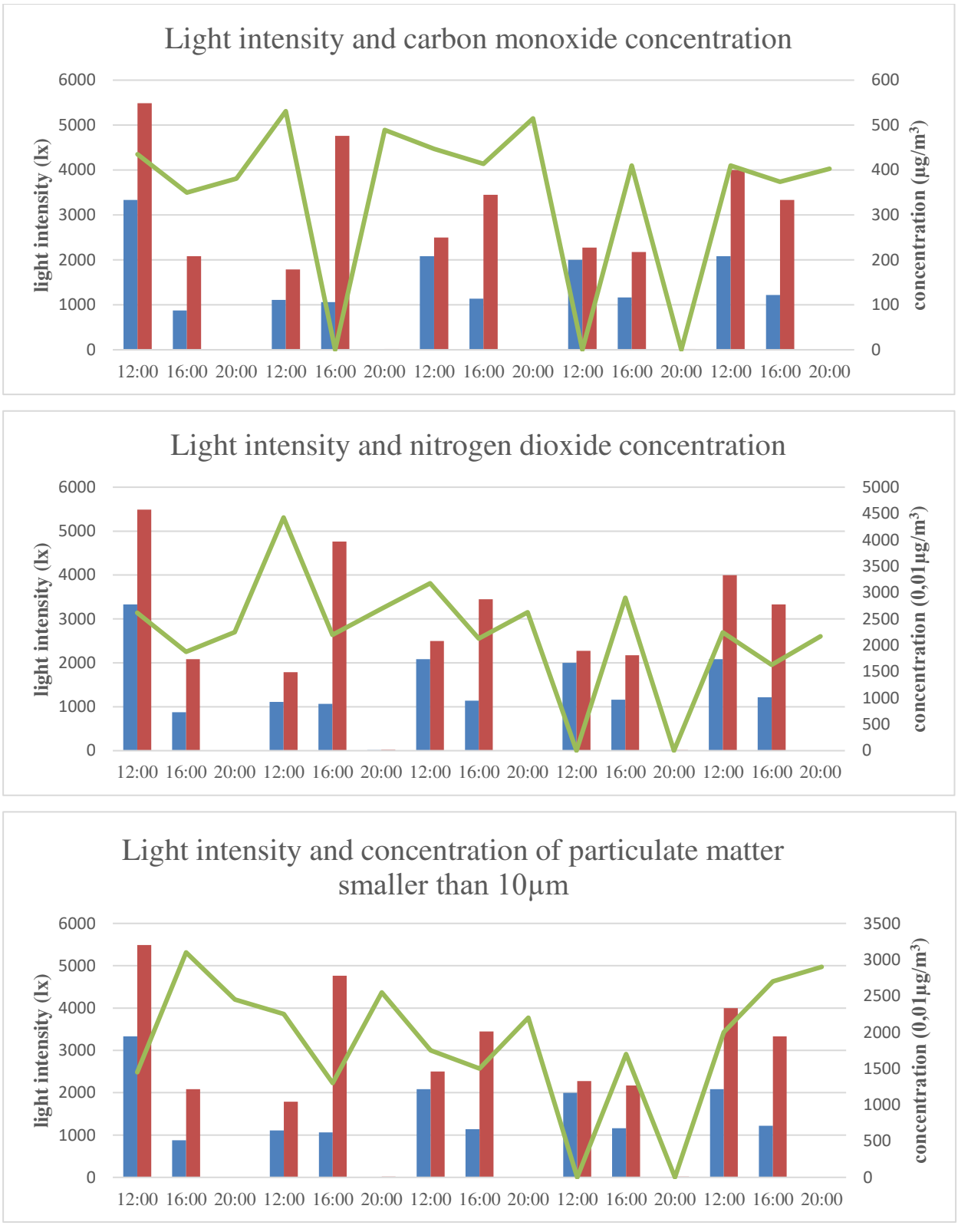

Figure 6. Diagrams made by the student from his own measurement results. Blue bar is A place of light meter, red bar is B place light meter, App: Physics Toolbox, green graph is the concentration of the substance

The measurements took place between 3 and 7 May 2022, using a telephone light intensity meter at two locations. Location A is an open wall window at a height of about 1 m from the ground, while location B is a garden table, also about 1 m from the ground in the same place (See Measurement location on the figure 5.). With this set-up, the light rays at both locations were perpendicular to the phone. At the measurement place, the sun was visible all the time during the measurement. The discrepancy between the results measured at the two locations is a measurement of the direct light rays and the light rays entering the room. During the measurement period, rain was only present in the afternoon of the first day, while clouds were typical at the measurement times. But the results of this day are not shown in the diagrams produced.

The air quality data were obtained by averaging the data from the two nearest stations to the measurement point (Figure 6.). There are 13 air quality monitoring stations in Budapest, and the National Meteorological Service provides data every 60 minutes (Air quality, 2023). The stations measure the presence of various substances that are most likely to characterise air pollution, such as carbon monoxide, nitrogen oxide, nitrogen dioxide, ground-level ozone, PM10[1], PM2.5[2], sulphur oxide and benzene. (Air quality, 2023)

We were also able to determine the air quality on a given day from the measuring stations. The following table will help you with this discussion (Figure 7.)

Concentration of pollutants $\left(\frac{\mu g}{m^3}\right)$						
	Good	Moderate	Unhealthy for sensitive groups	Unhealthy	Very unhealthy	Hazardous
Benzene	0 – 4	4 – 8	8 – 10	10 – 20	20 – 30	30 – 50
CO	0 – 4.000	4.000 - 8.000	8.000 – 10.000	10.000 – 20.000	20.000 – 30.000	30.000 – 50.000
$PM_{2,5}$	0 – 10	10 – 20	20 – 25	25 – 50	50 – 75	75 – 800

[1] Particles of dust that are less than 10 micrometres in diameter.
[2] Particles of dust that are less than 2.5 micrometres in diameter.

PM_{10}	0 – 20	20 – 40	40 – 50	50 – 100	100 – 150	150 – 1.200
NO_2	0 – 40	40 – 90	90 – 120	120 – 230	230 – 340	340 – 1.000
O_3	0 – 50	50 – 100	100 – 130	130 – 240	240 – 380	380 – 800
SO_2	0 – 100	100 – 200	200 – 350	350 – 500	500 – 750	750 – 1.250

Figure 6. Concentration of pollutants $\left(\frac{\mu g}{m^3}\right)$. Data came from the Hungarian National Meteorological Service (Országos Meteorológiai Szolgálat) (https://legszennyezettseg.met.hu/levegominoseg/informacio/aq-index-tajekoztato)

The student was only able to prognose a correlation with dust, i.e. the higher the dust concentration, the lower the light intensity.

The aim of the project is not primarily to find the actual, complex relationship between air pollutant particles and mobile measurable light intensity, but to think about what influences measurable light intensity. This was the main theme of the assessment discussion after the handing in of the protocols, to recognise the complexity of atmospheric processes. It was also emphasised that possible relationships that were discovered in the measurements could be due to other factors that had not been taken into account. This illustrates the difficulties of scientific understanding.

An important contribution of the project is to link optics with modern physics. The measurement is based on the logic of how light is scattered by polluting particles in the atmosphere. In this way, the physics of light scattering can be transferred from the similarities of the Rutherford experiment to atomic physics.

6. Final thoughts and assessments

Projects with students showed that student motivation increased significantly compared to the beginning of the project. However, as well as increasing their knowledge of physics, the older students were able to experience a system of scientific measurement and reasoning. The

younger age groups were able to gain insights into the use of physics knowledge at its frontiers through guided experimentation and thematic exercises. Tasks thematically addressed regional and global natural problems, providing a good opportunity to develop natural awareness.

The projects are a good stimulus for reflection, but beyond their completion, it is important to support the teachers in their work, motivate students to complete the tasks and then evaluate them reflectively. The tasks are designed to provide a good opportunity for nature education and the development of naturalistic thinking. Depending on the context, they can be used to raise awareness of global environmental issues.

As a result of the projects, students could experience that built-up areas increase temperatures, gain a deeper insight into the understanding of sea level rise through a numerical example. They also explored the complexity of the spread of air pollution and did research by comparing light bulbs. And a discursive discussion of the projects gave space to environmental education from a scientific perspective. Projects are evaluated through formative evaluation, which is used to help, correct and reinforce during the process, and a final summative evaluation, which is a rating against the objectives set. The importance of this aspect of assessment is increasingly recognised in education and its use supports the overall workflow of student. (Nicol and Macfarlane-Dick, 2006; Theall and Franklin, 2010; Trumbull and Lash, 2013).

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Adaptation of ERASDG projects at the BGSZC Dobos C. József Technical and Vocational School of Hospitality: self-evaluation of the students participating in the project

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Abstract: *This paper presents how the project method builds competences. and how students evaluated the project and their own work, and what their impressions of the projects were during the adaptation of the ERASDG (Education Requires Application of SDGs) projects in Hungary. The adaptation of the projects was implemented in the BGSZC Dobos C. József Hospitality Technology and Vocational School in the school year 2022/2023. The main aim of the Gamification project is to illustrate and combine the potential and importance of using gamification through project-based learning with an innovative learner-centred approach. As the results show the Team Learning project aims to strengthen the learning and thinking processes of students in teams.*

Keywords: *education, project education; environmental education; sustainability education; competences;*

1. Introduction

In this work, It is presented how the project method develops competences, and how students evaluated the project and their own work, and what their impressions of the projects were during the adaptation of the ERASDG (Education Requires Application of SDGs) projects in Hungary. The research used a questionnaire survey to measure what information they had about the four projects (Innovation camp, Living lab, Gamification, Team learning). The adaptation of the ERASDG projects was implemented at the BGSZC Dobos C. József Technical and Vocational School of Hospitality Industry in the academic year 2022/2023.

Competences in environmental education

Education for sustainability must start in early childhood and continue at school. (Wells & Lekies, 2006) For example, transformative pedagogy helps in this, the purpose of which is to address social-ecological issues and promote critical thinking about conflicts of interest. As

well as building a responsible environmental behavior and helping the active participation of citizens (Gericke et al., 2020).

In schools, teachers must ensure that young people are able to deal with the various natural, social, political and economic conflicts in their daily lives, and not only deal with them, but also resolve them. Teachers need to instil in their pupils an environmental ethos and socio-environmental responsibility. These all require new teaching and learning strategies that take into account individual differences and create opportunities for all children to acquire environmental culture and the related competences (Paksi, 2013).

Environmental competencies can be interpreted as cross-competence (Varga, 2009). They connect a group of competencies based on their long-term goals and their role in the sustainability system.

In order to create sustainable development, the following areas of competence are also required (Horváth–Száraz–Varga, 2009):

- Systems-oriented, critical and creative thinking.
- Awareness of knowledge elements related to sustainable development and their ethical dimensions.
- Knowledge of the consequences of decisions that do not support sustainable development.
- Knowledge of global, regional, national and local environmental problems.
- Methodological comparison of forest school programs (Kopasz, 2015).

The Vocational Training 4.0 strategy aims to ensure that young Hungarians leave school with the skills and competences to succeed in the jobs that will be transformed in the fourth industrial revolution (Innovative Training Support Centre, 2020). Project-based learning develops these skills and competences.

Through the adaptation of ERASDG projects, the students gained experience and their competences and skills were significantly improved. According to the National Curriculum 2020, the priority areas of competence are: basic competences, learning competences, communication competences, digital competences, thinking competences, personal and social competences, competences for creative work, self-expression and cultural awareness, workforce, innovation and entrepreneurship competences (Katona, 2020).

This paper state that the elements of the 2020 NAT include the individual XXI. 20th century competencies, however, not to an equal extent, some of them only play a tangential role in it,

and information literacy does not even appear in the document at a conceptual level. It can be interpreted as a positive phenomenon that, in addition to the use of digital resources, traditional documents and the ability to use them also play a role in competence development (Egervári, & Kovács, 2021).

The concept of competence of action and thinking (see 4. Competencies of thinking above) should occupy a central place in environmental education (Jensen & Schnack, 1997).

A brief introduction to the adaptation of ERASDG projects

The Gamification project was adapted from a field trip to Normafa, where during the one-day nature walk, the students completed the gamification tasks. In addition, they had to produce different outputs, e.g. Connect the knowledge learnt in the Basics of Tourism and Accommodation and the Compulsory Complex Science subject this year. Make a recommendation to your guests about possible hiking routes in Normafa, the most typical tourist signs and also the accommodation and catering facilities of the routes. In total, there were six similar themes.

Unilever was an external partner in the adoption of the Teams Learning project. There were different project tasks, such as the creation of a Food Supply and Sustainability Project Map. In total, there were seven similar topics.

The external partner in the adoption of the Living Lab project was Színrelép Kft. represented by Nikolett Balogh. For example, the students participating in the project had to plant different plants with kindergarten children and elderly people in an outdoor location as well as complete 8 project tasks at school. In total, 11 classes were involved in the project, 8 kindergartens and nursing homes took part in the event and 88 project tasks were submitted. E.g. poster competition - my own spice garden, video and photo production of events at the external site.

The Innovation Camp project was adopted to address the topicality of the Sustainability Week. In a presentation by external partners, the students heard how donation shops work, and through them, donating and volunteering. Then there were different project tasks. For example: organising a school poster and campaign for a joint collection, making a demonstration poster on how to collect waste correctly, reporting on the nominations, the organisational structure of the Maltese Relief Service, interviewing, editing a small booklet together with the coordinator titled "how to involve your family".

2. Material and method

The research methodology employed involves utilizing questionnaires distributed among students participating in the projects. This approach is categorized within the spectrum of quantitative research methods. The fundamental aim of employing questionnaires is to gather substantial volumes of data through predetermined queries. The term "closed form" refers to the structured nature of the questions, where the options for responses are pre-defined (Babbie, 2008).

Questionnaires based on two main parts: self-assessment and complex questionnaires. In the first part of the Self-assessment questionnaire, students read 8 statements (see below for the self-assessment of the students involved in the project) and marked on a five-point scale how they felt they were described. In the self-evaluation questionnaire, the students are also asked what were the 3 things they added to the project and what they liked and disliked about each project. The last question ask how the project contributed to the students' success in their future careers. The complex questionnaire was used to know more about the projects.

The questionnaire was completed with students of the 9th-10th grades of the Dobos C. József Vocational School of BGSZC. Google questionnaire was used for data collection The questions of the questionnaire were shared on Google Drive.

Quantitative analysis used for evaluation, the observations were presented in numerical form, in an attempt to describe and explain the phenomena behind them (Babbie, 2008).

3. Results

3.1. Self-assessment and complex questionnaire results for students participating in the Gamification project

3.1.1. Self-evaluation of students participating in the Gamification project

At the end of the project, the students completed an online self-evaluation questionnaire in which they could evaluate their own work and share their impressions of the project.

In the first part of the questionnaire, they were asked to read 8 statements and to indicate on a five-point scale to what extent they felt they were representative of them. The 8 statements:

1. I was actively involved in the project

2. I did my best to achieve the project's objectives

3. I actively communicated with my team members throughout the project

4. I worked well with other team members

5. I tried to be creative and come up with new ideas

6. I accepted ideas from other team members and shared my own with them

7. I managed my time effectively, trying not to get distracted

8. I am satisfied with the outcome of the project

A total of 37 people completed the gamification self-assessment questionnaire. Self-evaluation was only carried out in the project departments.

Most of the respondents, so 86.4% of the respondents answered with a score of 4 (43.2%) and 5 (43.2%) to the statement that they were actively involved in the project.

83.7% of the respondents (48.6% rated 4 and 35.1% rated 5), the statement that did their best to achieve the project's objectives.

75.6% of the respondents (43.2% rated 4, 32.4% rated 5), actively communicated with their team members throughout the project.

73.8% of the respondents (51.4% rated 4, 32.4% rated 5), worked well with other team members.

67.5% of the respondents (32.4% rated 4 and 35.1% rated 5), tried to be creative and come up with new ideas.

70.2% of the respondents (35.1% rated 4, 35.1% rated 5), accepted the ideas of other team members and shared their own.

72.9% of the respondents (37.8% rated 4, 35.1% rated 5), managed their time efficiently and tried not to be distracted.

80% of the respondents (43.2% rated 4, 37.8% rated 5) were satisfied with their presentation.

In the second half of the questionnaire, the students were asked questions about the project and their role in it:

- These are the 3 things that I myself contributed to the project (question 9)
- What I liked most about the project (question 10)
- What I did not like about the project (question 11)

● What I learned from the project (question 12)

● This is what I learned from the project that will help me in my future career (question 13)

In response to question 9 on what were the 3 things they themselves did for the project, most respondents wrote finding resources (43%), followed by ideas (33%), and the third was implementation and presentation (21%).

When asked question 10, what they liked most about the project, most of them, 59% of the respondents, said nature, 18%, being with their friends, 12%, the lecture, 8%, everything, 3%, teamwork.

In response to question 11 on what they did not like about the project, most of the respondents (43%) said that there was none, 23% said it was difficult, 13% said there was not enough time, 11% said IT tasks, 10% said there was a lot of rubbish in the forest.

In response to question 12 on what they had learnt during the project, most respondents (53%) said cooperation, 21% said that the tasks should be distributed fairly, 17% said that they should pay more attention to the environment, 9% said that theory and practice should be combined.

In response to question 13 on how the project has contributed to the success of their future profession, most of the respondents, 42%, answered that tourism is linked to hospitality, 29% that nature studies and hospitality are linked, 13% that medicinal plants can be used in hospitality, 6% that toxic plants are dangerous to life and 6% that sustainable and local ingredients should be used according to the season.

In conclusion, the students surveyed were actively involved in the project, more than half of the respondents said that it was important to cooperate during the project and that the project contributed to the success of their future profession, i.e. they realised how tourism and nature studies are interlinked in the hospitality industry.

3.1.2 Results of the complex questionnaire of the Gamification project

In the Complex Questionnaire, I wanted information about the Gamification project.

My questionnaire was completed by 47 people.

The majority of the respondents, 46.8%, found the project compulsory, but 42.6% also found it exciting, so there was a mixed picture among the students (see Figure 1).

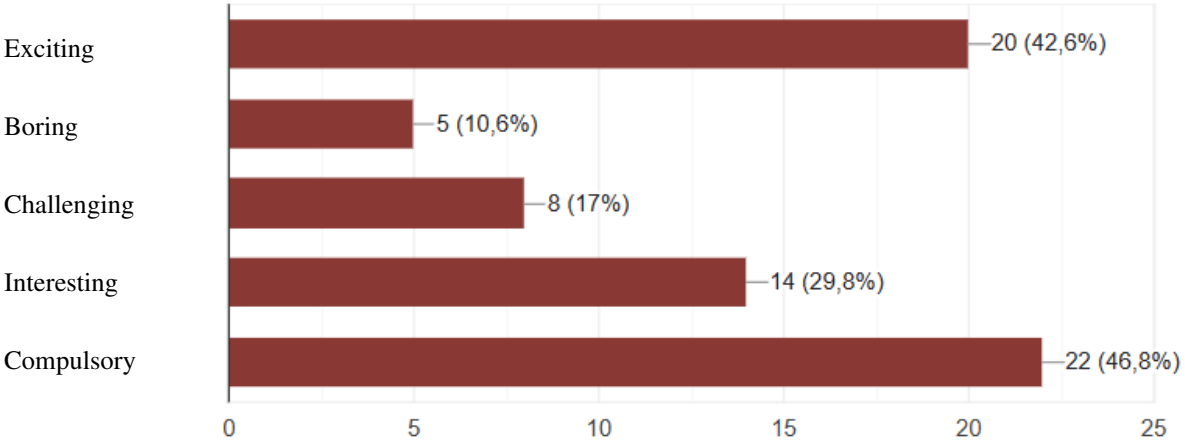

Figure 1: What respondents thought about the Gamification project (N=47)

Most of the students involved in the project, 59.6%, said that there were difficulties, but that they managed to find common ground.

Most of the respondents to the questionnaire, 48.9%, said that the sessions were well varied.

Most of the respondents, 46.8%, found the task/challenge of the project familiar and 27.7% found it interesting.

Most of the respondents, 66%, could identify SDGs 12 and 13. Goal 12 is Responsible consumption and production and Goal 13 is Action against climate change (see Figure 2).

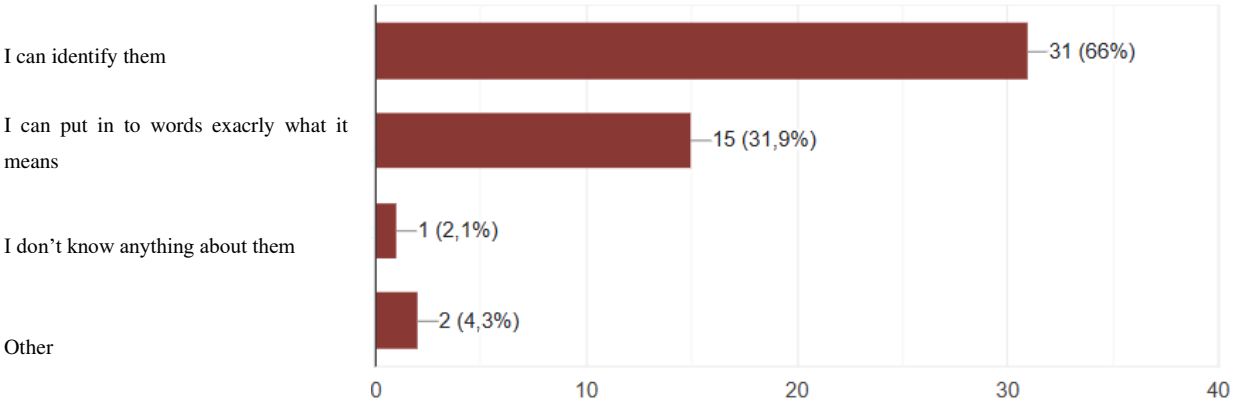

Figure 2: Questionnaire respondents could identify SDGs 12 and 13 (N=47)

Most respondents, 59.6%, think it is important to live consciously and 44.7% think it is everyone's responsibility to live sustainably.

In response to the question of why what they learned here is valuable to them, most of the respondents (57%) said that it brought them closer to nature, 29% said that it is important to have knowledge of tourism in the confectionery industry, and 14% said that it is important to know and protect plants and animals.

When asked how they think this experience will help them to be better prepared in the workplace, most respondents (63.8%) said they will be better able to work in a team, 26.2% learned to manage their time well and 27.7% said their communication skills improved (see Figure 3).

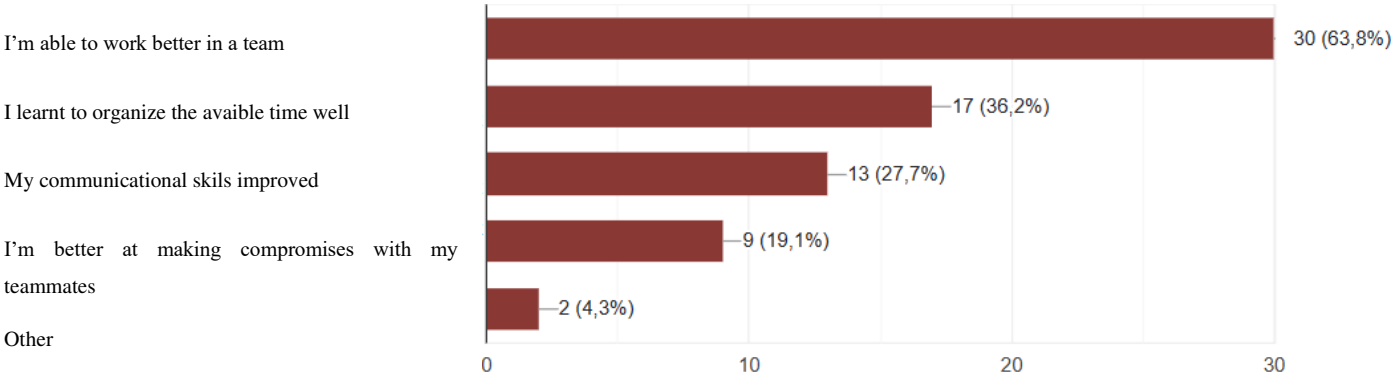

Figure 3: How do the respondents think this experience will help them to be better prepared in the workplace (N=47) (Source: Own research, 2023)

When asked which tools they used to approach the task, the most common answer was a mobile phone, with 83% of respondents saying this was the case. Only 25.5% used traditional devices, 23.4% a laptop, 10.6% a desktop computer and 8.5% a tablet.

Most of the respondents, 51.1%, cooperated with other team members and 42.6% supported each other, so the respondents had a very good experience of cooperation within the team.

Asked for their advice on the eleventh question, most of them, more than half of the respondents, 52%, said they had no advice, 22% said they wanted more projects like this, because they liked it so much, 13% said they wanted the tasks to be simpler next time, and 13% said they wanted to be able to choose their own team members next time.

Most of the respondents got the information they needed for their project from their teacher (72.3%), followed by the internet (59.6%).

Most of the respondents, 91.5%, shared the information they had learned with other teams.

Most of the respondents, 42.6%, identified their own limitations in terms of the expertise needed to complete the project.

The majority of respondents, 48.9%, identified the people important for project implementation, including their interests, perspectives, expertise and contacts.

36.6% of respondents contacted some other people who were close to the problem and easy to contact (e.g. recommended by teachers). Outside people were contacted more through digital means.

36.2% of the respondents sought targeted cooperation with people relevant to the project. Identified and/or contributed to the development of a tool for participants to facilitate the collaboration needed to implement the project. Thus, the coordination of project participants was particularly good, and only 12.8% of the respondents did not actively and consciously cooperate with others and/or were frustrated by the challenges they faced in cooperating.

36.2% of respondents showed an explicit willingness to learn from others during the project.

38.3% of the respondents actively explained and/or discussed the different perspectives relevant to the project and looked for opportunities to combine perspectives (e.g. how different perspectives can contribute to and strengthen the project). 36.2% of the respondents showed an explicit willingness to learn from others during the project. Thus, perspective taking and peer learning were rated as good by the students surveyed, and only 8.5% of the respondents had the aim of completing the project rather than learning from others. 29.8% of respondents reflected on their own learning and development throughout. 38.3 % of the respondents to the questionnaire initiated reflective activities among the people involved, with the aim of learning from the project (both in terms of process and content).

If we look at the transformation of the participants in my research, i.e. the intention to develop a new sustainable practice, we can find that 42, 6% of the questionnaire completers showed an attitude of wanting to develop a project outcome with multiple perspectives.

44.4% of the respondents showed an unconventional mindset and considered several aspects by weighing up the pros and cons of different possible solutions, so most of the respondents could easily generate new practice plans during the project process, and only 8.5% of the respondents showed no interest in unconventional thinking.

40.4% of respondents showed how their own and other students' ideas were incorporated into the final outcome. They showed how other perspectives are integrated and how the final

outcome is realistic in practice. In other words, respondents were able to integrate different perspectives, interests and expertise into the final outcome, and only 17% of respondents to the questionnaire presented a compilation of the insights of the students who participated in the final project. They did not describe the integration of multiple perspectives, interests or expertise.

46.8% of the respondents completed the project and then explained how it could be put into practice and what steps needed to be taken, and only 12.8% showed no interest in follow-up activities.

3.1.3. Summary of gamification measurements

The main aim of the Gamification project is to illustrate and combine the potential and importance of gamification through an innovative, learner-centred approach to project-based learning. This has been proven by the surveys (Self-assessment questionnaire, Complex questionnaire) as I have presented.

3.2. Self-evaluation of students participating in the Team Learning project and results of the Complex questionnaire

3.2.1. Self-evaluation of students participating in the Team Learning project

At the end of the project, the students completed an online self-evaluation questionnaire to assess their own work and share their impressions of the project.

In the first part of the questionnaire, they were asked to read 8 statements and to rate on a scale of 5 how they felt they were representative of them. The 8 statements:

1. I was actively involved in the project

2. I did my best to realise the aim of the project

3. I actively communicated with my team members throughout the project

4. I worked well with other team members

5. I tried to be creative and come up with new ideas

6. I accepted ideas from other team members and shared my own with them

7. I managed my time effectively, trying not to get distracted

8. I am satisfied with the end result of the project

A total of 47 people completed the Team Learning self-evaluation questionnaire. Self-evaluation was only done in the project classes.

The majority of the respondents, 66%, rated between 4 and 5 on the statement that they were actively involved in the project, i.e. the participating students were actively involved in the Team Learning project.

The majority of the respondents, 70.2%, rated the statement that they did their best to make their presentation a reality with a score of 4 and 5.

Most of the students, 63.8%, actively communicated with their team members during the project, rating this statement as 4 (40.4%) and 5 (23.4%).

Most of the participants in the project, 71.4%, cooperated well with other team members, rating this statement as 4 and 5 respectively.

Most respondents, 66% (51.1%) and 66% (14.9%) rated the statement that they tried to be creative and come up with new ideas as a 4 (51.1%) and 5 (14.9%) respectively.

Most of the respondents, 68.1%, accepted the ideas of other team members and shared their own.

The statement that I managed my time effectively and tried not to get distracted was less agreed with, as 31.9% of respondents rated it as a 3 and 34% as a 4.

The majority of the respondents, 85.2%, were satisfied with their presentation, with a score of 4 (42.6%) and 5 (42.6%) respectively.

In the second half of the questionnaire, the students were asked explanatory questions about the project and their role in it:

- List 3 things you yourself contributed to the project
- What you liked most about the project
- What you did not like about the project
- What I learned from the project
- What I learned from this project that will help me in my future career

When asked what were the 3 things they themselves contributed to the project, most respondents wrote data collection (43%), followed by editing (32%) and then contact management (22%).

Asked what they liked most about the project, most students said it was realistic (41%), followed by teamwork (39%) and not having to sit in boring classes (23%).

When asked what they did not like about the project, most students said that it took a lot of time (31%), followed by being difficult (27%) and thirdly, not being able to work together as a team (18%).

When asked what they had learnt from the project, most respondents said that sustainability was important (41%), 28% said that it was good to work together as a team and 12% said that it was a modern approach.

In the final question on how the project contributed to their future success, most respondents said that it broadened their horizons (41%), 38% said that they had gained new information and 29% said that they had tried to adopt a practical approach.

3.2.2. Teams learning Complex questionnaire results and evaluation

With my Complex questionnaire survey, I was looking for information about the project.

My questionnaire was completed by 45 people.

Most of the respondents, 48.9%, found the project compulsory but also exciting (see Figure 4)

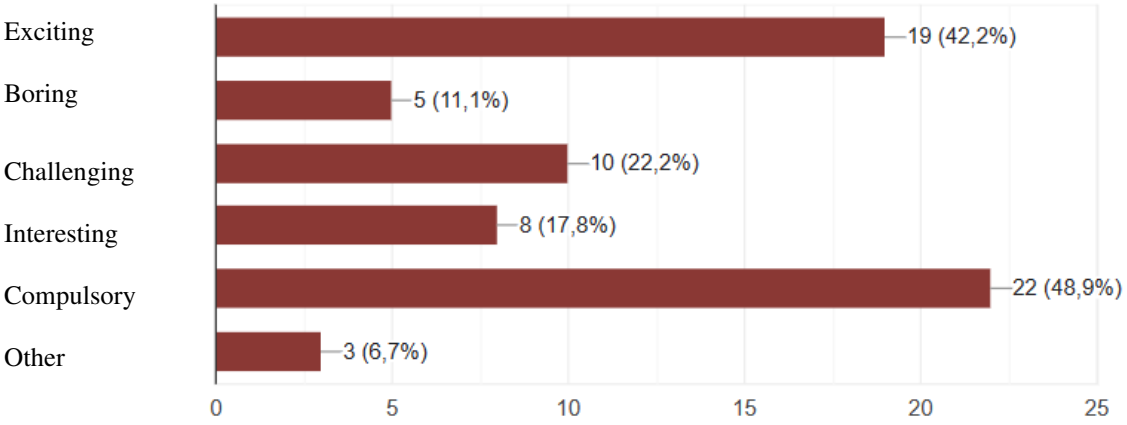

Figure 4: What respondents think about the Team Learning project (N=45) (Source: Own research, 2023)

Most of the respondents, 75.6%, said that they had difficulties but had managed to find the points of contact.

Most respondents, 88.8%, said that the programmes were varied.

Most of the participants in the survey, 64.4%, found the challenge/task easy.

Most of the respondents, 40%, could describe SDGs 12 and 13 and 33.3% could identify them. Goal 12 is Responsible consumption and production and Goal 13 is Action against climate change.

Most of the respondents, 77.8%, learned from the Team learning project that it is everyone's responsibility to live sustainably, 42.2% said it is important to live consciously. See Figure 5 for the other responses.

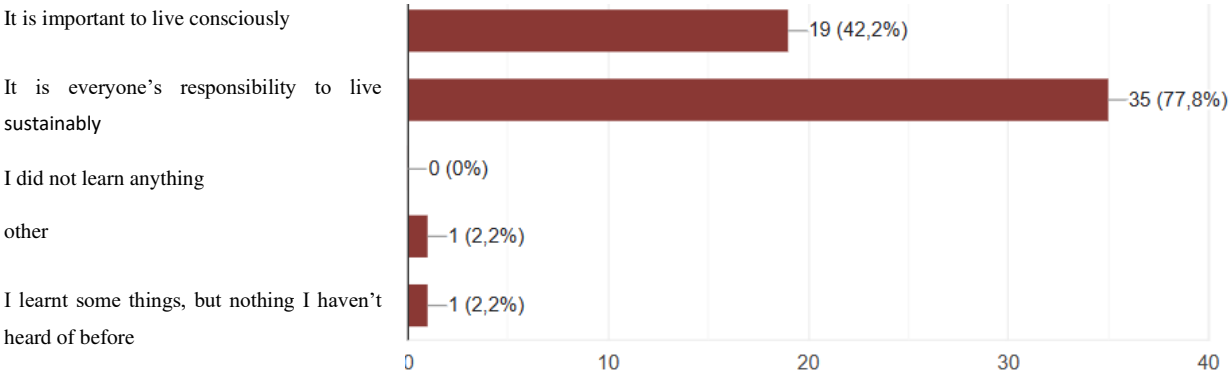

Figure 5: What respondents learnt from the Team learning project (N=45) (Source: Own research, 2023)

On the question of why they value what they have learnt here, most respondents (61%) said that they had learnt a lot, 19% said it was because sustainability was important, 11% said it was because of new trends and 9% said it was not valuable.

When asked how they think the experience gained during the project will help them to be better prepared for the future, most of the respondents, 46.7%, said that they can work better in a team, 44.4% learned to manage their time well, and the other answers are shown in Figure 6.

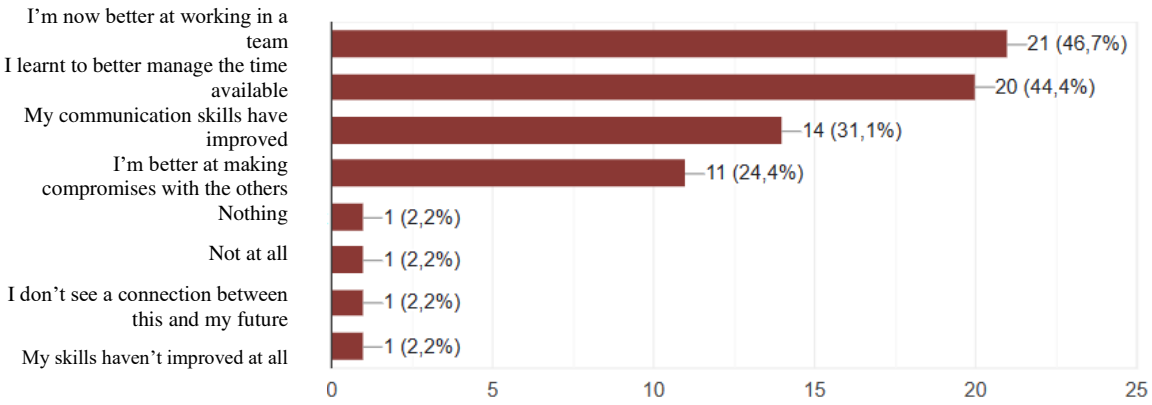

Figure 6: According to respondents, how will the experience gained from the project help them to be better prepared for the future (N=45) (Source: Own research, 2023)

Most of the respondents, 91.1%, used mobile phones, 33.3% used desktop computers and only 22.2% used traditional tools such as pens, paper and notebooks, so the project is a modern method of education.

The majority of the respondents' experience of cooperation within the team was that they worked together (64.4%), 51.1% said they shared ideas and 37.8% supported each other. See Figure 7 for the other results. In summary, the students' intra-team cooperation in the project was good, they could easily cooperate and think together.

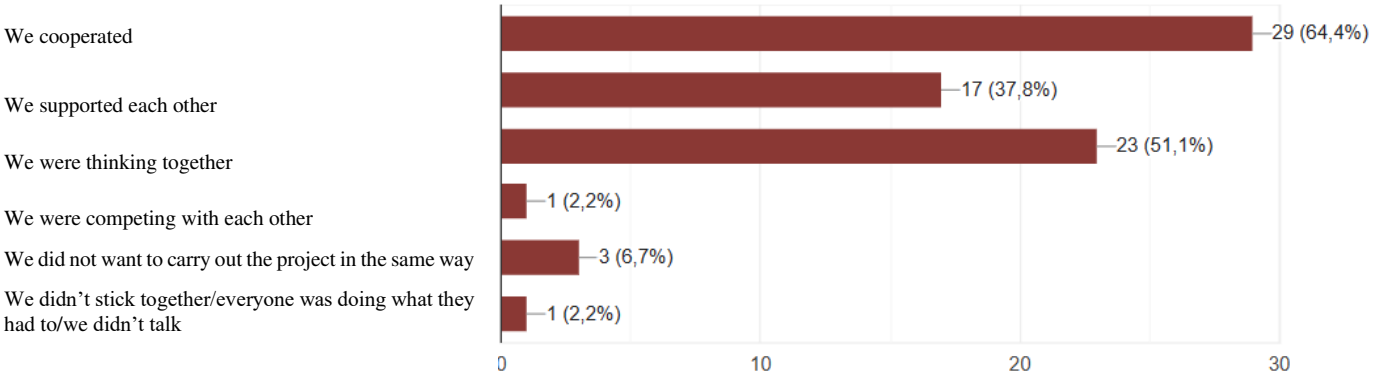

Figure 7: Respondents' experience of cooperation within the team (N=45) (Source: Own research, 2023)

Most of the respondents, 56%, said that their advice for me would be that it is important to be environmentally aware, 14% to work with the group, 10% to do more of these projects, 8% to allow more time to solve them, 6% to be more determined and 6% gave no advice.

Most of the respondents, 71.1%, got the information they needed from the internet, and 44.4%-44.4% from teachers and external collaborators.

Most of the respondents, 65%, shared the information they had learnt with others because they needed help and found the sharing of knowledge useful.

From question 14 to question 24, there were different statements on identification, coordination, perspective taking, peer learning and transformation. In the following section, I will describe the statements that were most frequently ticked, i.e. those that characterise them.

28.9 - 28.9 - 28.9% of the participants in my research explained their expertise in terms of knowledge and skills they could contribute to the project. They also identified their own limitations in terms of the expertise they would need to implement the project, compared their own expertise with that of other members of their project team and identified the knowledge they lacked to successfully implement the project.

Most of the respondents, 40%, identified people important for the implementation of the project, including their interests, perspectives, expertise and contacts.

31.1-31.1% of the respondents had established active and personal contact with relevant people, or had contacted some other people close to the problem and easy to contact (e.g. recommended by teachers). Outside people were contacted more through digital means.

Most of the respondents, 55.6%, sought targeted collaboration with people relevant to the project, i.e. they discovered and/or contributed to the development of a tool for participants to facilitate collaboration for project implementation. Thus, the coordination of project participants was particularly good, and only 2.2% of respondents did not actively and consciously cooperate with others and/or were frustrated by the challenges encountered in the process of cooperation.

Most of the respondents, 38.8%, actively expressed and/or discussed different perspectives relevant to the project and looked for opportunities to combine perspectives (e.g. how different perspectives can contribute to and strengthen the project).

31.8% of the participants in the research reflected on their own processes of learning and development.

42.2% of the respondents reflected with team members on each other's roles, contributions and development during the project, but did not translate the results into improving the performance of others.

When looking at the transformation of my research participants, i.e. their intention to develop a new sustainable practice, we can find that 33, 3% of the questionnaire respondents demonstrated an attitude of wanting to develop a project outcome that represented multiple perspectives.

44.4% of the respondents tried to incorporate innovative elements into traditional solutions.

46.7% of respondents showed how their own and other students' ideas were incorporated into the final product. They showed how other perspectives are integrated and how realistic the final outcome is in practice.

40% of the respondents completed the project and mentioned some possibilities for follow-up.

3.2.3. Summary of Team Learning measurements

The Team Learning project serves to strengthen students' learning and thinking processes in teams. This has been proven by the surveys (Self-assessment questionnaire, Complex questionnaire) as I have presented. As we could see from the results of the Complex Questionnaire, most of the students surveyed (more than 60%) experienced cooperation within the team as working together, more than half of the students surveyed said they were thinking together and more than 30% of them supported each other. In summary, the students who participated in the Team Learning project had a good level of cooperation within the team, and found it easy to work and think together.

3.3. Self-evaluation of Living Lab students and results of the Complex Questionnaire

3.3.1. Self-evaluation of students participating in the Living Lab project

At the end of the project, the students completed an online self-evaluation questionnaire to assess their own work and share their impressions of the project.

A total of 97 people completed my self-evaluation questionnaire.

In the first part of the questionnaire, they read 8 statements and indicated on a scale of 5 how they felt they were described. The 8 statements:

1. I was actively involved in the project

2. I did my best to help the project achieve its goal

3. I actively communicated with my team members throughout the project

4. I worked well with other team members

5. I tried to be creative and come up with new ideas

6. I accepted ideas from other team members and shared my own with them

7. I managed my time effectively, trying not to get distracted

8. I am satisfied with the end result of the project

A summary of the responses is shown in Figure 8:

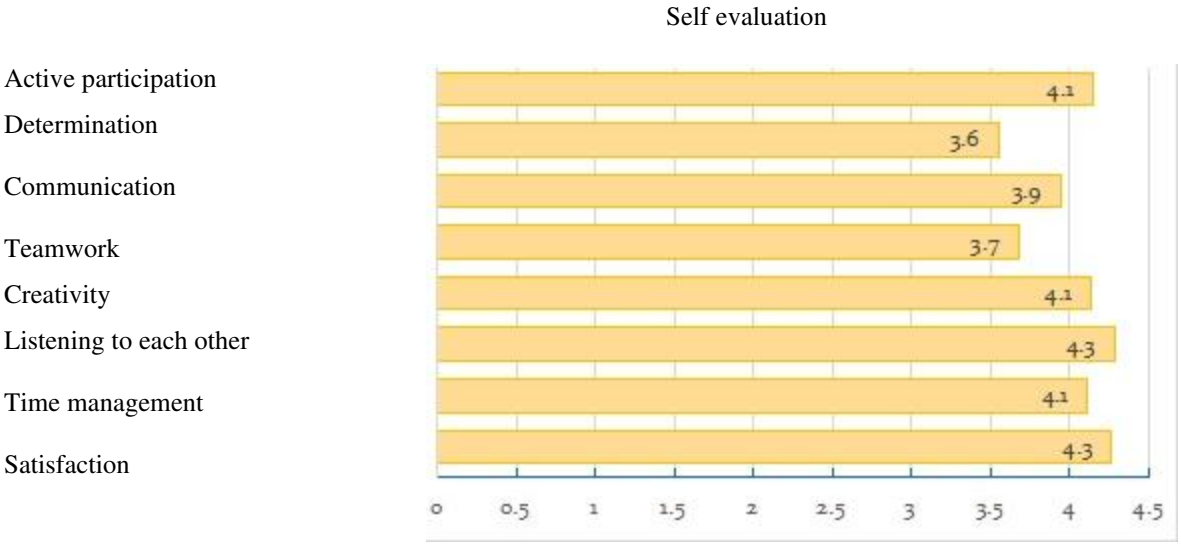

Figure 8: Self-evaluation of project participants (N=97) (Source: Own research, 2023)

The students involved in the project were mostly satisfied with the outcome of the project and seemed to have worked together effectively (although teamwork and communication between them was not always considered a clear success). Given the complexity of the project, with many sub-tasks, many felt that their work could have contributed more significantly to the collective outcome, but feedback indicated that students still had the opportunity to actively participate and express their creativity.

In the second part of the questionnaire, the students were asked elaborative questions about the project and their role in it:

- List 3 things you yourself contributed to the project
- What you liked most about the project

- What you did not like about the project
- What I learnt from the project
- What I learnt from the project that will help me in my future career

Some typical details from the answers:

What I added: *"My ideas, my time, my labour", "Planting, cocktail gathering, taking photos", "Leading the project team", "My creativity, my directness, my people skills", "Making video, doing interview, editing video", "I helped with writing the article, gathering information or interviews", "Drawing, ideas", "I tried to do my best in planting, doing the project", "I helped with weeding, watering and digging", "Making presentation, uploading, atmosphere", "Collecting data, decorating the ppt, looking for pictures", "We wrote the sustainability goals together and I have been working on it at home and helping others plant".*

What you liked/disliked*: "I liked that we could make our own environment more beautiful", "I liked that we didn't have to do it alone", "We were able to work well together both during the garden clean-up and during the ppt", "It was interesting and I had a good team", "I learnt lots of interesting things", "I liked planting herbs and making presentations", "The nursery when I had to work with the children", "It was a good team builder and brought people closer together and there was lots of laughter throughout the days. ", "I liked working as part of a team and learning new things", "It was good to get to know the older people there", "I didn't like that not all the older people were friendly, but I can deal with that", "I thought the number of tasks was too many on the project day and it could have been easier, and there were so many of us working together, it could have been a bit more transparent", "I didn't like the lack of space and the fact that there were so many of us in one place, we could hardly fit", "I would have taken on more planting".*

What I learnt: *"How I can improve the environment for myself and others", "How to sort the rubbish properly", "Planting, working in a team", "There are many types of mint and how many herbs and spices can be used to make cocktails and syrups, and what herbs and spices are good for" "I have increased my knowledge of the effects of herbs and spices", "Being in and working with a community, communicating", "Herbs can be used to make many delicious and tasty cakes and that there are many varieties of herbs", "Better use of Power Point and planting skills", "Sustainable healthy eating", "Gained a more comprehensive understanding of the plants".*

What I can benefit from: *"Sustainable production in the confectionery industry", "I will do my work in an environmentally friendly way", "I know which spices to use for what", "If I were*

to open a pastry shop, I would make sure to waste as little as possible", "It has improved my patience and I have learnt how to create better ppts.", "I learnt about the effects of plants, flavour combinations and unconventional combinations that work well", "I became more tolerant and patient with children, adults and the task at hand", "Developing stamina was very important for my future profession as a waiter", "Accepting the opinions of my teammates", "Learning to accept the opinions of other people in the team", "Learning new cocktails", "How to have a spice garden in my restaurant garden".

The responses show that students generally found it useful to participate in the project and found ways to contribute to the common goals. The feedback suggests that the project contributed to the development of students in several areas: many gained important experience in human relations and communication, others found the work useful from a professional point of view, many felt that their digital competence was enhanced, and we were pleased to see that thinking about sustainability goals and an interest in environmental awareness touched many of the participants.

3.3.2. Evaluation of the results of the Living Lab complex questionnaire

With my complex questionnaire, I wanted information about the Living Lab project.

A total of 91 people completed my complex questionnaire.

Most of the respondents, 57.1%, found the project exciting and only 6.6% found it boring. The other response results are shown in Figure 9.

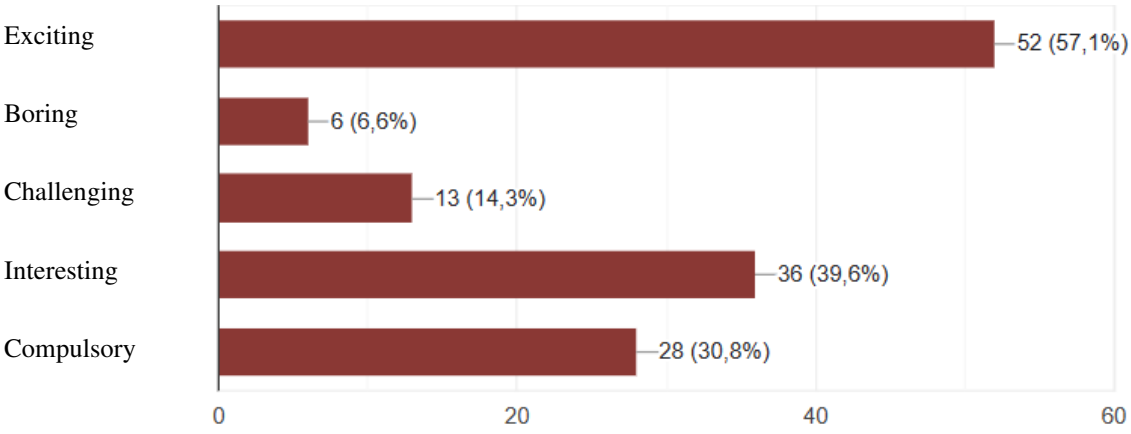

Figure 9: What respondents thought about the Living Lab project (N=91)
(Source: Own research, 2023)

Most of the respondents, 52.7%, said they had difficulties with the information they received in the Living Lab project, but managed to find the links, 42.9% could make the connections immediately and only 4.4% did not see the connections.

Most of the respondents, 41.8%, thought that the activities were varied, 36.3% thought they were mixed and only 3.3% thought they were mediocre. So, according to the project participants, the Living Lab had a varied programme overall, with 18.7% saying it was very varied.

Most of the participants in my research, 49.5%, liked the challenge/task of the project, and 29.7% of them found it interesting, and only 6.6% found it uninteresting, so overall we can say that the students liked the challenge/task of the project.

Most of the respondents, i.e. 50%, could identify SDGs 12 and 13 (12: Responsible consumption and production, 13: Action against climate change). 36.7% could say exactly what they meant and only 17.8% did not know anything about them, so the result was quite good as far as knowledge of the SDGs is concerned.

Most of the respondents in my research, 64.8%, learnt from the project that it is everyone's responsibility to live sustainably. 41.8% said that it was important to live consciously.

In the seventh question, asking why the lessons learnt were valuable for the respondents, most of the respondents, 56%, said they could use them in the future, 25% said they had learnt new knowledge about sustainability, 11% said they were exciting tasks and only 8% said they were not valuable.

When asked how this experience will help them to be better prepared in the workplace, most respondents (70.3%) said that they were better able to work in a team. The other answers are shown in Figure 10. Thus, according to our project participants, the Living Lab best reinforced their teamwork skills, which will be very useful for students in the future in their workplace.

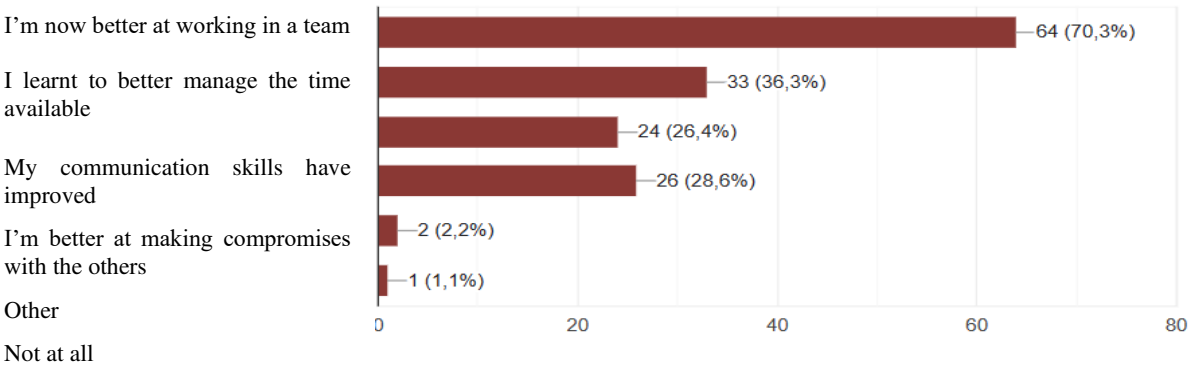

Figure 10: How do respondents think the experience gained in the Living Lab project will help them to be better prepared in the workplace (N=91) (Source: Own research, 2023)

When asked which tools they used to approach the task, most respondents (91.1%) said they used their mobile phone, 41.1% said they used a desktop computer and 30% said they used traditional tools (pen, paper, notebook).

The respondents' experience of cooperation within the team was that they worked together. 73.6% of the respondents answered this, 51.6% said they were thinking together and 40.7% said they supported each other, so teamwork worked very well in the Living Lab project. Based on the answers to the current and previous questions, we can clearly conclude that this project has strengthened teamwork as an employee competence. The students worked well with the other team members.

In response to the eleventh question, "What advice would you give me?", most of the respondents, 72%, said that they would like to do more projects like this in the future. I was very surprised by this result, I had expected worse, but it seems that the students liked this kind of teaching-learning. 21% of the respondents said they wanted more playful tasks, 3% said they wanted more time for the task and only 4% did not give any advice.

Most of the students in my study, 74.7%, got the information they needed from their teacher and 62.2% from the internet. The other answers are shown in Figure 11.

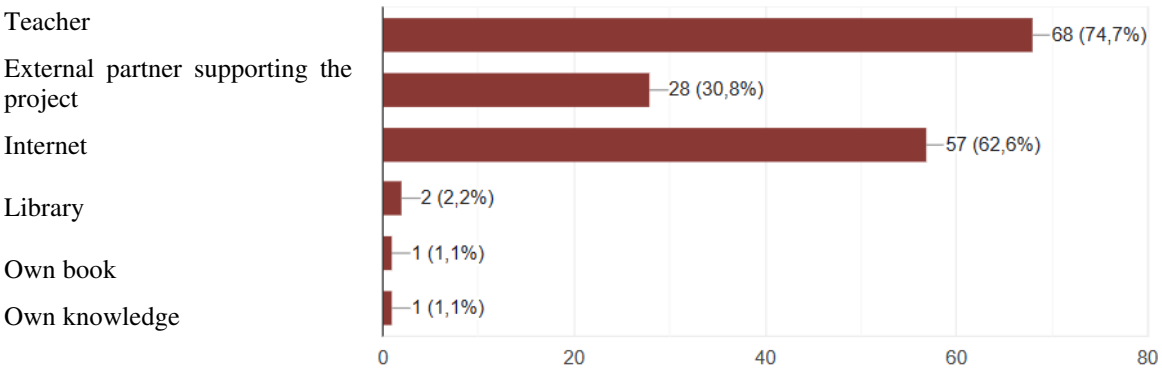

Figure 11: Where did respondents get the information they needed during the project (N=91) (Source: Own research, 2023)

Most of the respondents, 57.1%, did not share the information they learnt with other team members and 45.1% did.

Most of the respondents, 38.5%, explained their expertise in terms of knowledge and skills that they could contribute to the project.

Most of the survey respondents, i.e. 50%, identified the people important for the implementation of the project, including their interests, perspectives, expertise and contacts.

Most of the questionnaire respondents, 37.8%, have established active and personal contacts with relevant people.

The majority of respondents, 57.3%, pursued targeted cooperation with people relevant to the project. Discovered and/or contributed to the development of a tool for participants to facilitate the collaboration necessary to implement the project. Thus, the coordination of project participants was pronouncedly good, and none of the respondents ticked the box that they did not actively and consciously cooperate with others and/or were frustrated by the challenges they faced in cooperating.

Most of the respondents, 37.1%, actively expressed and/or discussed different perspectives relevant to the project and looked for opportunities to combine perspectives (i.e. how different perspectives could contribute to and strengthen the project).

Most of the respondents, 28.9%, showed an explicit willingness to learn from others during the project.

Most of the students in my research, i.e. 35.6% of the people involved, initiated reflective activities aimed at learning from the project (both in terms of process and content). Thus, perspective building and learning from each other was rated as good by the students

interviewed, although 32.2% of the students interviewed reflected with team members on each other's roles, contributions and progress during the project, but did not translate the results into improving the performance of others.

The majority of my respondents, 42.2%, demonstrated an attitude of wanting to develop a project outcome that represented multiple perspectives.

Most of the respondents, 48.9%, tried to incorporate innovative elements into traditional solutions.

Most of the respondents in my research, 37.8%, convincingly demonstrated how they had weighed different perspectives and interests when creating the final product and taken into account its practical and innovative nature.

And finally, most of the respondents, 38.2%, completed the project and then explained how it could be put into practice and the steps to be taken to do so, and only 12.4% showed no interest in follow-up activities

3.3.3. Living Lab project survey summary

A good method of project-based learning is the "living lab", an environment in which research and innovation are co-created, following the principles of co-creation and co-operative design.

This has been proven by the surveys (Self-assessment questionnaire, Complex questionnaire), as I have presented. The respondents' experience of cooperation within the team was that they worked together. More than 70% of the questionnaire respondents answered cooperation, more than 50% said they were thinking together and more than 40% said they supported each other, so teamwork worked very well in the Living lab project. Based on the answers to the current and previous questions, we can clearly conclude that this project has strengthened teamwork as an employee competence. The students worked well with the other team members.

3.4. Self evaluation of students participating in the Innovation Camp project and results of the Complex Questionnaire

3.4.1. Self evaluation of students participating in the Innovation Camp project

At the end of the project, the students completed an online self-evaluation questionnaire to assess their own work and share their impressions of the project.

A total of 41 people completed my self-evaluation questionnaire. Self-evaluation was only carried out in the project departments.

In the first part of the questionnaire, they were asked to read 8 statements and to indicate on a scale of 5 how they felt they were representative of them. The 8 statements:

1. I actively participated in the project

2. I did my best to make the presentations happen.

3. I actively communicated with my team members throughout the project

4. I cooperated well with the other team members

5. I tried to be creative and come up with new ideas

6. I accepted ideas from other team members and shared my own with them

7. I managed my time effectively, trying not to get distracted

8. I am satisfied with the end result of the project

Most of the respondents to the questionnaire, 61%, rated the statement that they were actively involved in the project as 5.

Most of the respondents (56.1%) rated the statement that they did their best to make their presentation a reality as a 5.

Most of the students, 78.1%, rated the statement that they actively communicated with their team members during the project between 4 and 5.

Most of the students, 58.5%, rated 5 for the statement that they worked well with other team members.

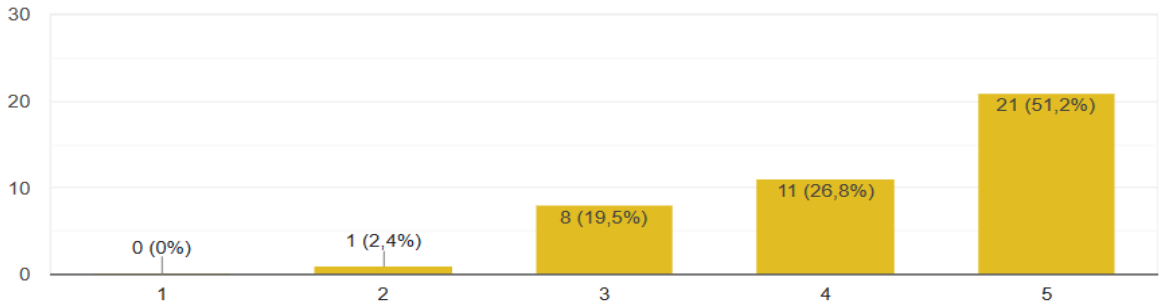

Figure 12: Students' evaluation of their efforts to be creative and generate new ideas (N=41)

(Source: Own research, 2023)

Most of the respondents, 51.5%, gave a rating of 5 (see Figure 12) to the statement that they tried to be creative and come up with new ideas. In my opinion, creativity is the most characteristic feature of the Innovation Camp project, as Innovation Camp is a new teaching method that can be applied in Hungarian vocational education and training and contributes to making students more creative, as it develops their creativity and problem-solving skills (Tóth, 2021).

The majority of respondents, 51.2%, accepted the ideas of other team members and shared their own.

Most of the students in my study rated the statement "I managed my time effectively and tried not to get distracted" as a 4 (39%) and a 5 (36.6%) respectively.

Most of the respondents to my questionnaire, 65.9%, were satisfied with their presentation.

When asked what were the 3 things they added to the project, most respondents (71%) said ideas, followed by task completion (51%) and data collection (31%).

Most of the respondents liked the teamwork (46%), 32% liked the theme, 11% liked the chance to get out of school, 6% liked the activity itself, the clothes selection, and 5% liked the opportunity to combine theoretical knowledge with practical experience.

Most of the participants in my research, 42%, did not dislike anything, 28% said it was time-consuming, 11% said the fact that they had to clean, 11% said the task itself was difficult, 8% said it was difficult to work with others.

When asked what they had learned from the project, most respondents, 41% of the respondents, said that it was good to work together in a team, 25% said patience, 17% said confidence, 12% said volunteering was good, 5% said how difficult it is to be a leader.

To my last question on how the project contributed to the success of their future profession, most of them, 41% of the respondents, said that they learned to work together in a team, 21% that they learned confidence, 19% that they learned to improve communication, 19% that they should definitely donate.

3.4.2. Analysis of the results of the Innovation Camp complex questionnaire - project information

My complex questionnaire was intended to gather information about the projects.

My complex questionnaire was completed by 41 people (9.B, 9.C)

Most of the respondents, 43.9%, found the Innovation camp project exciting. The rest of the responses are shown in Figure 13.

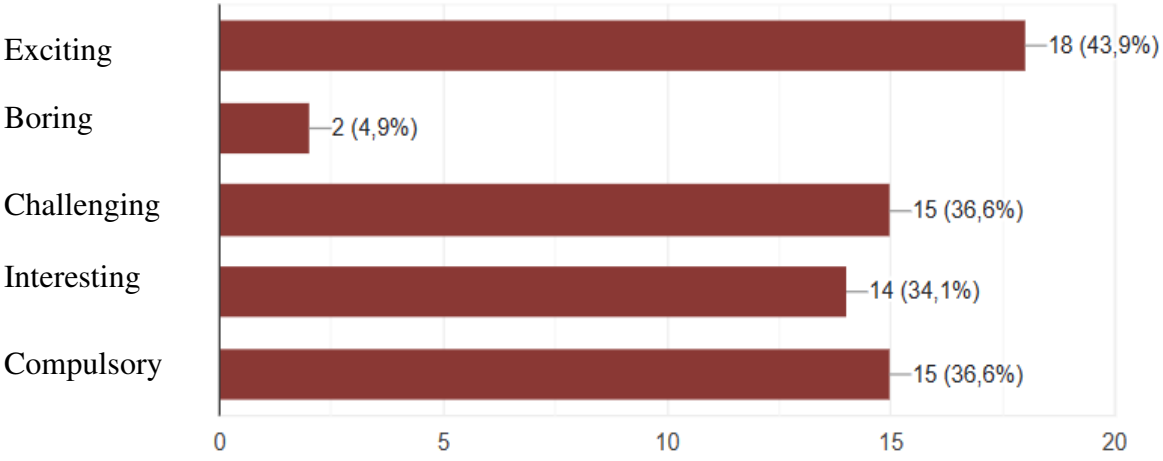

Figure 13: What respondents thought of the Innovation Camp project (N=41) (Source: Own research, 2023)

Most of the respondents, 56.1%, had difficulties but managed to find the points of contact.

Most of the participants in my research, 41.5%, thought the sessions were varied, 31.7% thought they were mixed.

43.9% of the students surveyed liked the challenge/task of the project, 31.7% found it interesting, and only 9.8% found it distant and the same number found it monotonous.

The majority of respondents, 43.9%, could identify SDGs 12 and 13. Goal 12 is Responsible Consumption and Production and Goal 13 is Action against Climate Change. The other responses are shown in Figure 14.

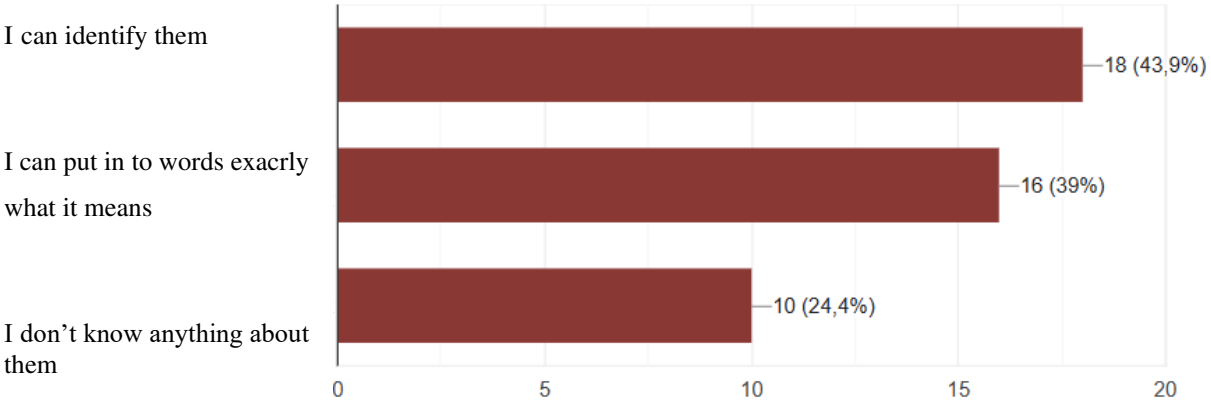

Figure 14: Respondents to the questionnaire rated Sustainable Development Goals 12 and 13 (N=41) (Source: Own research, 2023)

Asked what students learned from the project, most students, 58.5-58.5% of respondents, said that it is important to live consciously and that it is everyone's responsibility to live sustainably.

In response to the seventh question on why the things they have learnt are valuable, most respondents, 52%, said that they could use them in their lives, 18% said that awareness was important, 15% said that they had learnt more from others and 15% said that they had improved.

Asked how this experience will help them to be better prepared in the workplace, most respondents (70.7%) said that they are better able to work in a team. See Figure 15 for the other answers. In conclusion, the project has helped students to become better team workers in the workplace, to improve their communication skills and to learn to manage their time well.

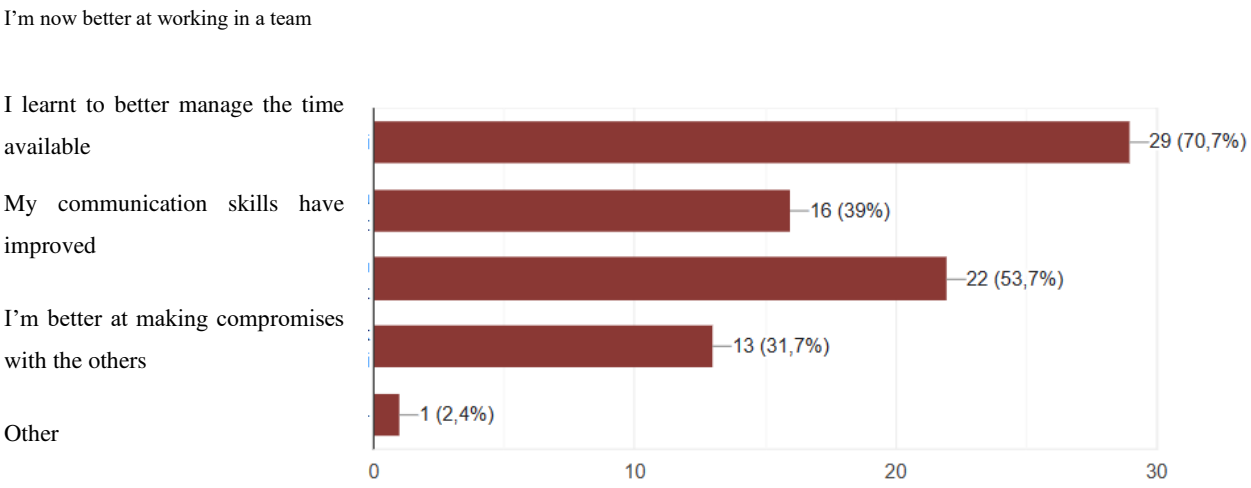

Figure 15: How do respondents think the project has helped them to be better prepared at work (N=41) (Source: Own research, 2023)

Most of the students surveyed, 95.1%, used their mobile phones to approach the task. I was surprised to see that 43.9% of them also ticked traditional tools (pen, paper, notebook).

When asked question 10 about their experience with cooperation within the team, most of them, i.e. 80% of the respondents, answered that they cooperated. 55% supported each other and 47.5% thought together.

In response to question 11 on their advice to me, most of them, i.e. 48% of the respondents, answered that everything was perfect (!). 21 % said that time management was very important, 15 % that there should be more of these projects and 16 % that they had no advice.

Asked where they got the information they needed during the project, most respondents, 78%, said the internet and 63.4% said the teacher. I was a bit surprised that the teacher was not the

first choice, but it seems that in the 21st century, much more information can be found on the internet and in a very short time.

63.3% of respondents shared the information they had learned with other team members.

From question 14 to question 24, there were different statements about identification, coordination, perspective taking, learning from each other and transformation. In the following section, I will describe the statements that were most frequently ticked, i.e. the statements that describe them.

Most of the respondents, 46.3%, identified their own limitations in terms of the expertise needed to implement the project.

The majority of respondents, 51.2%, identified the people who are important for the implementation of the project, including their interests, perspectives, expertise and contacts.

Most of the participants in my research, i.e. 43.6%, have established active and personal contacts with relevant people.

Most of the respondents, i.e. 48.8%, sought targeted collaboration with people relevant to the project, i.e. they discovered and/or contributed to the development of a tool for participants to collaborate more easily in the implementation of the project. Thus, the coordination of project participants was pronouncedly good, and only 4.9% of respondents did not actively and consciously cooperate with others and/or were frustrated by the challenges encountered in the process of cooperation.

Most of the respondents, 53.7%, actively expressed and/or discussed different perspectives relevant to the project and sought ways to combine perspectives (e.g. how different perspectives could contribute to and strengthen the project).

Most of the research participants, i.e. 48.8%, explicitly showed a willingness to learn from others during the project.

Most of the respondents, i.e. 48.8% of the people involved, initiated reflective activities aimed at learning from the project (both in terms of process and content).

If we look at the transformation of the participants in my research, i.e. the intention to develop a new sustainable practice, we can find that 46, 3% of the questionnaire respondents showed an attitude of wanting to develop a project outcome with multiple perspectives.

36.6% of the respondents showed a non-conventional mindset and considered multiple perspectives by weighing up the pros and cons of different possible solutions, so that most of the respondents could easily generate new practice designs during the project process, and only 9.8% of the respondents showed no interest in non-conventional thinking.

Most of the respondents, 43.3%, convincingly demonstrated how they had weighed up different perspectives and interests when creating the final outcome and taken into account its practical and innovative nature.

46.3% of respondents had completed the project and then explained how it could be put into practice and what steps needed to be taken, and only 9.8% showed no interest in follow-up activities.

3.4.3. Summary of Innovation Camp project surveys

The Innovation Camp project can be applied in Hungarian vocational education and training, and it contributes to making students more creative, because this method develops their creativity and problem-solving skills.

This has been proved by the surveys (Self-assessment questionnaire, Complex questionnaire) presented in my study. As I have shown, most of the respondents to the Self-Assessment Questionnaire, i.e. more than half of them, rated their efforts to be creative and to generate new ideas as 5. It can be concluded that creativity is the most characteristic feature of the Innovation Camp project, as Innovation Camp is a new teaching method that can be applied in Hungarian vocational education and training and contributes to making students more creative, as it develops their creativity and problem-solving skills.

4. Summary and conclusions

It can be clearly stated that the main aim of the Gamification project is to illustrate and combine the potential and importance of using gamification through project-based learning with an innovative learner-centred approach.

As we have seen, the Team Learning project aims to strengthen the learning and thinking processes of students in teams.

I have also shown that a good method of project learning is the "living lab", an environment in which research and innovation are co-created, following the principles of co-creation and co-operative design.

My questionnaire-based research also confirmed that the Innovation Camp project can be applied in Hungarian vocational education and training and contributes to making students more creative, as it develops their creativity and problem-solving skills.

In my study, I have presented how students evaluated the projects and their own work, what their impressions of the projects were during the adaptation of ERASDG projects in Hungary.

It can be concluded that project-based vocational education and training is the future of vocational education and training, because it develops the competences of students in an effective and multifaceted way.

Thanks to the ERASDG project, there is a good chance that the four innovative themes developed (Innovation camp, Living lab, Gamification, Team learning), the good practices and the forward-looking solutions, if spread to other schools in Europe, could improve the quality of vocational education and training in the green sector.

In conclusion, the adaptation of the ERASDG projects in Hungary has improved students' communication competences the most, and their digital competences have also benefited from the programmes. Thinking about sustainability goals and interest in environmentally conscious lifestyles also touched many of the participants. In particular, the Living lab and Gamification projects reinforced teamwork as an employee competence. Students worked well with other team members. However, in particular in the Innovation Campand Team learning projects, the students' creativity competences (see 6. Competences for creative work, self-expression and cultural awareness (Katona, 2020)) were the most developed.

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Qualitative analysis of international strategic trends pertaining to the digital ecosystems of libraries

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Abstract: *The principal driving force behind contemporary changes is the Fourth Industrial Revolution. While similarly to previous industrial revolutions the Fourth Industrial Revolution radically altered technology, economy and society, the latter displays an exponential growth as compared to the linear development of the former. Consequently, cyber-physical systems emerge blurring the distinction between hardware and software, and take advantage of the options provided by networks and artificial intelligence. Furthermore, communication takes place not only between humans but machines as well (Schwab, 2015). The Fourth Industrial Revolution results in a cultural paradigm shift and dramatically changes how society functions. Since the library has a complex role as an information system and as a culture and value transmitting institution it is extremely sensitive to these developments. Therefore in order to preserve their competitive edge, libraries must continuously and adaptively respond to the given changes. In our essay we explore the impact of the respective paradigm shift on libraries and identify external factors influencing library ecosystems and the related expectations. We will provide a definition for the digital ecosystem of libraries followed by a trend analysis of the given components' actual role and the extent of their effect on library strategies. We base our conclusions on a software supported content analysis of strategic documents issued by several international library organizations (IFLA 2013-2024, ALA 2017-2022).*

Keywords: digital ecosystems of libraries; digital ecosystems;

1. Introduction

The principal driving force behind contemporary changes is the Fourth Industrial Revolution. While similarly to previous industrial revolutions the Fourth Industrial Revolution radically altered technology, economy and society, the latter displays an exponential growth as compared to the linear development of the former. Consequently, cyber-physical systems emerge blurring the distinction between hardware and software, and take advantage of the options provided by networks and artificial intelligence. Furthermore, communication takes place not only between humans but machines as well (Schwab, 2015.). The Fourth Industrial Revolution results in a

cultural paradigm shift and dramatically changes how society functions including learning and information acquisition (Szűts, 2022). Since the library has a complex role as an information system and as a culture and value transmitting institution it is extremely sensitive to these developments. Therefore in order to preserve their competitive edge, libraries must continuously and adaptively respond to the given changes. .

The magnitude and significance of the problem is indicated by the fact that while numerous research efforts focus on the future of libraries and the impact of digitalization (Koen, 2018, Logan & McLuhan, 2016), system level changes in the library information systems and the resulting digital ecosystem have not yet been given the same level of researcher attention.

In our essay we explore the impact of the respective paradigm shift-generating features on libraries and identify external factors influencing library ecosystems and the related expectations. We will perform a trend analysis of the strategic documents of several international library associations (IFLA 2013-2024, ALA 2017-2022). The results of a software-supported content analysis will help in defining the concept of the library digital ecosystem.

2. Theoretical framework

2.1. The digital transformation phenomenon

In the past decades a digital technology-focused perspective has permeated all spheres including the industrial sector. The process is best described by the term “digital transformation” implying a multifaceted development effort aimed at the maximization of the potential functions of public libraries in the context of digital ecosystem criteria via the comprehensive development of digital competences, the application of human performance support systems through the propagation and integration of the technologies of the information society (ICT devices). In addition to infrastructure the process is based on management, professional development of human resources, and the channels and services of the respective collections.

Similarly to the chronological division of the web reflecting changes in the digital world (web 1.0, web 2.0, web 3.0) the phenomenon can be represented in various developmental stages. The respective phases, however, are not arranged in a linear fashion as they tend to appear simultaneously or in a parallel manner and frequently display cyclical features. Consequently, during the adaptation of a technological innovation into the instruction process we re-enter the first stage to advance gradually forward to the second and third stage.

In the first stage of digital transformation the emphasis was on the search and testing of the infrastructural (currently digital) conditions, the human resource competences, and new methodological approaches. While the main concern was the actual launching of the process, a frequent contemporary misconception considered the mere existence of an appropriate infrastructure necessary and sufficient condition for its successful pedagogical adaptation. This perspective, however, has become more refined as it was revealed that digital transformation requires the development of the other pillars of the process as well, in other words it is a multifaceted approach.

The second stage entailed the evaluation of the schedule and extent of the respective development, the identification of options for assessing digital maturity, outlining further developmental steps along with the search for methodological solutions. (Lengyel, Szűts and Racsko, 2021). The improvement of infrastructure did not guarantee success by itself (OECD, 2018), as a modified attitude to information and the related new methodology became necessary (Kiszl, Rado and Hubay, 2018). The third stage is likely to include the actual integration following a stabilization along the lines of a paradigm shift (concepts, methodologies). The respective changes will result in the rearrangement of scholarly paradigms as the previous theories are not capable of providing answers to newly emerging questions eventually leading to a scientific crisis. Thus the digital transformation is a long process since the conversion of new perspectives to paradigms, during which one approach can gain dominance among its counterparts is slow and time consuming.

2.2. The digital ecosystem

Due to its inherent features the process of digital transformation is part of a larger system, which can be defined as the digital ecosystem. “A digital ecosystem is an interactive system established between a set of active agents and an environment within which they engage in common activities. “Agents” include (but might not be limited to) providers of software services, information sources, and human agents. The environment is a combination of a socio-economic context and a digital infrastructure.” (Krause, Razavi, Moschoyiannis & Marinos, 2009)

The digital ecosystem operates or functions similarly to its natural counterpart emphasizing cooperation among organisms in a competitive context. The concept is applicable to several areas including the computer industry, entertainment sphere and special profession-related policy formation. The digital ecosystem can be also be considered a specific technological

solution. The main representative of this school is Gerald Briscoe, a researcher of the technologies of the future, asserting that the digital ecosystem is a technology designed for the realization of specific human objectives and is capable of development in order to solve dynamic problems in a simultaneous and efficient way (2009). According to Briscoe the main difference between biological and digital ecosystems is that while the former develops via a hereditary or evolutionary process, the latter facilitates the realization of objectives set by humans and its "evolutionary" impact is implied by the dynamic solutions of the respective problems.

In 2022, a team of researchers conducted a literature review to identify the key features and main challenges of digital ecosystem research by reviewing 94 publications. The result was a service-centric definition: "A digital ecosystem consists of one or more digital ecosystem services that fulfill the criteria DS1 and ES1–ES6. Additionally, the digital ecosystem contains all service assets, the digital platform, the ecosystem roles service asset broker, service asset providers, service asset consumers, and potential support providers.

Digital Service Criterion:

DS1. The digital platform enables the digital core service activity.

Ecosystem Service Criteria:

ES1. There is a service asset broker who brokers service assets between service asset providers and service asset consumers.

ES2. The service asset broker is responsible for arranging the onboarding of service asset providers and service asset consumers.

ES3. Service asset providers are responsible for the placement of service assets.

ES4. The service asset broker is responsible for service asset matching.

ES5. The service asset broker is responsible for enabling physical or digital fulfillment.

ES6. The service asset broker must be neither the only service asset provider nor the only service asset consumer." (Koch et al, 2022.)

2.3. The library ecosystem

Any definition of the ecosystem of libraries has to consider the social norms and the general culture determining library-related attitudes, and indicators of one's social position (one's

socio-economic background, qualifications) impacting expectations along with material aspects and the legal, regulatory and financial systems providing the given operational framework. While the preservation or survival of libraries is a crucial issue in the 21st century, the specific components of interaction have to be determined along the lines of cultural expectations, social requirements, the expectations of maintaining organizations, and the given professional and legal context (Lengyel, 2022).

Research concerning the future of libraries envisions a complete role or function change as in 50 years libraries due to their capability of providing access to data banks are expected to become universal sites for learning, the consumption, sharing, and creation of knowledge along with experience acquisition (Pescovitz, 2016). Such developments, however, are not solely applicable to the distant future, as they partially imply current changes too. An analysis of library strategies revealed a full harmony between the American and European perspectives in the 2013-2018 period. Consequently, libraries can provide space for or facilitate:

- learning in order to improve digital competences and to provide preparation for meeting challenges posed by the technological development,
- preparation and familiarization of the public with the relevant legal framework, copyright law, digital law, and the protection of the private sphere,
- access to the global information economy entailing credible and authentic information, new technologies, blockchains.,
- access to community services (internet services, social infrastructure, network-connected or network-based society).

Therefore the main functions of digital ecosystems of libraries include:

- Information providing –online information provision
- Preservation, retention – web archiving, creation and maintenance of digital collections
- Improvement of life quality, organizing digital workshops (Makerspace movement)
- Assuring equality of opportunity –Providing info-communicational accessibility
- Innovation – development of new methodological solutions
- Employment support – Competence development
- Informal education– The creation of an authentic learning environment, the training of digital citizens, online and ICT methodology supported instruction.

The digital ecosystem of libraries implies the goal-oriented application and provision of digital devices, methods, and platforms in order to strengthen the competitiveness and develop the

modernization capability of the cultural, social, and material dimensions of library ecosystems to facilitate the improvement of life quality and promote the social utility of libraries (Lengyel, 2022).

3. Method

In analysing international library strategies we relied on a qualitative non-reactive (intervention-free, non-consequential) approach (Hennink-Baily, 2020.) We performed indirect observations and drew consequences, provided explanations and descriptions related to situations and documents (Bortz and Döhring, 2003) We used a qualitative method during the content analysis of the given text. Text-based content analysis can be performed both in a qualitative and quantitative manner. The former implies a frequency assessment of categories established by researchers, the latter is an interpretative, meaning construing analysis highlighting the thoughts and messages related to the subject of the respective research (Mayring, 2002).

In our research we relied on a hybrid solution.

During the sample taking process we applied the typical/intensive strategy of qualitative selection strategies (Koivu - Hinze, 2017), facilitating a multidimensional consideration of the procedure (Mayring, 2002). Thus chronologically we emphasized the period lasting from 2010 until today, while from a spatial or geographic point of view we explored international strategies issued by supranational organizations among them the ALA and IFLA, primarily related to the United States and Europe. Regarding the organizational dimension, we consider the public collections, especially libraries as the basis of our analysis.

Besides the descriptive approach the actual research apparatus prioritises content analysis. Our exploration utilizes the MaxQda text analysis software relying on a knowledge-based programming language. (Mayring, 2002)

The inquiry results in conceptual maps and graphs visually describing the code systems and the respective connections revealed by an in-depth analysis.

4. Results

Libraries as an information transmitting system maintain a continuous and adaptive connection with all subsystems of society. We explored the role of the respective system components in

the international library strategies providing guidelines and strategic foundations for the total library sphere.

The 2017 strategy of the American Library Association states:

”The library is a hub of community engagement and continual learning: a place to form the critical thinking skills fundamental to learning in a technologically evolving world, to access information, and to create and share new knowledge.” (American Library Association, 2017.)

The IFLA (International Federation of Library Associations and Institutions) establishes primary guidelines for libraries as the leading organisation dedicated to library and information science. The IFLA publishes an annual overview of information society-related developments impacting libraries.

The first trend report issued in 2013 was updated annually until 2019.

In 2013 the IFLA summarised the primary changes impacting libraries in 5 crucial points:

1. the new technologies increase, yet at the same time limit access to information by narrowing the circle of those entitled to obtain the respective knowledge,
2. online instruction democratizes education globally while effecting radical changes in the learning process,
3. the borders of the private sphere and the scope of data protection have to be redefined,
4. new opinions and groups gain prevalence in network-based societies,
5. the new technologies transform the global information economy. (IFLA, 2017)

The qualitative analysis of the first Update issued by IFLA in 2016 reveals that libraries prioritise three out of the five abovementioned concerns:

1. The impact of new technologies.
2. Global learning emphasizing skills while online instruction is enhanced with blended learning, MOOC courses, and informal instruction schemes.
3. Data protection and copyright issues.

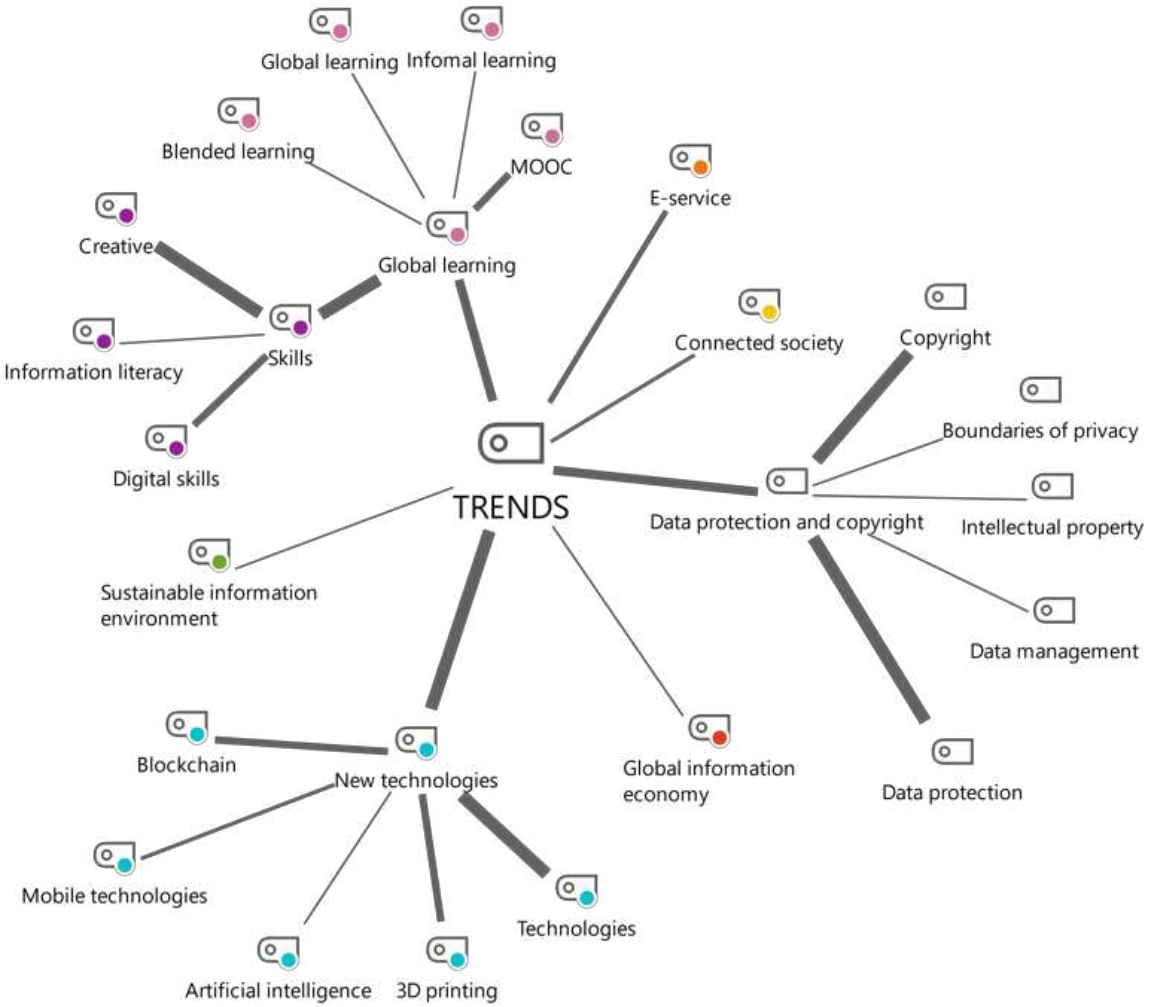

Figure 1. IFLA Trend Report 2016, Updated code map

As of next year, the newer trend reports reflected a different structure. The factors impacting libraries are not listed according to continents, but as the 2017 trend report indicates (IFLA, 2017) a futurist, a consultant, and a leader of a Makerspace lab wrote a chapter respectively. The most important issues include providing access to reliable information while highlighting the advantages implied by local features. As far as later strategies are concerned, the emphasis will shift to international connection and cooperation within the library sphere.

The content analysis of the 2018 Update Report (IFLA, 2018) singles out maximising the Internet provided options followed by such topics as community networks, environment and cooperation.

Figure 2. 2018 IFLA Trend Report

A similar emphasis is placed on the future importance of legal protection, the protection of the private sphere, digital law, copyright issues and the significance of the challenges posed by the digital age including the promotion of digital comprehension, and the improvement of digital skills. The concepts of technology and infrastructure are assigned special importance with attention to social infrastructure and the infrastructure for provision of services on a mass scale.

The 2019 Update Report follows a different structure introducing the action plans proposed by leaders of international library organizations. The most determinative aspect is the impact analysis of governmental measures and the respective political trends emphasizing the importance of advocacy efforts while especially persistent functioning and “the smart state” of libraries are identified as a key to long term survival . The Report reveals a widespread unfamiliarity with general rights and underlines the potential crucial role of libraries promoting access to information both for citizens and policy makers alike.

The code map of the 2019 Trend Report Update reveals the prevalent role of the political sphere and of governments. In addition, information, online work, transformation, uncertainty and the online form of education are emphasised, and a new element is the holistic approach and global thinking.

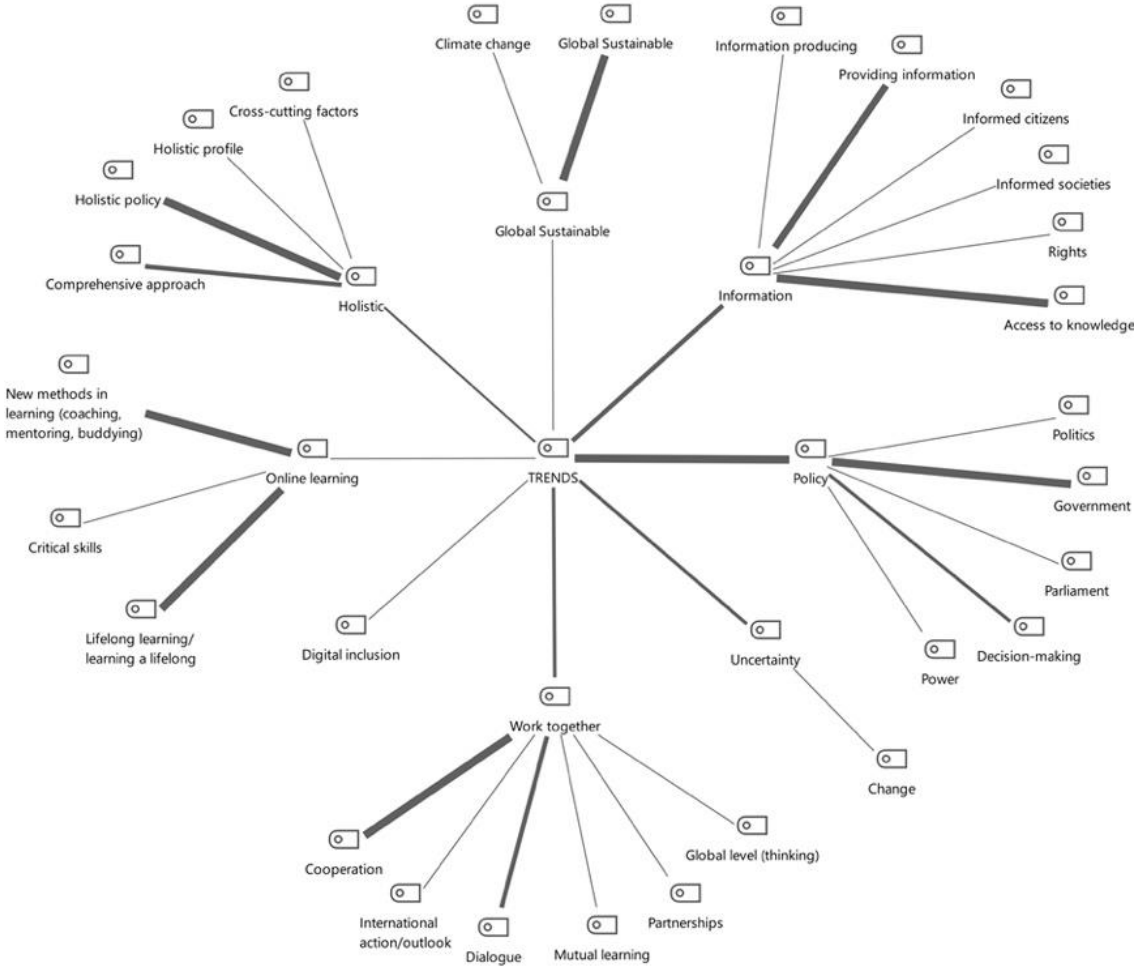

Figure 3. The 2019 IFLA Trend Report

Instead of issuing an updated report in 2020 a comprehensive strategic document spanning over a greater period was published. The IFLA Strategy 2019-2024 identifies 4 major guidelines: (IFLA, 2019).

1. Strengthen the global voice of libraries
2. Inspire and enhance professional practice
3. Connect and empower the field
4. Optimise our organisation

These points differing from previous practice promote the internal strengthening and reinforcement of the library profession,

The content analysis of the strategy for 2019-2024, a short document in itself, and the resulting code map provides a more refined picture.

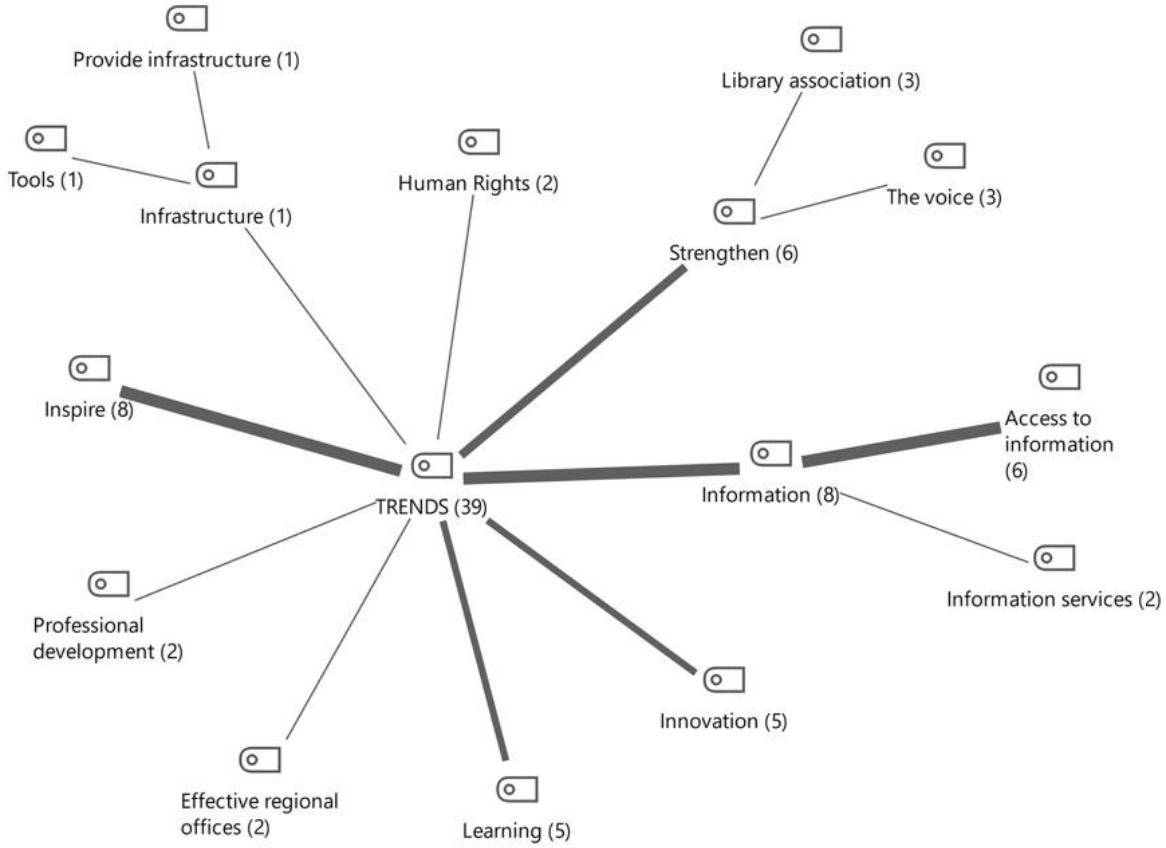

Figure 4. IFLA Strategy 2019-24 code map

The most important component or factor is inspiration, providing access to information and following the given guidelines, the respective strengths are highlighted. Learning is a crucial concept and the context-based analysis shows the emphasis is on the training processes of librarians and library managers. While the education of the public is also a genuine concern, the improvement of digital competence levels, online instruction and the preparation of the public to meet the challenges of the cyber-physical society are not included in the document.

5. Conclusions and future works

The exploration of major factors influencing the library sphere resulted in the identification of features, which not only have significant impact on society, but on the library profession as well. One of the most important issues is the Fourth Industrial Revolution radically changing

the labour market. The technological development will result in heretofore non-existent professions while several trades and professions are expected to disappear and the production of robots or the phenomenon of robotics will fundamentally modify the functioning of factories by forming automated systems free from human intervention. As a result of such processes the task-related competences have experienced continual change in order to meet the requirements of high technology oriented future work environments. The radical changes will not only impact the labour market and the work place as they will extend to transportation, the operation of households, everyday communication, and information acquisition. There is an unquestionable need for a facility where the public can prepare to meet these challenges by becoming familiar with the operation of the given digital infrastructure. Libraries can provide an excellent solution to this problem!

The realization of this goal, however, is far from simple as libraries have to cope with a variety of demands. These institutions have to determine the guidelines, which reflect the expectations of the public, and they are required to develop the competences of their own colleagues to enable them to meet these new demands and finally they have to implement the digital transformation process in the library sphere.

As the researchers of MIT declared: "To succeed digitally, big old companies need to embrace new organizational structures and processes that empower their people to collaboratively experiment with technologies and deliver integrated products and services to their customers." (Sebastian et al. 2017. 199.)

Consequently, not only the public, but the library sphere needs help. While library strategies determine specific trends, there is a continuous change in this area. Factors that played a determinative role in 2013, including technology, data protection, and the emphasis on a global information strategy have become superseded by the impact of governments and the need for advocacy. Such developments resulted in significant changes in the library perspectives. Consequently, the assessment of the current state of digital ecosystem entails the global information economy, digital public collections, digital services, digital competence and infrastructure.

Regarding competence development constructive pedagogy is a promising approach to libraries as it includes the learner in an active knowledge acquisition process or creative effort utilizing previous knowledge. In this case the crucial aspect of knowledge is its usability and adaptability (Alemu, Stevens, and Ross, 2012). In constructive pedagogy the environment plays a vital role

especially the digital learning environment and the application of relevant e-learning methodologies (Antal and Czeglédi, 2022).

According to the "Social constructivism is a theory of knowledge in sociology and communication theory that examines the knowledge and understandings of the world that are developed jointly by individuals. This theory assumes that understanding, significance, and meaning are developed in coordination with other human beings. The most important elements in this theory are (a) the assumption that human beings rationalize their experience by creating a model of the social world and the way that it functions and, (b) the belief in language as the most essential system through which humans construct reality" (Leeds-Hurwitz, 2009 qtd. by Amineh and Asl 2015. 13). The library can be an excellent support for socio-constructivist learning, as different groups in society can use the community to implement learning and knowledge acquisition, shared meaning creation, and cultural transmission.

Effective learning (Heick, 2018) requires informal, authentic learning environments provided by the libraries. Functioning as an alternative instruction facility, libraries can contribute to training for 21st century global citizenship through the given organization's management (perspective, vision) modern infrastructure, highly qualified associates and appropriate methodological background (OECD, 2021) (Kővári, 2022).

One question emerges in light of the new European trends. What kind of influence will advocacy, governments, and the international movements have on the ecosystem? The answers to this question will fundamentally determine the future of libraries. The reason is: libraries have to keep up with changes in human skills and must provide solutions and support for meeting the challenges of the current paradigm shift!

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