The Impact System of Science Centers and their Activities, in Support of Public Education and Career Guidance, during the COVID Pandemic

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Abstract: This paper investigates the complex impact system of the science centers, that play a key role in STEM career orientation and a draft model, for measuring these impacts. A review of the range of science centers in Hungary and an examination of the location of them provides an overview of this industry. Presentation diverse goals of science centers, their functions, along with the spatial effects of different activities, based on the comparative analysis of two institutions is presented herein. In addition to that, the paper also discusses the rural development impacts of science centers through a promising practice, and investigates innovative ways in which science center's support public education and STEM career guidance during the COVID-19 pandemic. This research is based on the review of the current international literature on science centers. Subsequently, the Hungarian science center ecosystem is described through the analysis of public data, supplemented by the authors' personal, professional experiences in the analysis of the institutions and projects presented using a case study approach. The results show that the importance of science centers goes far beyond their function as tourist attractions, and that regular participation in their programs can enrich the knowledge base of their host city and agglomerations. The study indicates that science centers have all the required tools and methodological experience to effectively support public education in STEM fields. Finally, their ability to adapt quickly to changing circumstances, during the COVID-19 epidemic, demonstrates a "future-oriented" approach and tremendous innovation potential that are inherent in these institutions.

Keywords: science center; public education; educational methodology; STEM; economic development

1 Introduction

Changes in the global labor market and demographic processes have been increasingly challenging since the turn of the millennium. Our transforming world is characterized by the breakthrough of STEM areas, the rapid spread of digitalization and robotics, and the expansion of the knowledge economy [1] [2]. The investigation of science centers is considered to be particularly important as they can be especially effective in the playful presentation of STEM fields that offer secure livelihoods, challenging jobs and diverse tasks. This special kind of institution plays a key role not only in arousing interest in STEM areas, but in a broader sense, also in presentation of science and technology, in developing the general knowledge capital of a region, and in building basic scientific literacy, that is essential for understanding and processing everyday phenomena.

The research is characterized by a duality: On one hand, it aims to provide a general overview of the science center ecosystem in Hungary, and on the other hand, it examines its specificities. The different objectives and operating models of science centers are illustrated by comparing two institutions. Finally, innovative methods to support public education and STEM career guidance during the COVID-19 pandemic are described using the example of a specific institution, Mobilis Science Centre in Győr.

Among the novelties of this paper, two factors should be highlighted. The complex approach to examining the science center industry in Hungary is unprecedented in the domestic professional discourse, and the use of draft model under development makes it possible to examine the complex impact system of the science centers. This can be suitable for the self-evaluation of institutions, but also for comparing the development and progress of science centers with similar goals and backgrounds.

2 Preliminaries

The main goal of today's science centers is to arouse the interest of their visitors in the world of science and technology through the method of experiential learning. Their unique exhibits form a special interactive playground which allows them to teach visitors in a playful way. The widespread methods of experiential learning are frontal science shows and interactive workshops, scientific experiments made by visitors, tinkering activities, robot programming sessions or demonstrations of technologies such as Leonar3Do VR system, VirCa, MaxWhere, Microsoft HoloLens or Oculus Rift, that can determine future of work and education [3-6]. The world of science centers bear many similarities to modern museums and some additional non-formal learning arenas, making it difficult to draw the boundaries of this particular type of institution.

The range of Hungarian literature investigating the operation of science centers is very limited, but the research of traditional North American and Western European institutions has been going on for much longer. Outstanding from the literature is the debate between Bradbourne [7] and Persson [8] around the turn of the millennium about the present and development potential of science centers. While Bradbourne compared science centers to endangered species and urged the creation of a new type of institution, Persson reported about a dynamically evolving industry. He refuted point-by-point criticisms of the operation of science centers, reporting on innovative, constantly evolving, sustainable, multifunctional institutions with much lower support than other learning arenas.

Persson [9] and Garnett [10] examined the impact system of science centers in a complex approach and distinguished four different types of impacts: personal, social, political and economic impact. In his study synthesizing results of about 180 previous researches, Garnett found that the vast majority (87%) of previous studies investigated the personal impacts of science centers. Meanwhile, only 9% focused on social impacts, barely 4% analyzed the economic impacts of the centers, while their political impact was virtually unaddressed in the literature.

Most scientific results proved personal impacts of science centers, mainly by summarizing the effects on visitors' knowledge level, attitudes towards science and openness to STEM careers. In their extensive study, Falk et al. [11] [12] measured the impact of 17 science centers in 13 countries, involving more than 6000 young and adult visitors. Visits of science centers were found to be positively correlated with level of knowledge, understanding of science and technology, positive identification with science, and openness to related leisure activities. Bamberger and Tal [13] measured the effects of using three interactive exhibits of Israel Institute of Technology over two different time periods: one day after the visit and 16 months later. The authors proved that the visit have long-term benefits: one-third of test subjects were able to connect their experiences to their studies months after the visit, and memories caused by science center exhibits did not fade even after 16 months.

The research of Groves [14] focused specifically on the economic impact of science centers. It found it significant, as the 199 institutions surveyed had a total operating cost of more than 1.1 billion USD per year, an annual investment of more than 300 million USD and they recorded nearly 77 million visits in a single year.

Presentation of Persson [15] at the ECSITE 2015 Annual Conference, can be considered as summary of previous research. He summarized previous findings proving that science centers had a positive impact on the level of knowledge, attitudes, academic interest, school performance, and openness to STEM career of their visitors both in the short and long term. He also highlighted the economic impact of the industry, estimating it at 7-17 billion USD, a year. He emphasized that the unit cost per visit was much lower than for other learning arenas. Going

beyond previous research, he illustrated with many examples that science centers could play an important role in supporting cultural tourism and public education, as well as in regional development and urban rehabilitation. Dissatisfied with these results, Persson called for a strategy to position science centers as an essential player in education, science and technology.

3 The Proposed Method/The Thesis

Investigating the impact system of science centers is one of the main topics of our ongoing research. Based on the first results of it and on nearly a decade of work experience in this industry, we intend to go beyond former findings of the literature to the extent that in addition to personal and economic impacts, we also attach great importance to social and environmental factors. Examining the operation of science centers, we see their real impact system in the unity of these four areas (Figure 1).

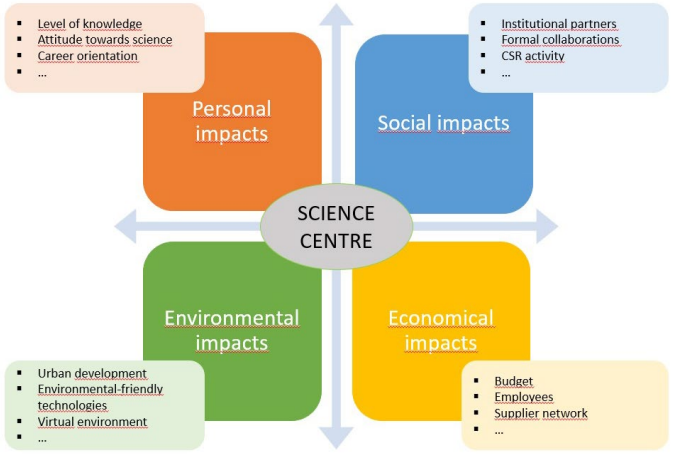

Figure 1
Impact system of science centers

As part of this research, in addition to developing a model for measuring the complex impact system of science centers, we provide a general overview of this industry in Hungary. Where do the boundaries of this particular type of institution lie? Which institutions can be considered as “classical” science centers?

As result of this research, a model is going to be developed, that can be suitable primarily for investigating the impact system of science centers, but can be also appropriate for demonstrating the impact of further non-formal learning arenas, e.g., museums, zoos or agoras. We divide each of the above mentioned four

dimensions into 5-8 subtopics, so the complex impact system of an institution can be investigated along progress in 20-30 different themes.

The characteristic of each subtopic can be associated with multiple possible outcomes, so the progress of a particular subtopic can be determined on a Likert scale. As a result of the analysis this way, the impact system of the examined institutions can be represented graphically in an easily interpretable way. A simplified model of this is illustrated in Figure 2.

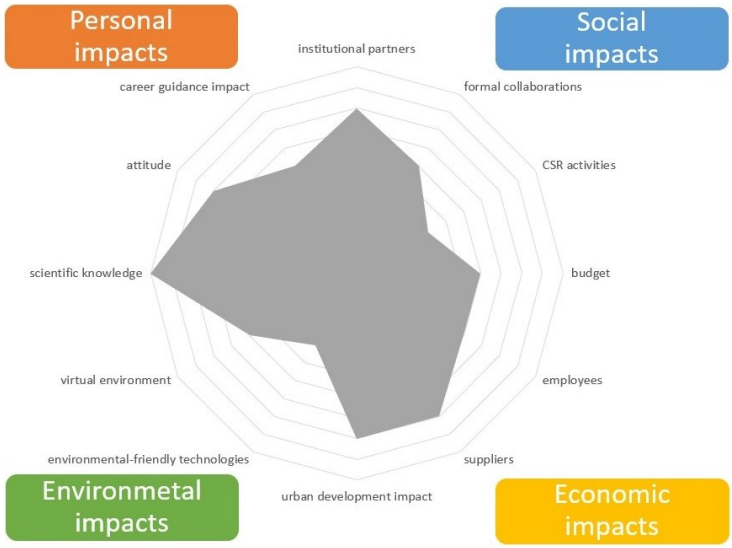

Figure 2
A simplified model to illustrate the impact system of science centers

The model can be excellent to use for self-evaluation of an institution, for illustrating results achieved so far and for identifying development potential. Its main aim is to examine the life-cycle and the development of an institution, e.g., by measurements before and after the implementation of a key project. In addition, it may be even suitable for comparing different institutions operating in a similar socio-economic environment. Along with recording the progress made in 20-30 subtopics, we consider it intriguing to identify and share the promising practices related to them, thus also fostering opportunities for further development.

As part of our research, in addition to developing a model for measuring the complex impact system of science centers, we provide a general overview of this industry in Hungary. Where do the boundaries of this particular type of institution lie? Which institutions can be considered as „classical" science centers and which further centers carry certain characteristics of this type of institution? How are these institutions located in the country? Through personal data collection from

two science centers in Hungary, we illustrate how different goals and philosophies can characterize these institutions. In addition to the four-dimensional impact system outlined above, we examine an additional aspect: When analyzing any kind of impact, the geographical area in which it appears is particularly important. As part of this study, we show how the territorial scope of science centers can be interpreted.

4 Discussion

4.1 Science Centers in Hungary

The first science center of Hungary was the Palace of Miracles in Budapest, the history of which began with a highly successful temporary exhibition in 1995, followed by conceptualization of a permanent exhibition. The location of the institution has changed several times in recent decades. Its 5000 m² scientific playground with more than 250 exhibits has been welcoming its visitors to Óbuda since 2017.

In the 2010s, further science centers were established in three other cities. In March of 2012, Mobilis started its operation on the campus of the Széchenyi István University in Győr. The first thematic science center in Europe focusing on vehicles, mobility and transport is located in an imposing building that resembles the piston of a Wankel engine. Its 1200 m² exhibition space features more than 70, largely unique, interactive exhibits. Thanks to its continuous development, since 2018 Mobilis has included two additional centers: Mobilis Student Laboratory, which supports public education with experiment-based STEM programs and innovative pedagogical methods, and MobilITy-Győr Digital Experience Centre, which covers our entire digital world. Futura Science Centre in Mosonmagyaróvár also opened its doors in 2012. It was established by the rehabilitation of an industrial building that was hundreds of years old at the time. Futura presents natural sciences, including the four elements (water, earth, air, fire), as well as the values of Szigetköz and Danube River to its visitors. The Agóra Science Centre has been operating in the botanical garden of the Great Forest in Debrecen since 2015. In addition to the classical exhibits that can be found in many other centers, the exhibition space also offers unique attractions developed by corporate partners. In the spring of 2020, the DigITér Digital Experience Centre started operating in Agóra, which carries out activities similar to MobilITy in Győr.

Some institutions do not have all the features of classic science centers, but at the same time, they have many similarities with the tools or methodology of them. In Hungary, these include Laboratory – Interactive Magic Square (Pécs), Szent-Györgyi Albert Agóra (Szeged), Magic Tower (Eger), Kemenes Volcano Park

(Celldömölk), Pannon Observatory (Bakonybél) and Zselic Star Park (Zselickisfalud) In figures below, the latter institutions are referred to as "further interactive science demonstration institutions".

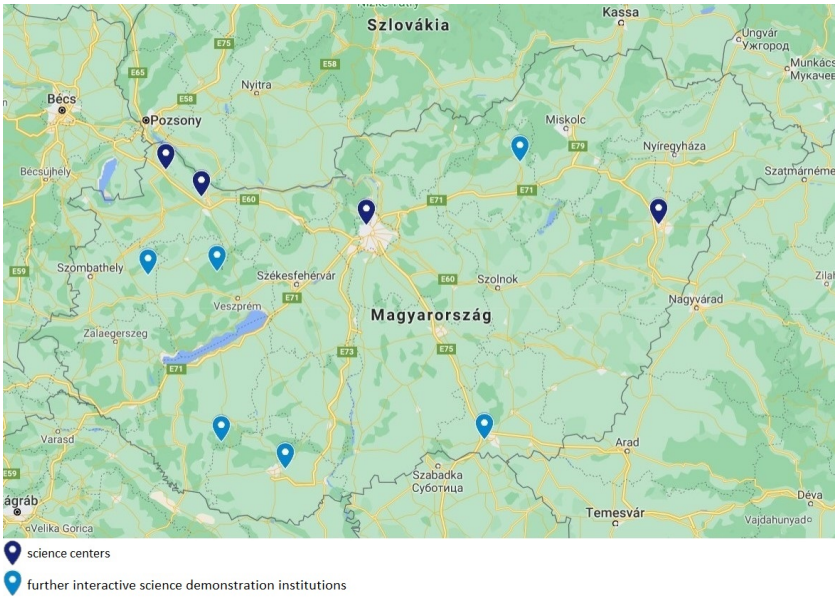

Figure 3
Science centers and further interactive science demonstration institutions in Hungary

Based on Figure 3, it can be stated that a significant part of the Hungarian science centers and further interactive science demonstration institutions are located north of Lake Balaton, so the residents of the already developed Central Transdanubia and Western Transdanubia regions access their services most easily.

After opening of new institutions in the first half of the 2010s, no further classical science centers were established in Hungary. At the same time, non-formal learning arenas offering innovative experiential pedagogical methods have been enriched in several waves in recent years. Following the example of MobilITy in Győr and DigITér in Debrecen, a digital experience center with similar functions, EDU&FUN, has opened its doors in Budapest. The infrastructural and methodological development of science education was aimed at a Human Resources Development Operational Program (HRDOP) tender, which provided an opportunity to establish 13 further science experience centers in 2018-2019. These developments were realized from a much smaller investment than classical science centers. Their methodological significance is much more emphasized than the implemented infrastructural development.

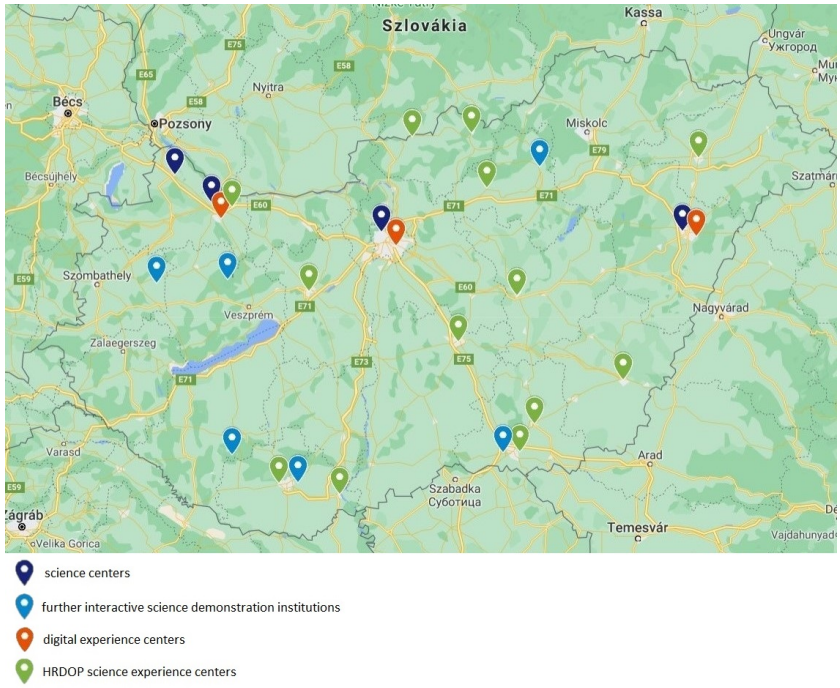

Figure 4
Innovative non-formal science learning arenas in Hungary

If we complete the series of science centers with these institutions, an interesting territorial rearrangement can be observed. There are cities (Budapest, Debrecen, Pécs, Szeged) with two, experiential educational centers, and the city of Győr operates three centers (Mobilis, including Mobilis Diáklabor and MobilITy-Győr Digital Experience Center) within one institution. It is gratifying, that modern experiential pedagogical programs are available for the region of smaller towns, such as Balassagyarmat or Gyöngyös. At the same time, it is unfortunate that big cities like Miskolc still do not offer this useful and innovative form of learning, and large areas in the northeastern and southwestern part of the country are lacking such services.

The representatives of science centers in Hungary can typically look back on a history of only a few years, and a scientific impact assessment of their operation is still pending. Most of them act as a kind of tourist attraction, offering fun and useful leisure opportunities for families or school groups, while others consciously develop their activities towards the function of a career guidance or STEM education methodology center.

4.2 Main Goals and Mission of Science Centers and their Impact on their Region, Following the Example of Two Institutions

The possible functions of science centers and their impact on the urban area are further examined through the example of two institutions in Western Hungary, Futura in Mosonmagyaróvár and Mobilis in Győr.

Mosonmagyaróvár is the 3rd largest city in Győr-Moson-Sopron county, with about 70,000 people living in its agglomeration. It has an excellent transport infrastructure, the proximity of two capitals (34 km from Bratislava and 84 km from Vienna) and the significant gravitational force of Győr (39 km) make it an important economic, transport, industrial and commercial center. The Lajta River and the Mosoni-Danube branch, crossing the settlement, as well as the Szigetköz, hides extraordinary natural values, which are also presented in detail by the science center of the town. The agglomeration of Mosonmagyaróvár extends beyond the borders, and its infrastructure and services (e.g., healthcare and beauty industry) are used extensively by Austrian and Slovak guests. The micro-region hosts companies of the automotive industry with significant economic potential. The agricultural and food science courses of its higher education institution, are nationally recognized, and it has been operating as a faculty of Széchenyi István University in Győr since 2016. According to spatial relationship analysis of Szörényiné Kukorelli [16], Mosonmagyaróvár is a medium-strength area-former center and its gravitational space breaks its independent attraction from the district of Győr. The town is growing dynamically and has significantly increased its weight since the turn of the millennium.

Győr is a settlement with significant industrial tradition and a hub of excellent transport infrastructure. It was the 5th largest rural city in Hungary, with 124685 permanent residents in 2019. In addition, there are thousands of people who are permanently in Győr due to work or study, so its actual population is well over 130,000. Based on its city rank, infrastructure and economic performance, it is an outstanding settlement in CEE. Today, it has become a major economic center of Hungary [17], thanks in large part to Audi Hungaria and its supplier network, which has been operating for more than 25 years in the city. Audi Hungaria operates the largest engine factory of the world in the city, also has a large volume of vehicle production and has recently made major developments in e-mobility. Its economic strength is well demonstrated by the fact that in 2016 it contributed 1.44% to the Hungarian GDP, and it plays a decisive role in Hungary's foreign trade volume, realizing 99.58% of its business turnover abroad. According to 2016 data, it was the 2nd largest manufacturing company in Central Europe in terms of sales revenue [18]. The impact of the operation of the city goes far beyond its administrative boundaries and does not coincide with any statistical territorial unit. Its agglomeration – including service functions, public services, commercial networks and, above all, the labor market – covers an area of appr. 60-80 km and

extends beyond the border of the country [19]. Analyzing the spatial relationships of commuting, Szörényiné Kukorelli [10] states that the pulling effect of Győr is outstanding in all aspects of the study. The city has a significant cross-border labor market attraction that is constantly spreading and expanding. In 2011, more than 30,000 crawlers worked in the city [20]. In recent years, presumably due to the very favorable labor market indicators of the Győr district, the role of more remote settlements in the agglomeration has become more important. Based on the above, it is easy to see that the performance of the economy of the city is closely related to the quality of life and opportunities of the entire urban area.

The range of science centers is examined below. The term range is hereinafter referred to as a specific part of the geographical area where a certain effect applies. In this sense, the range of science centers can be defined in several dimensions. Due to the often-repetitive nature of the activity, some of their services (e.g., outsourced school activities, study groups, etc.) serve the needs of the population of the settlement hosting the institution and the villages in the immediate vicinity of the city. We consider this to be the primary range of a science center. At the same time, users of other services (e.g., the unique interactive playground) can come from a much larger area, even from regions more than an hour's drive away, e.g., as a member of a group on school class trip or on a weekend family trip. The area covered by the latter function is considered to be the secondary range of science centers. Due to the distance between Győr and Mosonmagyaróvár (39 km and approx. 40 minutes), the primary ranges of the centers are spatially separated, but their secondary range with the function of a „tourist attraction" almost completely overlaps (Figure 5). Interestingly, the latter factor does not cause any tension in the operation of the institutions. They regularly participate at public events of each other (e.g., Experiment Bazaar in Mobilis), promoting attractions and services to visitors and strengthening the professional community of science centers.

Futura, like many other science centers, defines itself primarily as a kind of tourist attraction due to the uniqueness of the institution. The main goal declared by the maintainer is that the center should contribute to the increase of the tourist attraction power of the city and Szigetköz. In highlighted positions of its website are published information (e.g., school class trip, information in English, German and Slovak), which indicates that the main target of its services are primarily tourists (families and groups) arriving in Mosonmagyaróvár. Apart from the Birthday Party service, there are no offers or descriptions on the website that would specifically target the population of the town. As a result of browsing the Internet for the science center, its offer and services will appear mainly on thematic websites for tourism or program organization, such as:
www.ittjartam.hu
www.szallas.hu
www.tripadvisor.co.hu
www.gyerekkel.com
www.programturizmus.hu

Figure 5
The primary and secondary ranges of Futura and Mobilis

Since its opening in 2012, the institution has operated as part of the Flesch Károly Nonprofit Ltd, owned by the municipality. In the autumn of 2020, the city council decided to continue its operation as an independent financial body from 2021, as Futura Science Centre and Event House. Following the reconstruction of a former cultural institution unused for a long time, the Coast Event House has been operating by Futura since 2021. The main goals of the transformation are to boost special areas of tourism, such as event management and conference tourism.

The Mobilis Science Centre in Győr has also been operating since 2012. Although the institution has become a tourist attraction of the city, it was clear from its opening that Győr and its agglomeration could benefit primarily from its operation. The venue of Mobilis is also symbolic: the center operates in one of the imposing new buildings on the campus of the Széchenyi István University, the dynamically developing higher education institution of the city. The main mission of Mobilis is to promote STEM careers, that provide a secure livelihood, a modern work environment and a challenging job for future professionals. In the first years, the institution was operated by a non-profit Ltd. owned exclusively by the municipality and since 2016, Mobilis has been operating by the university and the city jointly. As a result, a closer professional relationship has been developed between the center and the university.

The unique permanent exhibition of Mobilis, focusing on the theme of transport and vehicles is undoubtedly a kind of tourist attraction. It is a popular venue for families and school groups, especially those who take part in class trips in the spring and early summer. At the same time, while the center can be a one-time program full of fun and experiences for tourists arriving in Győr, it offers regular

recreation and learning opportunities for families in the urban area. Excellent examples of this are study groups, talent management programs, summer camps or science-birthday parties of Mobilis. By the autumn of 2018, Mobilis implemented two significant developments: Mobilis Student Laboratory and MobilITy-Győr Digital Experience Centre. Since this transformation, the institution has been focusing on hosting school groups on weekdays, while retaining its popular "scientific playground" function. Thanks to these developments, the number of visitors showed a continuously increasing trend from 2017, until the outbreak of the coronavirus pandemic.

The management of Mobilis have recognized that a science center can be considered a special tool for economic development, so the relations with corporate partners and sponsors play a particularly important role in the life of the center. Mobilis is able to work especially effectively with companies that attach great importance to the development of diversified educational projects and STEM career guidance activities in their long-term strategies. The science center offers customized services to its corporate partners, that enable them to achieve their common goals: shaping the attitudes of upcoming generations and promoting STEM careers.

4.3 Science Centers, as Innovative Tools of Rural Development

In 2017, the Government of Hungary called for tenders for the development of experiential pedagogical programs and the establishment of new science experience centers. The aim of the Human Resources Development Operational Program-3.3.6-17 project was to implement experiential pedagogical programs that contribute to the promotion of science subjects, the dissemination of modern, experiment-oriented methodology and, in the longer term, to ensure the supply of professionals and university students in STEM fields. Such institutions have been established in 13 cities across the country, including the Mobilis Student Lab, which has been operating under the umbrella of Mobilis Science Centre, since September 2018.

A new auditorium for 120 people, evoking the atmosphere of university lecture halls has been set up in the Student Lab, as well as professional sound, lighting and projection technology. Well-equipped laboratory stations have also been established, on which, approx. 90 students can perform experiments and measurements, at the same time. Even more important than the advancement of infrastructure is the methodological and curriculum development that Mobilis carried out jointly with its partner schools. As a result of the ongoing consultation that had been taking place for almost a year, 8 different types of activity were designed. All of these aim to support STEM education in schools and to develop methodological skills of teachers. The development of the methodology of STEM education is extremely important, as research examining the effectiveness of

technical training has proven that teaching-learning environment, the instructor's inspirational abilities, and the learning methods have a significant impact on student dropout [21]. Based on results of major international educational surveys [22] [23] and the recommendations of the literature [24], the educational program of the Student Lab was compiled with active participation of teachers from more than 20 schools. The services of Student Lab are free for partner schools, including the transportation if necessary.

The Student Lab is one of the most significant enterprises in the history of Mobilis, and its implementation has brought a complete transformation of the operating model of the institution. Instead of the previous, typically random and, in most cases, one-time visits, classes from partner schools take part in regular sessions integrated into school curriculum, which was a big step forward in increasing the number of visitors: 6-7 classes take part in different programs on an average day.

The rural development impact of the project is at least as important: according to the tender, the services of the new science experience center must be provided for at least 10 schools outside Győr, during the three-year project. This means that schools have the opportunity to participate regularly in experimental pedagogical programs, that were previously not users of Mobilis, due to the geographical distance of their settlement, the required time of transport, or financial reasons. Until 2018, rural school groups typically got to the center only once, usually on a class trip and members of returning groups were almost exclusively students from schools in Győr, typically near to Mobilis. Now, classes of rural schools can take part in regular sessions integrated into school curriculum as part of the Student Lab project. Settlements have also been included in the programs of Mobilis, that typically cannot offer experimental pedagogical sessions for their students, due to the differences in the laboratory infrastructure and the methodological skills of teachers. During the first five semesters (September 2018 – January 2021), schools of 17 rural settlements participated in the sessions of Student Lab. The project provides a free shuttle bus service to Mobilis. The number of trips is well illustrated by the fact that the shuttle buses covered 38527 km during the first school year.

Figure 6 shows the location of the rural schools participating in the project. Their average distance from Győr by road is 15-16 km, the most distant settlements are Tét (24 km), Győrasszonyfa (29 km) and Tápszentmiklós (30 km away). Most of the partner schools are located along the traffic route 1401 to Szigetköz and along the major traffic routes 81, 82, 83 and 85. It is gratifying that in addition to developed settlements around Győr (e.g., Győrújbarát, Nyúl) and in Szigetköz (e.g., Győrzámoly, Dunaszeg, Győrladamér), it was possible to involve schools of more disadvantaged settlements in the southern areas of the agglomeration, such as Győrszemere or Győrasszonyfa. At the same time, there is a striking lack of settlements from the northeastern – eastern areas of the city, e.g., Nagybajcs, Vének, Gönyű, Nagyszentjános, Bőny or Rétalap.

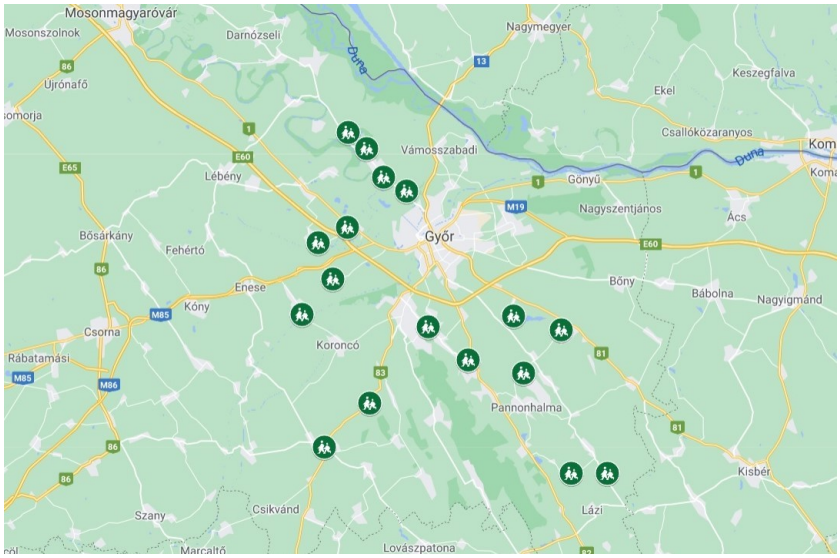

Figure 6
Location of rural settlements participating at Mobilis Student Laboratory project

As partner schools could choose between eight types of sessions based on their needs, and participation at different sessions required different number of visits, there might be significant differences in the total number of Student Lab visits per school.

Table 1
The settlements of schools made most visits to the Mobilis Student Lab per semester

Settlement	Number of visits per semester
Nyúl	650
Győrújbarát	535
Győrzámoly	508
Győrladamér	507
Töltéstava	456

Table 1 shows rural schools that made the most visits to the Student Lab every semester. In addition to pedagogical reasons and the number of students in each school, logistical considerations (amount of time spent on transport) may also have played a role in the background of school managers' decisions on student participation, as it is clear to see that the vast majority of these settlements lie near to Győr.

It is even more instructive to examine how the number of visits made by students of a rural school in a semester compares to the total population of their settlement, as this indicator shows the importance and weight of regular visits to the science center in the life of the settlement.

Table 2
The weight of regular visits to Mobilis Student Lab in the life of settlements

Settlement	Number of visits per semester	Population (persons)	Proportion of visits to Mobilis Student Lab per semester compared to population
Győrasszonyfa	164	530	30.9%
Győrladamér	507	1826	27.8%
Dunaszeg	423	2204	19.2%
Töltéstava	456	2464	18.5%
Győrzámoly	508	3154	16.1%

Analyzing data in Table 2, it can be stated that in relation to the population of the settlements, the students of Győrasszonyfa and Győrladamér are most active, making a number of visits to the science center corresponding to one third to one quarter of the total population of their village every semester. The average distance of the top 5 elements of this list from Győr is the same (15 km) as the total average of 17 rural schools participating in the project. This suggests that in their case, pedagogical considerations, rather than transport or logistics, may underlie the choice of programs that results in more frequent visits. The activity of Győrasszonyfa is especially welcome, as regular participation in experiential pedagogical programs can provide an opportunity to break out for students of settlements located in a less-developed micro-region.

According to feedback of school managers, teachers and parents, Mobilis Student Laboratory program, launched on the basis of results and recommendations of major international educational surveys and specific expectations and needs of partner schools, is of particular value, especially for rural schools. The application of state-of-the-art teaching methods, the implementation of experiential pedagogical programs together with teachers and thus raising the quality of STEM education in partner schools can contribute to the retention of pupils in rural schools, the survival of schools in rural areas, the broadening of services of villages in a broader sense, and the increase in the competitiveness of rural areas.

4.4 Operation of Science Centers during COVID-19 Pandemic

The changes after the spring of 2020, the pandemic that threatened the health of millions, our changed lifestyle and working methods, the economic downturn, the acceleration of technological development, the growing importance of knowledge and adaptability strengthened the role and importance of science centers. Over the past few years, many economies of the developed world have found themselves in a critical situation, and our centuries-old habits have transformed in just a few weeks. In the current situation, one of the main goals of science centers has become especially critical. This is the support of public education, which is closely related to several dimensions of the impact system outlined above

(personal, social, economic impact). In our study, we present how science centers could support public education during the time of homeschooling, through the example of Mobilis Science Centre.

During the lockdown, science centers obviously could not receive visitors and their education projects with the participation of schools were also suspended, or they could be implemented only by using a different methodology than planned before. During the rapid transition to homeschooling, there was a great demand from public education to new types of content and methodological support for teachers. This need was recognized by Mobilis, which responded immediately to the lockdown and started to provide online contents for schools from March 2020.

MobilITy-Győr Digital Experience Centre, operating under the umbrella of Mobilis is presenting digitization and robotics in a playful way. It supported the work of teachers during the lockdown with pedagogical articles and infographics. Tutorial videos were shot for students, presenting e.g., online Artec and LEGO WeDo courses. MobilITy connected to the national Digital Theme Week event with online solutions, programming courses and IT-related tasks. More than 8,000 people participated at the most successful digital detective game developed by MobilITy for the national Sustainability Theme Week. In addition to the successful implementation of nationwide online programs, special attention was paid to local affairs. Accordingly, MobilITy also contributed to the development of a complex student competition of its host city Győr, which was celebrating its 750th anniversary in 2021. During the months of lockdown, along with providing online content, MobilITy also placed great emphasis on self-education, the staff participated at online trainings (e.g., Python and Live Microbit).

In addition to teacher and student experimentation, the use of ICT and the development of multimedia contents play a central role in the educational program of the Student Laboratory presented in detail in the previous section. Within a few days after the official announcement of homeschooling, the shooting of Mobilis School TV recordings began in the empty Student Lab. More than 350 videos were shot and uploaded to the YouTube channel of Mobilis. The videos were divided into 14 different playlists, by grades and subjects. They had a total reach of more than 100,000 views in the first year, and since the return to offline education, they still have 5000 – 6000 views per month. It means that the online contents have become part of everyday activities of public education. After the second lockdown in the autumn 2020, Student Lab organized a large-scale online STEM competition with nearly 5000 participants. Homeschooling was particularly difficult for high school students preparing for graduation, they were supported by online study groups in Physics and Chemistry.

Mobilis has been one of the key players in the STEM career orientation of the Győr Economic District for many years. Its innovative programs present science, technology and related STEM career opportunities for primary and secondary school students facing university. During the months of the pandemic, of course,

career guidance programs could not be implemented with a personal presence either. Among online events, TechTogether Junior Győr online competition was an outstanding one, presenting the diverse training portfolio of Széchenyi István University through experiential and practical tasks. Another exceptional initiative was the online career guidance roadshow, promoting dual vocational training, jointly with Audi Hungaria, the number one employer in the region. This program presented basic scientific phenomena behind technology used by the company for 700 students from 25 different schools.

Another great success of online operation was the LEGO Mentor Program. Training for the global FIRST LEGO League competition is a key project of Mobilis, as it is far more than just a robotics competition. It became a complex career guidance program for kids at age 9-16. Mobilis plays a complex role in the Hungarian FLL community: it organizes regional competitions, provides mentoring for 8 regional schools and in addition to that, it operates an own team. The season 2020/21 was conducted entirely online and the online operation model of Mobilis Bits MRGT team was extremely successful. The team achieved the best result in its history, by qualifying for the World Final in the summer of 2021.

Conclusions

This paper proves that the significance of an innovative science center goes far beyond the function of an "Interactive Playground", with a specific set of exhibits, which guarantees a pleasant and useful pastime. It can function as a methodological center that support schools with variable laboratory background, as well as schools struggling with a shortage of STEM teachers. It is no exaggeration to claim that it's experiential educational programs can also ensure the future of STEM education in Hungary.

Diverse activities of science centers are well illustrated by the example of Mobilis. The paper indicates that a flexible and fast-adapting actor, responding immediately and effectively to the changing needs of public education can support students and educational actors with unique, gap-filling services. It is clear that the host city and its narrow area can primarily benefit from educational programs of science centers. At the same time, the analysis of activities carried out during the COVID-19 pandemic reveals that innovative solutions applied during lockdown may even offer a new perspective for institutions. Application of methods based on direct, personal experience is obviously impossible to replace through online channels, but feedback of school managers and teachers confirm that online contents and methodological support offered great help for educators and students in the period of lockdown. Digital solutions used during the pandemic provide an opportunity for science centers to break out of their traditionally defined range and, albeit in a limited way, to make different impacts, even in a much wider geographical area.

Referring back to the debate between Bradbourne and Persson, institutions with such a profile can hardly be characterized as an endangered species.

The main direction of further research is the refinement of the briefly presented model, with the involvement of recognized experts, in the four fields. After finalization of the model, it can be followed by the evaluation of various Hungarian institutions, which could provide an excellent basis for the management of science centers, for the conscious development of the institutions. Subsequently, in a second phase of research, it is planned to define globally, uniformly interpretable criteria, for each of the subtopics of the model, which will "Internationalize" the tool.

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