Educational Competition for Digital Presentation and Preservation of Scientific Heritage

Zsolt László Márkus[1], Tibor Szkaliczki[1], György Szántó[1],
Miklós Veres[1], Zsolt Weisz[1], László Molnár[2], László Csaba Szarka[3]

[1] Institute for Computer Science and Control (SZTAKI),
13-17 Kende u., H-1111 Budapest, Hungary
[2] ELTE Savaria University Centre
4 Károlyi Gáspár tér, H-9700 Szombathely, Hungary
[3] Institute of Earth Physics and Space Science
6-8 Csatkai E. u., H-9400 Sopron, Hungary
markus.zsolt@sztaki.hu, szkaliczki.tibor@sztaki.hu,
szanto.gyorgy@sztaki.hu, veres.miklos@sztaki.hu,
weisz.zsolt@sztaki.hu, astromol@gmail.com, szarka@ggki.hu

Abstract. Educational competitions belong to the most effective ways for motivating students to gain new knowledge on a specific domain. They can even bring scientific heritage closer to the next generation. The coronavirus pandemic put the organisation of competitions at risk. This paper presents how digital tools could help in organising educational competitions and transfer new knowledge during these events.

Keywords: Scientific Heritage, Educational Competition, eLearning.

1 Introduction

In association with UNESCO, the world's scientific community commemorated the 100th anniversary of the death of Roland Eötvös (in Hungarian: Eötvös Loránd, 1848-1919, see Appendix), a pioneer of high precision gravitational physics, founding father of geophysics and innovator of higher education (Patkós, 2020). Throughout the centenary year a series of scientific events and exhibitions were organized, and special publications were presented in Hungary and worldwide, all in remembrance of the genius Baron Eötvös. The project has been implemented with support from the National Research, Development and Innovation Fund of Hungary.

The eLearning Department of the Institute for Computer Science and Control (SZTAKI) implemented a complex package of services to support the Roland Eötvös Commemorative Year (Márkus, Szkaliczki , Szántó, Veres , & Weisz, 2020). The first component of this package, the Eötvös100 web site (https://eotvos100.hu/en) provided various features for the support of the Commemorative Year. See Fig. 1 for a sample page on the Eötvös100 web site. The web page was implemented by using the content management system developed by SZTAKI. The web page has been continuously updated and maintained, offering a deep insight into the life and achievements of the great

Digital Presentation and Preservation of Cultural and Scientific Heritage. Conference Proceedings. Vol. 11, Sofia, Bulgaria: Institute of Mathematics and Informatics – BAS, 2021. ISSN: 1314-4006, eISSN: 2535-0366

scientist. The contents to be elaborated and presented has been collected, organized, and made available by the board members of the Roland Eötvös Commemorative Year.

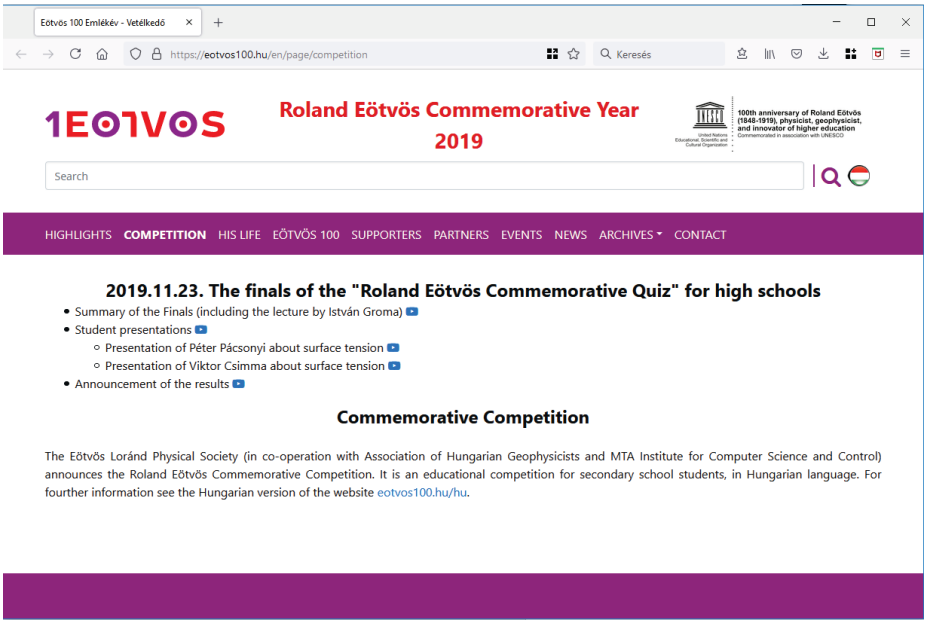

Fig. 1. The page of Roland Eötvös Commemorative Competition on the Eötvös100 web site

The second component, the EVENT@HAND Eötvös100 smartphone application was launched on April 8, 2019, for the occasion of the central ceremonial event of the Commemorative Year. The contents offered by the app can be downloaded in advance, hence no internet access is needed during its use. An integrated map helps all potential participants to get to the site of the events organized. Further useful features include (among others) the creation of preferences and reminders, recording personal experiences, receiving push messages, etc.

The third component was a competition for secondary high-school students, jointly announced by ELFT (Eötvös Loránd Physical Society), MGE (Association of Hungarian Geophysicists) and SZTAKI, under the general project management of the Library and Information Centre of the Hungarian Academy of Sciences The primary aim of this competition was the introduction and acquaintance of the life and scientific merit of Roland Eötvös, within the cultural environment of his age. SZTAKI contributed to the competition with professional experience in e-Learning development, developing and making available the necessary IT services.

The fourth component was the application of a novel service to present real spaces and special environments, support virtual navigation and interactive discovery of various objects. This made it possible to produce high-resolution, interactive 2D and very attractive 3D walks about the locations of his studies and explorations, as well as the exhibition about his life and heritage.

The fifth component was a GPS-based interactive guided tour (in Hungarian), which makes the visitors acquainted with the locations of the Ság Hill site measurements of Roland Eötvös and the success of his world-famous pendulum.

This paper focuses on the third component and presents the digital solutions used to support Eötvös 100 Commemorative Competition.

SZTAKI provided several digital tools to support online competitions including tools for management, content presentation and assessment. The methodology was proved to be successful, and the tools developed for the Roland Eötvös Commemorative Competition were applied to several traditional learning competitions as well in 2020 and 2021, which could not be organized by personal attendance due to the epidemic. Here are some examples for the online competitions, where SZTAKI provided the technical background:

- Pál Teleki Competition of Carpathian Basin in Geography - Geo Science
- Ottó Herman Competition of Carpathian Basin in Biology
- Károly Kaán National Competition in Nature and Environment Study

The next chapter presents the Roland Eötvös Commemorative Competition. Then the paper enlists the digital tools for educational competitions. Section 4 contains the evaluation of the results of the paper. The last section contains the conclusions of our development.

2 Roland Eötvös Commemorative Competition

School ceremonies and educational competitions were considered as the most impressive events of the commemorative year for primary and secondary-school students. Several schools organized events devoted to the great Hungarian scientist throughout Hungary and the neighbouring countries. Within the framework of Eötvös 100 project three competitions were organized in Hungary and in the Carpathian basin. The Eötvös Loránd Geophysical Foundation organized their competition for primary school pupils in the Commemorative Year. Besides the traditional Eötvös competition of the Eötvös Loránd Physical Society, the secondary school students were called for participation in the Roland Eötvös Commemorative Competition. This third, large competition had never been organised before the Commemorative Year.

The concept of the Roland Eötvös Commemorative Competition was prepared by the Eötvös 100 Coordination Committee. Teams of four students could participate in the competition.

The aim of the competition was to get secondary-school students acquainted with the life Roland Eötvös, his scientific and social achievements embedded in the cultural environment of his age. For this reason, the participants received questions on history and literature, as well, besides natural scientific questions and tasks. (Szarka, Győri, Molnár, & Ujvári, 2020).

224 teams were registered for the competitions, thanks to the Ministry of Human Capacities, Klebelsberg Centre and the Hungarian Society of Natural Science. 10 percent of the teams came from abroad. The first five rounds of the competition were online, organized with a weekly frequency on a Web-based platform, implemented by

the eLearning Department of SZTAKI. As many as 181 teams completed all rounds. Each round covered different domains of the age when Roland Eötvös lived and worked. The groups of four students had to answer questions in literature, history, physics, and geophysics in the first, second, third and fourth rounds, respectively. The fifth round included questions and tasks related to Roland Eötvös's life and manifold activities. The variety in topics meant various task types such as online tests, tasks with calculations, experiments, and their evaluations. The above tasks were completed on different platforms and with different methods, such as on-line and on paper or with real experiments and simulation.

The best 14 teams participated in the final of the competition in the Ceremony Hall of the Hungarian Academy of Sciences. The students answered written questions on the same topics as during the online rounds and conducted a physical experiment in the final. Finally, the students demonstrated their presentation skill by delivering a three-minute-long presentation.

Roland Eötvös lives in the memory of the people as a world-famous physicist. However, the organizers included tasks on his other significant activities e.g., hill climbing, stereo-photography and his role in managing social challenges.

The prizes also contributed to the preservation of the scientific heritage of Roland Eötvös. For example, the winners were awarded by a modern working version of an instrument invented by the great physicist. The Hungarian Academy of Sciences and the Eötvös Loránd University presented the Roland Eötvös Memorial Album (Dobszay, Estók, Gyáni, & Patkós, 2019) to all participants of the final.

The competition involved almost one thousand students. The final of the competition was reported on TV and radio channel as well. The video recorded during the final is available on YouTube.

3 Digital Tools for Educational Competitions

Providing the expected functionality to support the competition, several tools were implemented by using database, web and multimedia technologies. These digital tools could help in organizing educational competitions, transfer new knowledge during these events and assess what the students know about the achievements and life of Roland Eötvös.

3.1 Management System

Organizing online competitions requires a Web-based management system for administering the participating teams, learning material, tasks, solutions and results (http://vetelkedo.eotvos100.hu, see Fig. 2). SZTAKI implemented a Web portal for this purpose based on the open-source ILIAS Learning Management System (https://www.ilias.de). The ILIAS system was customized according to the requirements of the competition. The participating teams could register to the competition, study learning materials while preparing for the next round, receive new tasks, solve and submit the solutions on the Web portal. The solution could be evaluated

automatically or manually depending on the type of the task. The portal provided statistics on the results and the ranking list.

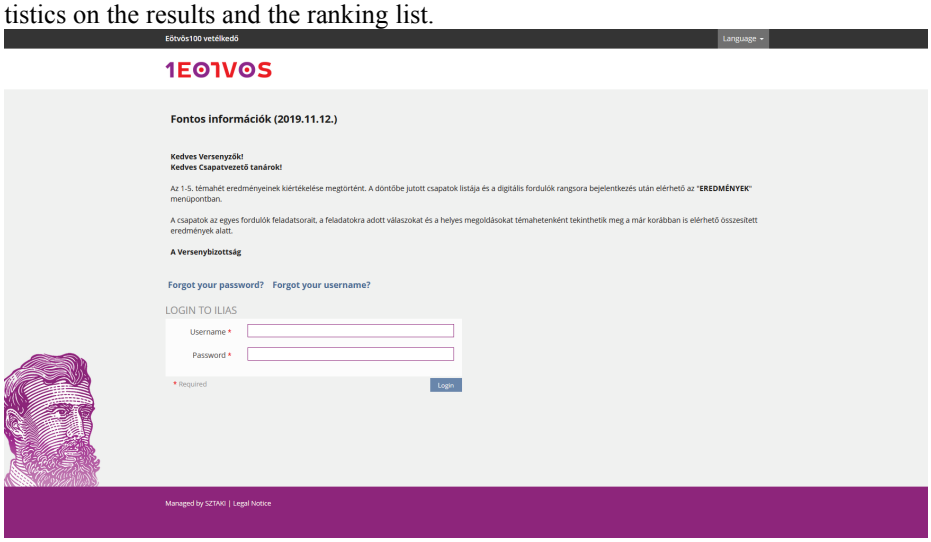

Fig. 2. Login page of the web site of the competition

The environment running the management system had the following technical specification:

- Computer
  - 4CPU, AMD64, 8GB RAM
- Bandwidth, network
  - At least 10 Gbps domestic and international bandwidth
  - Unlimited data transfer
- Storage
  - Storage size: ~ 50 GB
  - Scalable, multilevel CEPH storage environment
- Operation
  - Weekly backup of all data in the system to a system at a physically different location.
  - Second level expert support to the services during working hours.
  - Continuous monitoring of the services by a proprietary monitoring system (to comply with requirements on security and operation).
- Installation/setup
  - Linux platform – Debian
  - Database server: MySQL 5.5.60
  - PHP 7.0.33
  - Web server
  - outgoing mail
  - domain configuration

3.2 Virtual Walks

The contestants had to virtually walk along some location (e.g., Eötvös Exhibition or one of the Eötvös hiking routes) to solve some tasks (https://eotvos100.hu/en/page/emlekgyujtemeny, see Fig. 3). SZTAKI created virtual walks as a service to present, virtually walk around and interactively explore real spaces and special environments. High-resolution, real 3D and 360° spherical panorama pictures were taken of the target locations. After postprocessing and editing pictures, virtual walks were created which can be accessed via a multiplatform (Web, mobile, VR) player on various devices. This function proved to be especially useful during the pandemic. The participants could virtually visit museums that were closed or visit remote areas.

Fig. 3. Opening screen of the virtual walk.

3.3 Learning Packages

The participants received large amount of learning materials in advance to prepare for the next round which contained all knowledge required for the online rounds. Separate courses were created for each online round by using the ILIAS content editing tools. The learning package contained the description of the thematic week and the references to the learning materials. This content was published on the web site of the competition on the Friday preceding the online round.

3.4 Task Sheets

After the time for preparation, the task sheets were open and could be filled in the following Wednesday or Thursday within a given time frame. The task sheets included various types of tasks, e.g. online tests, calculations, experiments, and their evaluation. The tests were implemented by adapting the built-in tests of ILIAS (e.g., single choice tests, matching, ordering, cloze questions), see Fig. 4 for an example.

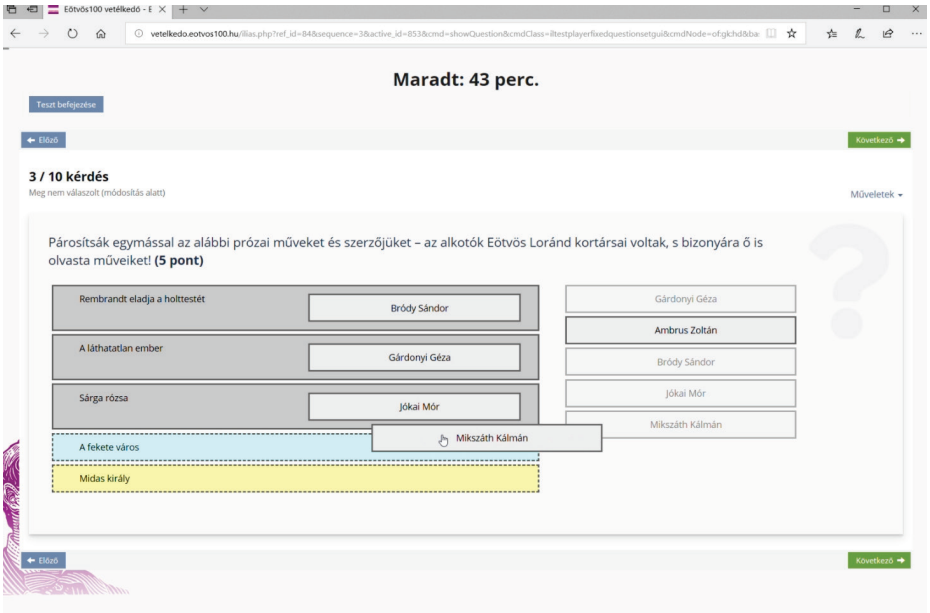

Fig. 4. Matching task on the online task sheet

3.5 Experiments

The students had to perform experiments and measurements, as well. The experiments included not only classical measurement tasks. An experiment was performed online when the students had to visit the Web page of the Foucault pendulum at the University of Miskolc. The students had to measure the period of the pendulum and the time needed to make a full circle by using the video of the Webcam.

3.6 Evaluation

The received solution were processed as soon as they arrived. The evaluation used the test assessment capabilities of ILIAS. The results were immediately presented to the jury and the contestants.

3.7 Presentations

The students had to deliver a presentation in three minutes to make a scientific topic popular as the last task. This task was named as FameLab after the international competition to find and support the world's most talented new science communicators (https://www.britishcouncil.org/education/he-science/famelab). The teams were free to select the content of their presentation. There was only one restriction: the topic of the presentation had to be closely related to the competition. The short presentations were

recorded and published on YouTube in Hungarian. The best presentations are available with English subtitles as the pearls of science communication. (Pácsony, 2019) (Csimma, 2019)

3.8 Technical Assistance

The computational background was provided by the colleagues of SZTAKI, namely Zsolt László Márkus and Miklós Veres. Helping the teams on phone or via e-mail to solve the emerging technical problems formed an important part of the duties of the SZTAKI staff.

4 Evaluation

Table 1 presents the results of each online round. The table shows that the average result proved to be the best in history and literature. Surprisingly, the average result was the worst on the last round related to the life of Roland Eötvös.

Table 1. The results of each round

Round	Maximal point	Best result	Average result	Rate of the teams above the average
1 Literature	24	24 points (100%)	21 points (88%)	40%
2 History	52	50 points (96%)	40 points (88%)	49%
3 Physics	68	66 points (97%)	35 points (51%)	48%
4 Geophysics	41	39 points (95%)	24 points (59%)	51%
5 The life of Roland Eötvös	33	32 points (97%)	16 points (48%)	49%

Table 2 presents the results of the final by thematic groups. The teams gained the most points in FameLab, geophysics and measurement task. Literature, history and the life of Roland Eötvös proved to be the hardest topic in the final.

Table 2. The results of the final

Task	Maximal point	Best result	Average result	Rate of the teams above the average
1 Literature - history	45	28 points (62%)	16 points (36%)	57%
2 Physics	49	47 points (96%)	22 points (45%)	36%
3 Geophysics	42	42 points (100%)	25 points (60%)	50%
4 Life and memory of Roland Eötvös	47	23.5 points (50%)	15.5 points (33%)	50%
5 Measurement task	52	52 points (100%)	36 points (69%)	57%
6 FameLab	42	41 points (98%)	35 points (83%)	57

5 Conclusions

The commemorative competition brought the scientific heritage of Roland Eötvös close to many students. The competition proved to be a great success among them. The methodology was applied to several subsequent traditional learning competitions as well. Competitions in natural sciences in a similar form but with different content every 1-2 years have been planned.

Acknowledgements

Support of the National Research, Development and Innovation Fund of Hungary (no. ED_18-1-2018-0011) is gratefully acknowledged.

Appendix

ROLAND EÖTVÖS 1848-1919

1857–1865	High School studies at the Piarists in Pest
1865–1867	State and law studies at the University of Pest
1866	The beginnings of his mountain climbing passion that lasted a lifetime
1867–1870	Science studies at the University of Heidelberg
1870	Doctorate in physics, mathematics and chemistry with highest honours
1871	Assistant teacher at the Department of Higher Science (later Theoretical Physics) at the University of Pest
1872	Full Professor, Department of Theoretical Physics, University of Pest
1873	Elected as corresponding member of the Academy
1878	Full Professor of the Department of Experimental Physics (successor of Jedlik)
1883	Elected as regular member of the Academy
1888–1891	President of Budapest Department of Hungarian Carpathian Association
1889–1905	President of the Hungarian Academy of Sciences
1891	Leading role in the founding of the Mathematical and Physical Society

	and the launching of the journal Letters in Mathematics and Physics (Mat-Fiz Lapok)
1891	President of the Hungarian Mountaineering Federation
1891–1892	University rector
1894–1895	Minister of Religion and Public Education. Act on Religious Freedom, and initiating the organization of the József Eötvös College
1905	Resignation from the academic presidency to devote all his time to scientific research

Scientific activities by Roland Eötvös

1875–1885	Capillary-related studies: a reflection method for determining capillary laws, Eötvös rule, Eötvös constant
1886–1919	Gravity- and geomagnetic studies
1890	"Gravitational attraction of Earth to different materials" (Academy lecture, 20 January)
1891	Curvature and horizontal variometers
1891	The first field measurement at Ság hill
1896	Investigations in gravity and geomagnetism (summary)
1898	The Balaton torsion balance
1901	Bifilar gravimeter
1901&1903	The first large-scale survey on the ice of Lake Balaton
1909	In relation to his research on proportionality between inertial mass and gravitational mass he wins the Beneke Prize
1915	Design of an experimental tool to demonstrate the Eötvös effect
1916	Field survey at Gbely (Egbell). Birth of hydrocarbon research geophysics

References

Csimma, V. (2019, November 23). Surface tension. *Finals of the Roland Eötvös Commemorative Competition*. Budapest. Retrieved from https://www.youtube.com/watch?v=CGrLmcXH0oI

Dobszay, T., Estók, J., Gyáni, G., & Patkós, A. (Eds.). (2019). *Roland Eötvös Memorial Album.* Budapest: Kossuth Publishing.

Eötvös 100 Competition. (2021, 06 30). Retrieved from http://vetelkedo.eotvos100.hu

ilias.de. (2021, 06 30). Retrieved from https://www.ilias.de/en/

Márkus, Z. L. (2019, April 8). *3D virtual presentation of the MBFS Eötvös Loránd Memorial Collection.* Roland Eötvös Commemorative Day, Budapest, Hungary.

Márkus, Z. L. (2019, October 17). *In the footsteps of Loránd Eötvös 3D photography.* Eötvös 100 Scientific Meeting, Egbell, Slovakia.

Márkus, Z. L., Szkaliczki , T., Szántó, G., Veres , M., & Weisz, Z. (2020). Preservation and Presentation of Roland Eötvös' Scientific Heritage. *Digital Presentation and Preservation of Cultural and Scientific Heritage* (pp. 149-158). Sofia, Bulgaria: Institute of Mathematics and Informatics.

Pácsony, P. (2019, November 23). The Eötvös law. *Finals of the Roland Eötvös Commemorative Competition.* Budapest. Retrieved from https://www.youtube.com/watch?v=S51rS61yVsU

Patkós, A. (2020, február 13). *Roland Eötvös: scientist, statesman, educator*. Retrieved from arXiv preprint arXiv:2002.05743: https://arxiv.org/pdf/2002.05743

Roland Eötvös Commemorative Year - Roland Eötvös Memorial Exhibition . (2021, 06 30). Retrieved from https://eotvos100.hu/en/page/emlekgyujtemeny

Roland Eötvös Commemorative Year. (2021, 06 30). Retrieved from https://eotvos100.hu/

Szarka, L. C., Győri, I., Molnár, L., & Ujvári, S. (2020). Eötvös Loránd jubileumi emlékverseny 2019. *Fizikai szemle*, 393-399.

Received: June 20, 2021
Reviewed: July 15, 2021
Finally Accepted: July 22, 2021