Thematic article

Play and Learn: Introduction of Robotics to the Library

Dániel Molnár, Erzsébet Dani

Recommended citation:

Molnár, D., & Dani, E. (2022). Play and Learn: Introduction of Robotics to the Library. *Central European Journal of Educational Research, 4*(2), 60–66. https://doi.org/10.37441/cejer/2022/4/2/11384

Abstract

Our library, the Katona József Library of Bács-Kiskun County, has recently started to introduce the basics of robotics, currently with LEGO Mindstorm kits. LEGO robots are programmed using a simple, graphical interface, making it easy for anyone to learn. Our main objective is to show the public that robotics is not just a thing of the future, but an important element of our time today. We see our work in this direction as a "first step". Considering different possibilities and needs, two types of programmes on robotics have been developed. The shorter, one-hour session will present the way to robotics in the modern sense, through examples of cultural and technological history and current applications. This will be followed by a playful trial of three different robots on display. For those who want to learn more about robots, we offer a weekly "Library Robot Hour", a club-like service where you can learn how to code robots and solve specific tasks, either with help or independently at your own pace.

Keywords: Library, robotics, Lego, presentation

Introduction

In 2020, our library introduced the basics of robotics as part of its services. Starting out as an occasional activity, the workshop continued as a regular activity in the fall of 2021, in the framework of a weekly club. As a completely new and undiscovered area, compared to our previous services, we needed to do some research on the subject, to find the best ways to make use of technology and bring it to the widest audiences, fitting to the library's knowledge transfer goal, and existing capabilities. We decided to be the first step for the interested in learning about robotics, to prepare them in time for the challenges (spreading of mobile devices, the artificial intelligence, wide ranging automation) of this rapidly changing world. Young people, who have been exposed to modern technology since birth also need to develop the necessary skills to use it consciously (Pansky & Rowinska, 2021, p. 255–276).

Of course, we want our participants to feel that the library is a good place, which is worth exploring beyond the robotics sessions.

Learning robotics and block-based programming is an ideal solution for developing algorithmic thinking (Fanchamps et al., 2021, p. 203–222). This is also included in the current Frame Curriculum.

The Curriculum contains the following expectations:

"Learning the topic contributes to the fact that, by the end of the educational phase, the student:

– knows and uses the basic building blocks of block programming;

– collects data using sensors;

– controls movements in a simulated or real environment;

(…)

Development tasks and knowledge:

– development of algorithmic thinking;

– creating an algorithm by breaking it down into steps;

(…)

– basic concepts of robot control;

– coding the control of sensors and robots with block programming;

– development of cooperation skills during group task solutions and project work"

By providing a non-formal learning opportunity, the library can also participate in the development of these skills.

Before the first public events, we knew as librarians, we had much to learn about becoming robotics instructors (Preciado Babb et al., 2016, p. 4–11).

After the first LEGO sets arrived, we had to choose, which build would be the best to achieve our goals (and sometimes the model that did not look the best ended up being the right fit for our needs, so we did a lot of rebuilds), and we had to learn how to program our new robots. We found a lot of great ideas on the internet and in scientific journals – written guides, study group materials (Barbalics & Solymos, 2018), Youtube video tutorials – to inspire ourselves. After many weeks of playing and learning, we started to think about how our new skills could be used as an actual service.

How did we establish a new service?

Our opportunities were determined by the following facts:

- **Available robots**: At first, we acquired eight Lego Mindstorm EV3 sets, then two years later, three Lego Mindstorm Inventor robots (*Figure 1*). These robots have a wide range of combinations and technical solutions, with beginner friendly programming, making them ideal for entry-level users. With advanced skills, they can also be used to create even more complex programs, allowing them to be used for longer periods of time to acquire deeper knowledge. The EV3 robots are available in four different configurations, two with a more spectacular model[1] and one with a smaller but more learning-friendly model[2], of which six have been produced. The three Inventor pieces are all assembled in different ways.[3] Through the different ways of construction, it is easy to see how the functionality of each type differs, even though they were assembled from the same elements. The different sensors (infrared, color, push-button, gyroscope) and the different motor strengths, lights and sounds provide a variety of tasks that the robot can carry out. With these sensors, we can teach or recall concepts like mathematical relations, reflected or ambient light, directions, units of measures. It was a question, whether we can let the participants assemble the robots themselves or not. The final decision was not, because these Lego robots are made from many small elements, and sometimes their assembly is not the simplest task. The participants' skills can vary drastically, and it could be easily an unpleasant situation, if not everyone would be able to progress at the same pace. Later, when our service had been going on for weeks, many people asked, when they could build their own robots. Thus, we started to think on how we could make this happen in the near future.
- **Target age groups and our roles in introducing robotics**: Although we have primarily targeted young people in school, who are still in the pre-career phase, we have looked for solutions that can work for more age groups. As a library, and given our role as a knowledge transfer agent, we aim to provide knowledge that is accessible to all, whether it promotes further study, whether it be private or institutionalised. The lower age limit is primary school pupils who can already read. To pre-schoolers, we demonstrate how to play with the robots and talk to them, while we also explain why robotics is important. Still, even with the available sets, they are too young to learn programming. Albeit, the programming application of the EV3 sets is available in English and Hungarian, both contributing to language learning (with English), and simplifying the experience (with Hungarian). There is no upper age limit, as the topic is interesting for older age groups and can be easily mastered. For adults, the aim is also to reduce their aversion to robotics and newer technologies, and to broaden their horizons. Even a 70-year-old lady tried to write a program, and after some success, she was very excited to tell her grandchildren that she was able to make a robot work.
- **Available technical tools and recommended locations:** To program the robots, you need an external device (they are not included in the sets) which can be a smart device such as a tablet, smartphone, or a desktop computer, or laptop. We chose the tablet because of its more intuitive handling and mobility. In time, taking advantage of a free downloadable app[4], several participants downloaded it to their smart

[1] The builds we have used: EV3STORM, R3PTAR

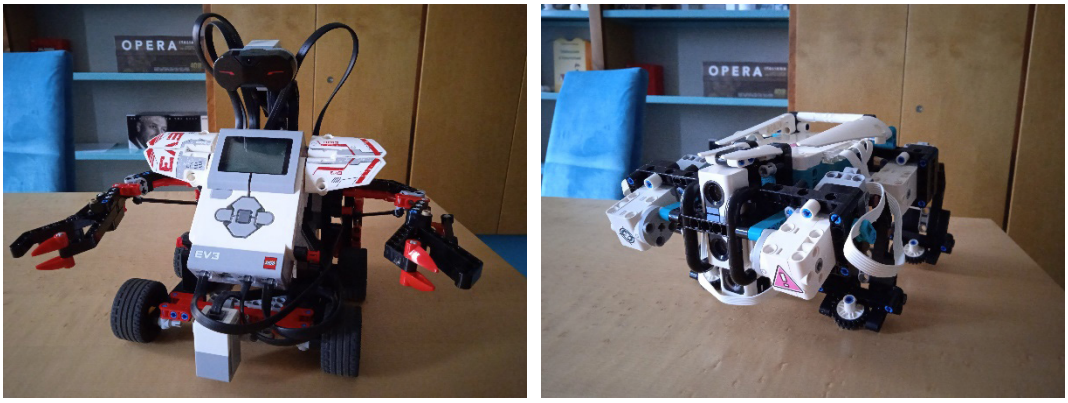
[2] This was based on a fan-made model, EV3MEG. The location of this model's motors and sensors makes it ideal for learning. We added a touch sensor as an extra to the existing building manual, to have all the available sensors.

[3] Blast, Tricky and Gelo models

[4] The Inventor application is availalble on Google Play store. The EV3 application we use is no longer available.

devices, practicing programming even at home, refining the final product at library sessions. The venue of the sessions was our library's Digital Lab, an enclosed area with projection facilities and enough space for exercises on tables and on the floor. If the task needs a lot of space, working on the floor is usually safer. For school, or summer camp groups with more people, our Teen World space – this is a part of our youth's section – also provides suitable conditions.

Figure 1. EV3 (r) and Inventor (l) robots, already assembled, ready for the workshop



To meet as many different needs as possible, we have developed two ways of presenting robotics:

– The shorter, one-shot version consists of a short presentation and a practical, interactive demonstration. This presentation is ideal for groups. The lecture presents some chapters of the history and possibilities of robotics, starting from antiquity. It discusses artificial humans or intelligent beings in Greek and Norse mythology, along with attempts made to automate machinery from the Middle Ages to modern times. These examples contextualize robotics in human history. The image of robots in science fiction and fantasy films and literature and how this relates to real-life machines is reviewed, and the audience is introduced to concepts such as the 'uncanny valley' phenomenon of human-like robots and the Frankenstein complex. These are followed by a compilation of current advances in robotics, cybernetics, and artificial intelligence, with many examples from everyday life, from robot vacuum cleaners and other household robots to self-driving cars, gaiters, and the concept of the smart home. As a library, we could not pass by the presentation of solutions such as robotic systems for library storage or robots for searching the open shelf. This is a good opportunity to teach some librarian jargon too. The presentation is designed to be understandable, informative, and entertaining for as many age groups as possible. By shifting the emphasis and choosing the right language, the presentation can be easily adapted to current needs, from pre-schoolers to the elderly. In the practical part of the presentation, the robots can be controlled remotely and playfully via an official Lego application. This makes it easy to get close to the audience and to overcome any possible distancing. It is also possible, if time permits to demonstrate simpler programming tasks. The graphical interface can be used to create a working program in just a few steps, so that the first encounter with the robots can easily be a success (*Figure 2*).

Figure 2. The remote control application is an easy way to make the robots move

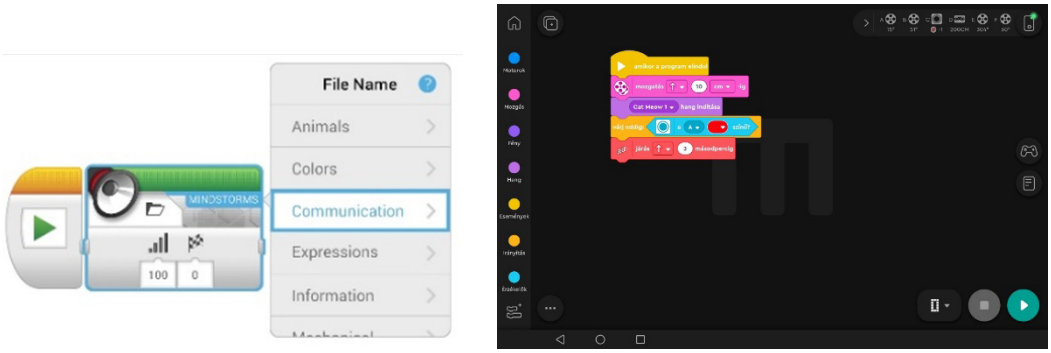
For those who want to learn more, we offer a weekly club-style service called Library Robot Hour. Within the club, there are several options: those who already have some knowledge of Lego robot programming or who want to learn about Lego robots on their own are free to work alone. For those who need guided learning, we have put together a printed, heavily illustrated guide of increasingly complex tasks that can be completed over five sessions, with tasks that can be solved independently or with help, alone or in small groups. The tutorial consists of these compiled tasks which were inspired by our own learning. The finished code blocks presented in the illustrations are all our own solutions. After five sessions, participants will be able to use all the main functions of the robots and create their own complex programs. When designing the possibilities of the club, one of the most important aspects was to give participants the opportunity to experiment, to think for themselves, to work together and even to teach each other (Gilca & Ionescu, 2021, p. 135–140).

The more experienced participants regularly help the newcomers, which strengthens the group cohesion.

As we have two types of robots, creative ideas can be implemented through multiple routes. The EV3 and Inventor robots can be programmed through different applications, and the applications currently in use offer different solutions for implementing similar programming options (*Figure 3*). Learning about each of the two types of robots and their respective software environments will help to foster flexibility, the perspective that a proven solution may no longer be appropriate in a new situation.

Using the block programming used in these applications the participants can encounter many concepts, for example: loops, relation signs, reflected and ambience lights, true/false situations, infrared light, motion sensors. After learning these concepts, they can create simple tasks for the first session, and later they will not only be able to create complex programs but also understand the reasons behind them.

Figure 3. The surfaces of the used applications. We are using an older, more graphic version of the EV3 application (left), and the current edition of the Inventor application (right), to maintain the difference the two surfaces.



Results of our work

In 2020, we had our first opportunity to test how the one-off session we had devised worked, with organised groups, occasionally with 20–30 school students or 10–20 library visitors as unorganised groups attending pre-announced presentations. The sessions showed that there was a demand for our work, and we received several responses that they would be interested in learning more about the topic. A series of five suitable in-depth sessions were tested with a pilot group of five children. The planned topics were adopted on time, so that we were able to plan the public launch of the programme with a high degree of certainty. Unfortunately, this was temporarily thwarted by the pandemic, and it was not possible to start until autumn 2021 when the Library Robotics Hour was finally launched. There was only one attendee at the first public event, but with further public presentations and the short introduction video, made by the collaboration of the library staff, “Library Robotics Expedition” posted on the library’s YouTube[5] and Facebook pages, the number of attendees soon increased to an average of 8–10.

As we have 11 robots in total, we will adjust the number of the accepted participants accordingly, so we have time to deal with everyone. Occasionally, individuals also come forward, and we can provide them with opportunities too. Typically, more students than average come during school holidays. We could count on the recommendations; many children recommended our workshop to their schoolmates.

[5] https://www.youtube.com/watch?v=Aeu-ZPO_xD0

The regular weekly sessions revealed the differences between the participants' skills, motivation, and progress. Some of the participants progressed on their own without any problems after the introduction of the basics, often using the time given for free practice and experimentation to make progress on their own, while others needed more attention and guidance. In the end, it was possible to keep within the time limit and to give everyone the desired amount of knowledge. The participants wanted to learn more skills afterwards, so it was necessary to introduce new programming options in addition to the existing ones. As they were already familiar with the basics, it was easier to work with newcomers during each session, while older visitors were also familiarised with the new tasks requested.

The long-term attractiveness of the club has been enhanced by the acquisition of newer robots, which have been a great source of enthusiasm to learn about, and the different programming interface has been a welcome challenge for those with a more advanced knowledge of robotics (*Figure 4*).

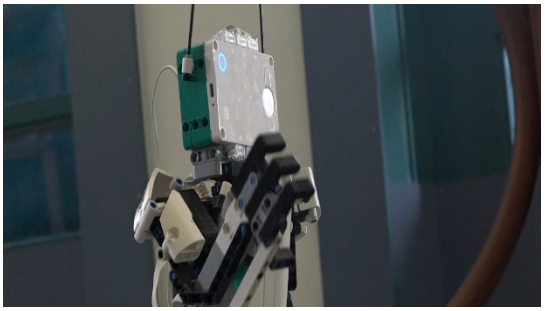
To develop creativity – after solving a few tasks on a pre-made model – it was also possible to create their own "obstacle courses", challenges, which the creators could try to complete as well as their peers. In addition, smaller, spontaneous competitions could also be organised on a regular basis, to see whose programme was more effective. One of the challenges was the robot dance competition, when the participants had to create a short choreography with the robots to a pre-selected song.

Figure 4. Moments of the Library Robot Workshops in the various points of the Digital Lab.

Sometimes, outside the usual framework of the club, there are also opportunities to do different tasks based on the knowledge acquired so far, such as making a film with the robots based on the ideas of the participants in collaboration with the Creative Studio of our library. The Creative Studio is our place to learn the basics of moviemaking, writing screenplays, using a professional camera, and try movie editing (*Figure 5*). By collecting ideas and putting them into practice, the participants of the Library Robot Hour will not only gain an insight into robotics but also into the practice of filmmaking, thus gaining experience and broadening their horizons in several areas. Shooting the scenes for the film involves several weeks of work, but fortunately the motivation has remained steady, and our co-workers in the library were very helpful in providing space for filming. The editing work was made by the students of the Creative Studio (*Figure 6*).

Figure 5. Process of filmmaking in the areas of our library. Our co-worker from the Creative Studio helps with controlling the camera and finding the right setups.

Figure 6. Actual stills from the short film, made by the students of the Robot Hour and the Creative Studio Only robots are appearing in the film.

As a county library, our service area extends far beyond the walls of our institution. We regularly visit libraries in small villages with one-to-one sessions, so we can bring robotics closer to those who have fewer opportunities to learn about it in their everyday lives (*Figure 7*). These are organised groups, school classes and summer camps. This is when we take three of the EV3 robots on trips. These groups listen the same lecture about the robotics, as the visitors in the main library, then they can try all the currently available robots.

One of the primary schools in our town, Kecskemét was also interested in our robotics-related programmes, and they asked us to visit them several times to give demonstrations for all grades. Many of the participants have become returning visitors to the Library Robot Hour.

There are also non-regular returners who, depending on their schedules, return for participate occasional sessions.

Classes from the primary schools often visits our library to participate on different programs. Since robotics is available, they can choose to try the one-shot version. Many schools do not have the opportunity to provide their own robotics education, so we can help them in this way. To other schools, which have a better equipment, they are also welcome to visit the library, because they can meet a different point of view, different solutions, tools.

Figure 7. Robotics workshops in small village libraries. School classes and summer camps are particularly interested in robotics. The holiday seasons or the national level events, like the National Library Days or the Internet Fiesta are great opportunities to invite us.


Look into the future

In the future, we would certainly like to expand our robotics-related opportunities, both in terms of tools and types of activities. Our goal is buying new Inventor sets, using them with different, new builds, and we have interest to try non-Lego solutions, to make new experiences to our visitors. To the already existing participants we always try to find and offer new challenges, tasks. The new idea is the Robotics Adventure Card, which contain random tasks to be solved in the Robot Hour.

Our close up plan is organizing more robotic workshops in the week, at even more favorable times than the present, with new beginner groups, also with different, not only programming focused thematics, taking advantage of the possibilities of newly acquired robots. Our brand new robots will be Artec robots, which can be assembled by the participants themselves. It will be a great opportunity to cooperate with other co-workers

with our children's department, because the Artec robots are ideal to process even literary works with their easy assembling to made quick, custom built sturctures. to give an opportunity, so that as many people as possible can try our robotics services, and discover our library.

Conclusion

In the past year, there has been continuous interest in our robotics service. Our goal, to start this new service, and be a part of our participants' first steps in the discovery of robotics, has been achieved. Participants in our regular sessions continuously developed their skills in programming the robots we provide, harnessing their creativity and teamwork skills.

After the initial small successes, participants' algorithmic thinking developed, and they boldly used the basic concept required for block based programming. They learned the importance of constant monitoring the feedback of the robots, and their patience for trying again and again increased. Numerous regular participants indicated that they would like to take up robotics at a higher level in the longer term, so our aim to be a first step on the path to robotics has been motivating.

Acknowledgments: We thank Johnathan Dabney for the English language editing.

References

Barbalics, D., & Solymos, D. (2018). *Lego Mindstorms EV3 robotok programozása* [Programming of Lego Mindstorm EV3 robots]. Szakköri segédanyag tanárok számára, ELTE Informatikai Kar.

Fanchamps, N. L., Slangen, L., Hennissen, P., & Specht, M. (2019). The influence of SRA programming on algorithmic thinking and self-efficacy using Lego robotics in two types of instruction. *International Journal of Technology and Design Education*, *31*(2), 203–222. https://doi.org/10.1007/s10798-019-09559-9

Gilca, G.; Ionescu, M. (2021). A study of robots used in education. *Fiability & Durability / Fiabilitate si Durabilitate*, *24*(1), 135–140.

Kerettanterv az általános iskola 5–8. évfolyama számára [Framework curriculum for grades 5–8 of primary school] (2020). https://www.oktata.hu/pub_bin/dload/kozoktatas/kerettanterv/Digitalis_kultura_F.docx

Pansky, T., & Rowinska, Z. (2021). A holistic digital game-based learning approach to out-of-school primary programming education. *Informatics in Education, 20*(2) 255–276. https://doi.org/10.15388/infedu.2021.12

Preciado Babb, A. P., Takeuchi, M. A., Alnoso Yáñez, G., Francis, K., Gereluk, D., & Friesen, S. (2016). Pioneering STEM education for pre-service teachers. *International Journal of Engineering Pedagogy (iJEP)*, *6*(4), 4–11. https://doi.org/10.3991/ijep.v6i4.5965