Horizon 2020 European Union Funding for Research & Innovation

AMASS acting on the margins. arts as social sculpture

HUNGARIAN PROJECTS

CORVINUS UNIVERSITY of BUDAPEST

MATHEMATICS THROUGH ART

developing spatial skills and digital literacy through visual arts education

In public education, it is expected from schools to cater for student diversity, and support those who are challenged with social disadvantages, learning deficits or mental, behavioural problems. Our institution also strives for **educational equity**. However, when behavioural or developmental problems are identified, the role of the family is crucial: children who are diagnosed with such challenges, are mostly given special treatment by speech therapists, special educators, or psychologists, for example, due to the caring attitude of their parents. There are, however, **children deprived from appropriate parental care, who will receive remedial education at school only**. It is not easy to accommodate these developmental programs, as the curriculum is overburdened with special classes for sport, languages, or high-level arts, according to the focus of the institution.

Teachers face the problem of **individualised instruction**: they must cater for those lagging behind, due to their special needs, and average performers, or the talented ones in need of nurturing. Those who are less successful in the race for better learning results because of their challenges, will develop aggressive behaviour or sink into depression, even entertain suicidal thoughts. Struggling with the task of teaching these children, teachers often leave the profession for the lack of competence to face students with special learning needs. Therefore, there is a burning need for teaching methods and aids for the development of students with **attention deficit disorder (ADD) and attention deficit hyperactive disorder (ADHD)**, to name only the most frequent challenge. Art education in Hungary is not one of the major disciplines. With one, 45-minute lesson hour per week, the developmental potentials of the arts are hard to realise. However, this discipline may be instrumental in supporting the cognitive and emotional development of challenged learners through scientific visualisations and arts-based interventions.

1. Figure: Spatial constructions of girls aged 11, Grade 5

OBJECTIVES

In the framework of the AMASS project, we develop programs that enhance mathematical skills of students with learning difficulties.

- **We personalise instruction** to include hearing impaired, lefthanded, hyperactive, depressive, even suicidal children in the teaching-learning process
- **We motivate learners** through arts-based activities that give them a new and flexible channel of expression
- **We facilitate student learning through experience-based instruction**: hands-on tools for problem solving, visualising concepts and rules, and offer carefully structured, meaningful manual activities to develop cognitive skills
- **We encourage visualisers** to use their skills in a predominantly verbal instructional culture and teach them how to make meaning through images

2. Figure (a, b): Participants of the experimental program, girls and boys aged 11, Grade 5

PARTICIPANTS

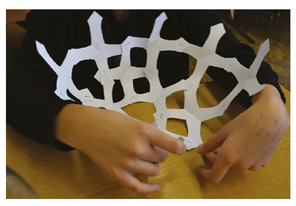
Program development and realisation: Erika Kugler, MA in art and design education, Master Teacher, lecturer in teacher education

Research consultant: Andrea Kárpáti, Prof. Dr., art historian and educational researcher, Corvinus University Budapest

Program venue: Szent István primary and Secondary Grammar School with Sport Specialisation, Jászberény, Hungary. (Director: Imréné Pomázi)

Students: this longitudinal developmental program is realised in afternoon sessions, at school, in the optional stream of the timetable. Students opt for the arts-based, mathematics focused experiment for a semester only, but most of them stay. The program started in September 2020, with students in **Grade 5 (average age: 11 years)** and is now in its third semester (November 2021) with students in Grade 6 (average age: 12 years).

3. Figure: Logo and school building, Szent István primary and Secondary Grammar School with Sport Specialisation, Jászberény, Hungary



4. Figure (a,b): Boys aged 11, Grade 5, produce a spherical lattice – a complicated spatial imaging task

THEORETICAL BACKGROUND

The development of students is supported in a holistic, reflective way, considering student development in social behaviour, interpersonal skills, task-centeredness as well as in digital literacy, numeracy, scientific visualisation and spatial skills. Visual competence is also enhanced and assessed through the process-oriented portfolio method. The theoretical foundation of the methods employed are arts-based inquiry

Arts-based interventions address two major societal challenges:

1. ***Negative attitudes to leaning***: encouraging students to develop their learning skills, attitudes and interests towards science and art disciplines and deepen their knowledge and critical skills. Art and arts education are perceived as a way of enhancing the agency of students at risk of alienation from school and the wider society (Ahonen et al, 2008).
2. ***A lack of transparency in knowledge production:*** we exploit the role of arts for innovating knowledge acquisition and overcome barriers between scientific and artistic domains. We intend to create conditions for long-term educational change and development and play an active role as agents of change (c.f. De Piccoli et. al. 2019).

METHODOLOGY

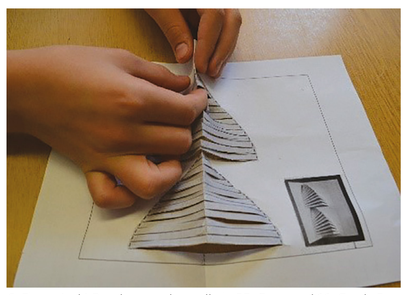
Semester 1. Art and Mathematics integration

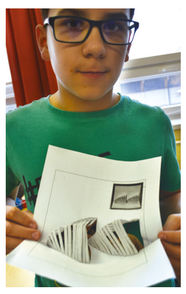
We employ the arts as expressive means but also as agents of meaning making. Students develop spatial skills and thus enhance their understanding of mathematical problems. Information and Communication technology (ICTs) are constantly employed to create an authentic imaging environment. Informal (after-school) arts programs will interact with formal arts education and beneficially influence learning results of students.

The program started with the **identification of students with multiple behavioural and mental challenges** and their invitation to join the program "Mathematics through Art". Ten students were selected from the two parallel classes (Grade 5, average age: 11.3 years) and their background folder was drawn up. **Homeroom teachers characterised the students**:

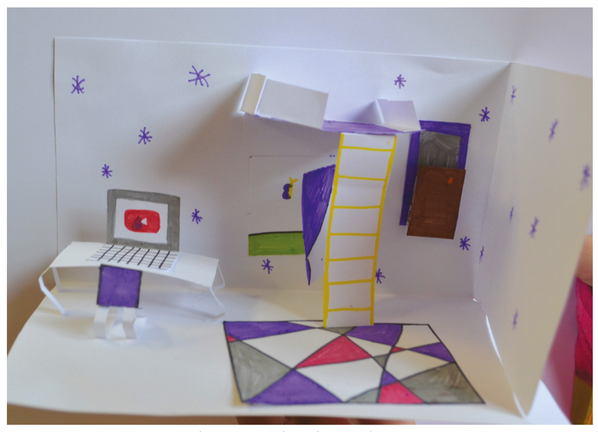
- creativity and problem-solving skills (as diagnosed in previous assessments)
- areas of interest, preferred activities
- skill deficits, learning problems
- current mental state and behaviour
- social background
- any other information relevant for development

5. Figure (a, b): Egyptian frescoe in 3D: Pond in a garden. A work by a girl aged 11, Grade 5





6. Figure (a, b) Developing a leporello in 3D. Boy, aged 11, Grade 5



7. Figure: Monge axonometry study in space. Girl, aged 11, Grade 5

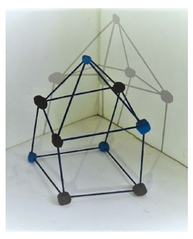
Standardised diagnostic art tasks were given to identify visual competence and further life problems revealed in creative assignments (Task 1-2. below, Kárpáti & Gaul-Ács, 2020) and **visual skills tests**:

1. **Double self-portrait:** in favourite dress and happy mood / in a dress you dislike, being sad
2. **Art map** about a place you liked or one you want to visit
3. **Free expression**: a painting entitled "Storm"
4. **Spatial representation**: 2D representation of a house from 3 angles, based on a photo

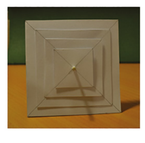
These tasks were analysed in collaboration with a special education teacher and the school psychologist, and developmental trajectories were drawn to **identify areas of excellence and skills to be developed**.

The learning program focused on the development of spatial abilities and numeracy, to support the most difficult thematic areas in Mathematics for the students with special needs. The interdisciplinary learning content was developed in collaboration with the teachers of Mathematics and Art (E. Kugler, the project co-ordinator). **Intersecting areas of Mathematics and Visual Culture were identified:**

- space and plane geometry
- the concept of distance
- radius, diameter, arc of a circle, annulus, and tangent
- constructing a triangle
- splitting a section by half
- characteristics and construction of rectangle and quare
- perpendicular and parallel lines
- diagonals of plane figures
- examination of symmetry
- types of angles
- network of space figures (cube and cuboid), rules of frontal axonometry, overlay



8. Figure (a, b, c): Spatial constructions. Boys, aged 11, Grade 5



9. Figure (a,b,c): Teaching aid for constructing a star-shaped pyramid by Erika Kugler, art educator, 2020

The art educator gave **tasks from everyday life that needed the utilisation of geometrical concepts and rules**. Mathematics teachers coached students with special needs on a conceptual level. Construction of objects and spaces, building complex spatial ensembles and modelling based on images were well received even by students with short attention spans because the tasks provided a chance for individual solutions. After the development of basic spatial skills like orientation and manipulation in space, sign systems depicting space was acquired. Learning Monge axonometry was preceded by a series of constructing and depicting tasks. The image of a spatial object from different angles was carefully studied through 3D models, and only then was represented in a realistic way, and finally drawn using the Monge system. This long process of spatial imaging development will continue all through the four years of the program.

Semester 2. Art and ICTs integration

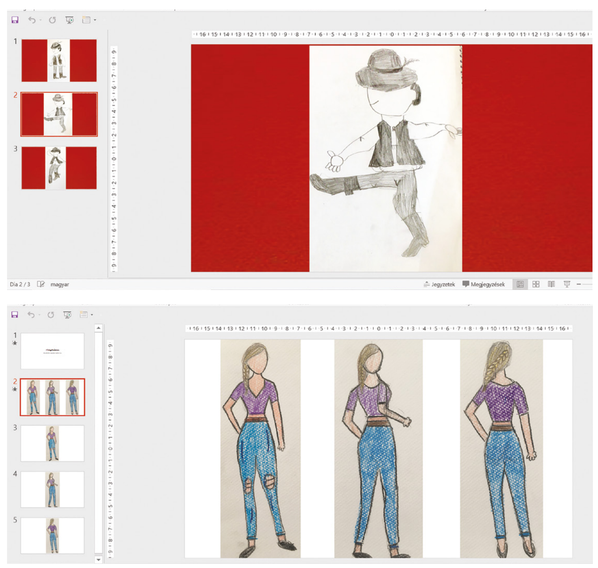
This part of the program focused on the integrated development of visual and digital skills. Students acquired the techniques of digital imaging and produced **animations, video clips, photo sequences, photo collages** and learnt about digital editing and postproduction. During the quarantine resulting from the COVID pandemic, children continued developing their media pieces:

Film 1: Music-image, photocollage

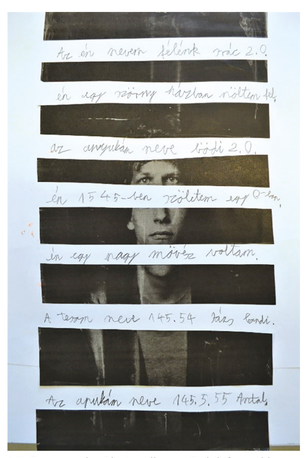
Film 2: Dancers

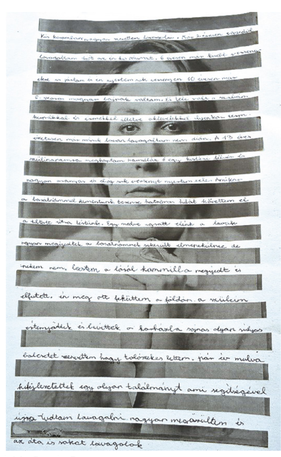
Film 3: A puzzle of images

10. Figure: (a, b, c) Scenes from a videoclip about Wassily Kandinsky, girls and boys aged 11, Grade 5



11. Figure (a, b): Human figure animation, girls aged 11, Grade 5





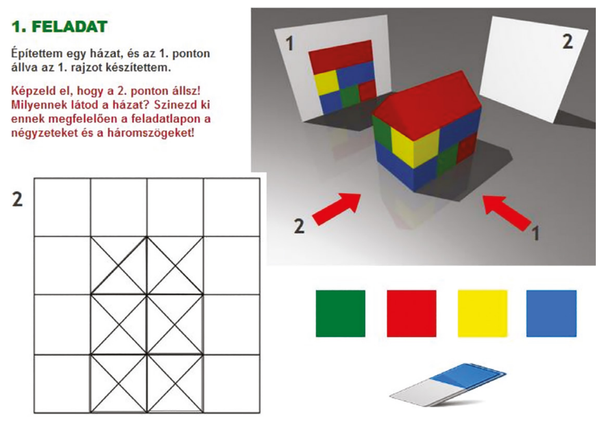
12. Figure (a, b): Photocollages. Girl (left) and boy aged 11, Grade 5

ASSESSMENT

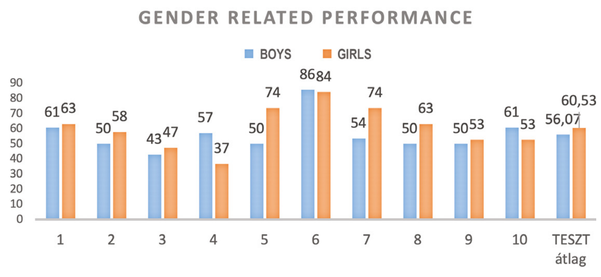
Arts-based social interventions generally do not focus on skills development – the usual target of any educational program. Their objectives are much wider, as they want to heal the wounds of marginalised minorities, neglected children or abused youth and, at the same time, encourage and empower them to express their problems and prospects. Despite careful planning and meticulous implementation, socially oriented arts projects often remain islands in the sea of traditional arts-based programs, as their effects are unclear and unsupported by research data politicians are used to interpret and, if they are convincing, probably accept. As we wanted to **support "problem children" to develop a successful and fulfilling learning career at school, we had to employ formative assessment**: standardised tests, portfolios documenting learning trajectories and qualitative accounts of performance and behaviour.

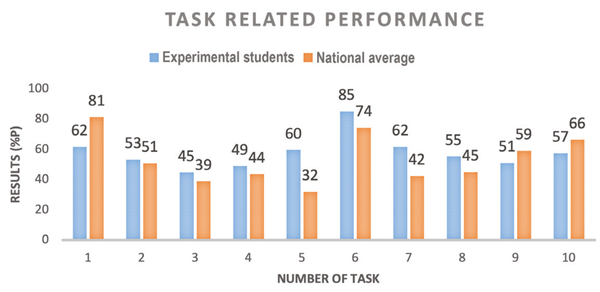
Development of spatial skills – the pre-tests

We used the standardised spatial ability task series developed Bernadett Babály, architect and art teacher. The tasks have a quiz-like, playful character and students found them so interesting that they required similar "games" for future lessons. The items measured the key components of spatial skills: **visuo-spatial perception, spatial visualization, mental folding, and mental rotation**. Surprisingly, girls performed better in the pre-test, at the beginning of the developmental program in September 2020. **Many of our "problem students" with learning challenges performed better than the national average.** As they develop further through the program, it may facilitate an orientation towards a successful career in engineering, architecture, or design. Often considered "school failures", such a life perspective is a significant benefit.



13. Figure. A task from the spatial skills test by Bernadett Babály: „I built a house and drew it, standing in Point 1. Imagine that you stand on Point 2. How is the house from your ange? Colour the triangles and squares ont he sheet accordingly!





(Babály, 2021)

Portfolio assessment and qualitative accounts of performance and behaviour

We have started collecting drawings, media works and 3D constructions of 17 students and will continue till the end of the longitudinal educational experiment in 2022. In the first year of the project, students with severe learning issues were in focus. We considered **individual life problems of the students revealed in expressive drawings and interviews, but also promising performance identified in the testing process**. Their visual competence assumed a wide spectrum – there were several gifted (and so far, unrecognised) visualisers, while others found it difficult to use the visual language.

A qualitative methodology was employed to organise and evaluate evidence collected in the portfolios to define the optimal motivation methods and learning support strategies. These were entered in the portfolios that also included the reports of the psychologist and special educator. Students were assessed by their homeroom teacher at the start of the project, and in the quality of visual competence, many of these were over-optimistic. Those with learning challenges often struggle with visual expression, as they have hardly ever been encouraged to draw or build – they were instructed to "learn", that is, to read and memorise. Now they started to develop their personal imaging repertoire and elaborated on deprivation (death of a family member or divorce) or joys of life. Many of them have shown traits of depression and needed the involvement of an art therapist for individual care. During the two semesters of competence development, we could witness the evolution of the visual language of students and also the variety of ways imaging supports their learning process. **After the analysis of tests, portfolios, interviews and expert reports and observations, we could co-design the developmental program for the second experimental year, based on research data.**

Acknowledgement

This research was supported by the AMASS - Acting on the Margins: Arts as Social Sculpture project, 2020-2023, Reg. No. 870621, of the Socioeconomic and Cultural Transformations in the Context of the Fourth Industrial Revolution subprogram of the EU HORIZON 2020-SC6 Framework Program.