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DIGITAL CREATIVITY FOR NET GENERATION STUDENTS: RETOOLING THE ART AND DESIGN ENVIRONMENT AT SCHOOL

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In arts education, the *iconic turn*, the steady increase of images and icons in communication and the appearance of multimedia art works became an agent for paradigm change in the 21st century. Beyond fine arts, contemporary curricula focus on visual communication that includes digital graphics, photography and video. Research has consequently intensified on the skill structure and developmental stages of the *new child art* and the need for a suitable learning environment soon became evident. In Hungary, digital pedagogy has only targeted the visual arts in the last decade when tablets and smartphones began to offer numerous imaging options that invaded social web pages. Digital child and youth art has by now become a curriculum component in many countries and the art studio has integrated e-learning technology and pedagogy. This paper summarises Hungarian experiments in developing a new, creative learning environment for art and design education.

Introduction: retooling the art and design education environment in the 21st century

The *iconic turn* (Moxey, 2008), resulting in increased importance (and, in social media, the predominance) of visual language became an agent for paradigm change in arts education in the 21st century. Digital creativity found its way to the UNESCO Policy Brief on Digital Literacy (Kárpáti, 2011) and contemporary curricula shifted focus on visual culture including digital media – major forms of expression of adolescents (Duncum, 2002; Freedman et al., 2013). In a recent study to develop the Common European Framework of Reference for Visual Literacy (CEFR_VL, Schönau and Wagner (Eds.), in preparation for 2016) visual literacy, understood as a competency, as it is manifest in certain situations. Visual literacy as a subject-specific competency is embedded in an interdisciplinary, general educational concept integrating *self-competency, social competency* and methodological competency. This approach indicates the need for a reconsideration of the art and design education environment and integration of digital technology and pedagogy in aesthetic education the way it is already manifest in self-expression and social life. Developing competences of visual expression and creation cannot be restricted to media in use for centuries – they have to find a synergy of working in real and virtual space through tangible and digital tools.

Figure 1. On the left: Giovanni Francesco Carroto: Portrait of a Young Boy Holding a Child's Drawing, Verona, Castelvecchio Museum, about 1515 – On the right: Girl with her multimedia work on a tablet, Eger, Laboratory School of Eszterházy College, 2014

Traditional assessment practices (mainly testing realistic representational skills only) have become obsolete and art education research turned to the structure and development of new, partly digital child and youth art (Boughton, 2013). Manipulating objects in space through two-dimensional abstractions has been accepted as a valid means of identifying spatial skills and assessing them – however, working with generations of students deeply immersed in multimedia technology, many teachers find this solution unauthentic and idiosyncratic. Edutainment and gaming applications (like those developed by the Quest to Learn project, http://q2l.org) have long been using sophisticated virtual spaces that activate skills ranging from orientation to memory, manipulation to construction. KINECT applications (http://www.xbox.com/hu-HU/KINECT) transmit real movement to virtual space and thus provide authentic orientation experiences and is being already used in museum education. The Leonar3Do software (http://leonar3do.com) enables users to manipulate in real space and create 3D images that can be shown through a 3D printer as sculptures or objects. The software is in use at art and design academies, universities of technology and medicine, but its utilisation options for public education still has to be developed.

We employ digital technology in two forms: first, to provide students with a personalised, flexible, online practicing and testing environment. Second, we started experimenting with three-dimensional (3D) software solutions that provide authentic methods for creation, manipulation and perception of space in a dynamic virtual environment. In this paper, we give a brief account of our first results comparing traditional and innovative evaluation methodologies.

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Developing a new learning environment for digital creation

In a longitudinal study to describe the visual language of children and adolescents of the 21st century, we have asked some educational institutions where digital technology was regularly used for teaching and learning, to do the drawing tasks using digital tools as well as traditional ones like pen, pencil and paint. Four tasks were selected – three with a narrative character to avoid the use of schemes and clichés from cartoons and animated films and a completion tasks to investigate hidden skills that are not needed for young children to express their ideas but are part of their visual language and when revealed, they may be may be further developed in art education. The first task was a map of an (imaginary) place children want to (re)visit, the second was a dwelling design for a favourite tale / film / cartoon character, the third was a task for self-expression: a double portrait in the favourite / most hated dress in happy and gloomy mood. The two completion tasks involved the creation of a landscape and an interior space. Assessment criteria included *task centeredness* (understanding the theme provided and developing an image accordingly), *expressivity* (using the visual language in a manner to share ideas and moods), *image development level* (ranging from scribbles to shapes), *use of colours* (as signifiers or representational tools), and *composition* (arrangement of forms and their interrelations in the pictorial space). In Kindergarten, with children aged 2.5-6, we experienced no problems with digital media. Using tablets and laptops and drawing on the interactive whiteboard was a familiar activity for most children – not always from own experience, but from observing their peers. (Mobile computing tools seem to be widespread in middle class Hungarian homes from where children of our experimental sample came from, even in those with a below average income). *There was no quantitative (developmental level related) difference between digital drawings and those prepared with traditional tools*: crayons, pencils or felt-tipped markers as most digital imaging tools for children resemble traditional alternatives.

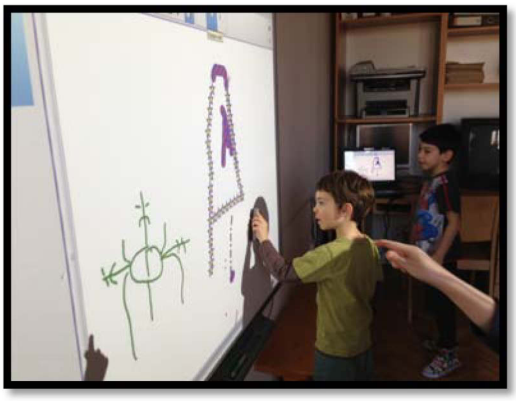


Figure 2. Drawing digitally on laptop and interactive whiteboard (on the left) and tablet (on the right) at Óperenciás Kindergarten, Budapest, 2015

In terms of *style and working processes, we found significant differences between the traditional and digital environments*. Both support pair and group work, but digital imaging seems to motivate for more exchange and co-operation, perhaps because of the ease of correcting faulty lines and patches on the screen. Traditional images are richer in detail and manifest better proportions, while digital images developed on interactive whiteboards and tablets show more

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complex composition, sharp colour contrast, and more signs and symbols. Clearly, experiences with digital images influence the style of creation: social media are rich in symbolism, and tend to use vivid colours and sharper contrasts for a more immediate effect, children using digital tools will at likewise.

For art education, digital imaging offers an excellent opportunity to educate for safe, expressive and aesthetically pleasing self-expression. Creation with traditional tools is important for skills development and the preservation of cultural heritage, but it is the digital media that children and young adults will regularly practice. School art and design studios must therefore be furnished to satisfy the need for digital self-expression.

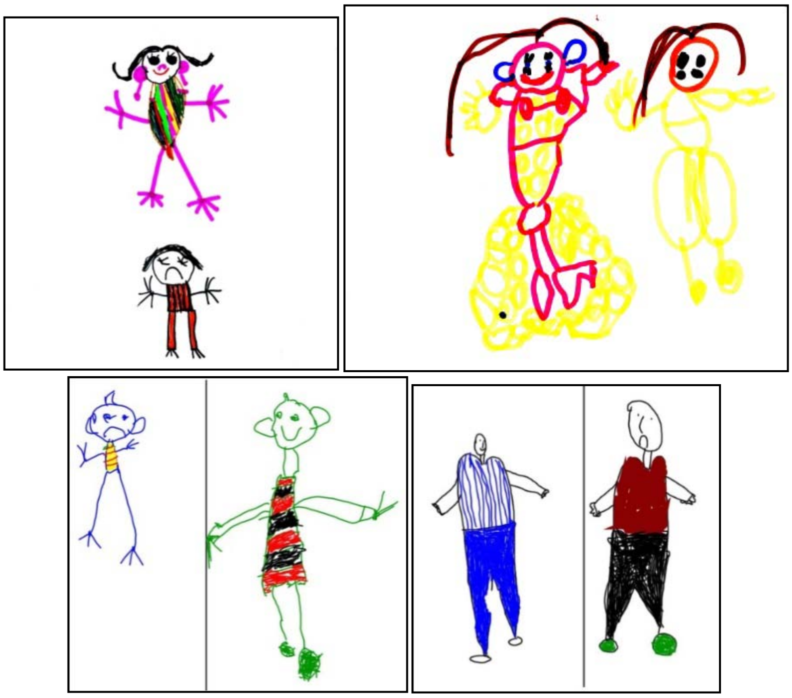

Figure 3. Self portraits in a happy and sad mood, with felt-tipped pen (on the left) and Paint software (on the right) of a girl and a boy aged 4 years, Óperenciás Kindergarten, Budapest, 2015

At the Eszterházy College of Eger, researchers (among them, authors of this paper) decided to adopt a new, trialogical model of innovation and introduce mobile learning devices (tablets and laptops) parallel with in-service teacher training and mentoring. In the course of ten years, in 2004-2014, three generations of mobile devices (e-paper, laptops and tablets) were introduced and their integration in teaching and learning carefully documented (Kis-Tóth et al., 2014). Primary and secondary school teachers received devices for their personal and professional use and were enrolled in weekly introductory courses by experienced IT trainers and didactics specialists to acquire both technological and pedagogical content knowledge. Mobile devices were introduced to students by their IT teachers first and their special functions were then put to use by their discipline teachers (on primary level, generalists). The sequence of retooling experiments had constant and changing elements. Constant elements included the *1:1 access to mobile tools*. Teachers were provided with these tools for school and home use – a feature that proved to be decisive for success, as teachers need more time than students to adapt to new infrastructure. Students got access to mobile tools furnished with

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learning materials at school only. Later, when learning content was gradually made available through dedicated school web sites, a BYOD model could be offered for some disciplines.

In-service training courses and personal or group based mentoring also belonged to the constant elements of the project sequence. Innovation in education needs constant professional support, and the more profound educational changes are, the more personalised this support should to be (Kárpáti & Dorner, 2012). At the Eszterházy College, discipline-based teacher groups were formed and two types of mentors (IT specialists and college staff teaching didactics) were provided. In the course of five years, more and more school disciplines were involved. First, the languages and natural science subjects, then also the arts. During the last term, interdisciplinary competencies were developed as integrated arts and science projects initiated. Art educators also formed a mentoring group and developed a series of successful and motivating art and design projects.

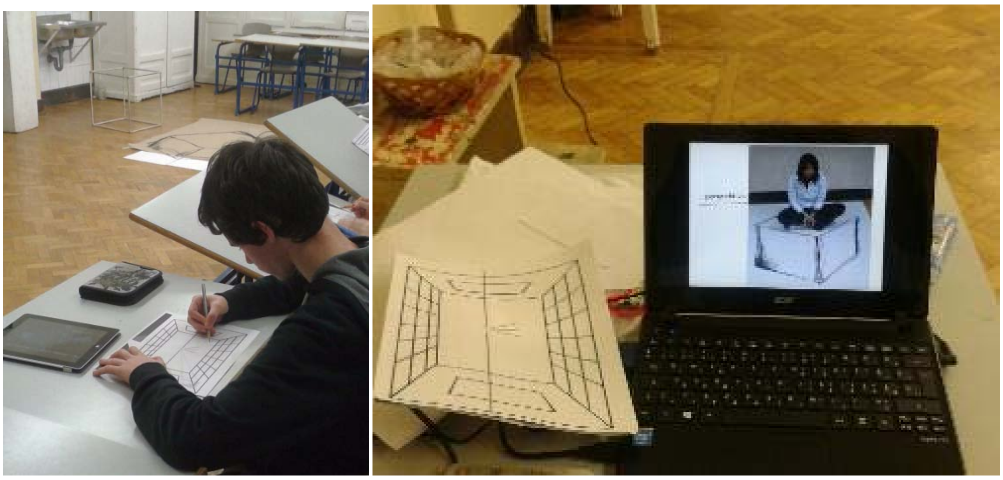

Figure 4. Using tablets in art class: studying perspective in life and in visual representation through self-made photo sequences and drawings (Secondary Grammar Laboratory School of Eszterházy College, Eger, 2014. Grade 9, age 15 years, Art and Visual Culture teacher: Eszter Igric)

The Noldus Observer XT video-based interaction analysis software was used to analyse actions and, through facial expressions, also attitudes and moods during the use of digital tools. Already in the first phase of integrating mobile solutions as learning tools, teachers employed them both in formal and informal learning. Working with laptops in the schoolyard or the neighbouring forest during a Biology class, documenting works of art in a museum with tablets made informal learning easier to integrate with formal, disciplinary studies. Teachers could easily call forth images and text produced or collected outdoors during classes and were thus encouraged to expand the learning environment and think outside the (school)box when planning a learning sequence. While Classmate PCs and e-books involved more static classroom management with limited pair and group work, teachers utilised the increased mobility of tablets and iPads to involve student teams (often from several cases and grades) to work collaboratively at field trips or school bad informal learning events.

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Developing a new learning environment for digital assessment

The Hungarian Diagnostic Assessment System, eDIA, developed by B. Csapó and Gy. Molnár at Szeged University, Research Group on the Theory of Education, provides an internationally unique educational environment for interactive online testing through dynamic, multimedia tasks (Molnár et al., 2016). The Arts section of the testing system assesses spatial abilities, colour sensitivity and visual communication. Visual communication tests contain about 120 interactive tasks. Content ranges from decoding images, sorting and matching styles or concepts to learning from infographics, and cultural interpretation. Taken by more than 2000 students aged 6-12, the tests are reliable measures of assessment and also applicable for development of visual skills. Eye tracking is being used for item improvement, and it also reveals perceptual patterns and decoding strategies of students. Digitally literate children perform best in modality change tasks but have problems with matching concepts with complex images. Perceptual style also influences visual communication.

The wide variety of item types integrating sound, image, video and animation and functionalities like colouring and rearranging images, entering text, pairing words and pictures are ideally suited for the analysis of verbal and visual communication forms using multimedia. (Simon, 2015; Kárpáti & Simon, 2014). In the *Visual Culture* test package, practice items are provided that show manipulation options and also a voiceover for slow readers. Visual communication tests containing 200 interactive items were developed by Tünde Simon in co-operation with professional communities of art educators and piloted with class size samples and results discussed with art teachers of the schools. Item contents involved recognition, interpretation, visual analysis, abstraction, symbolisation and visual dynamics. Stimuli were selected from fine, applied and media arts as well as infographics and scientific visualisations. Abstractions items included tasks for conveying essential meaning through reduction, simplification, emphasis of main features of an image, modality change (visual representation of verbal text, music, sounds, gestures, etc.) and use of conventional abstraction systems (e. g. languages of scientific visualisation, interpretive drawings, process graphics, sign systems).

The eDIA testing environment performs diagnostic, criterion-oriented assessment and supports the creation of individual educational programs. As a result of our visual skills research project, the development of skill components can be determined and special applications prepared to identify talent or fight deficits. Figures below illustrate how this testing and development environment can be suited to perceptual styles of primary school students, using real life representations and abstractions.

Static online tasks for the assessment of spatial skills

Drawing conventions for representing space in two-dimensional form has traditionally been one of the central tasks in visual skills development because of its relevance for a wide range of professions. Digital image processing software, the virtual spaces of computer games, the multimedia tools and applications, however, have significantly altered our visual thinking and the perception of spatial relations as well. Through the use of digital images we can visualize

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space in a more authentic manner and reproduce the complex spatial situations accurately. These types of tasks can imitate real-life spatial problems that we encounter every day. Manipulation in virtual space is also being employed at the Harvard Mental Imagery Lab (http://www.nmr.mgh.harvard.edu) where a spatial aptitude test is developed using Virtual Reality and Augmented Reality solutions.

Our methodological objective is to integrate these digital solutions in educational assessment in the visual arts. Spatial skill components (mental and physical manipulation, transformation, completion, planning, construction, etc.) are also valid indicators of the developmental level of visual skills and therefore often used for the detection of talent. However, from the copying exercises of gypsum models of academies, through studies of old masters and careful representation of arrangements of objects, tasks required activities unrelated to real life experiences of creation and perception of space. *Spatial positions, relations, directions* (e.g.: sense of direction, distances connected with changes of measurement, orientation in the built environment/ orientation virtual reality), *comprehension of structures of 3D shapes* (e.g.: parts and whole, connections among structural elements, spatial bulks and their concave-convex extensions, covered elements, regular-irregular spatial structures), spatial reconstructions (e.g.: projection drawings, section planes, ground plan –elevation –layout, point of view, spatial abstractions, reductions) as well as *spatial transformations and manipulations* (e.g.: mental cutting, rotation, removal, mirroring, assembly and construction) can be evaluated through the tasks that Bernadett Babály developed for the eDIA system (Babály & Kárpáti, 2013).

The spectacular visual appearance of the tasks makes them not only enjoyable for children, but also easier to comprehend than the black-and-white abstract axonometric projections in traditional paper-based tests. *Digital literacy* does not play a significant role as the testing environment includes functionalities well known from virtual environments frequented by the subjects, students aged 6-12 years. Some abstraction items were also found easier than expected as they contained modality changes often encountered by adolescents who regularly use social web sites and gaming environments. Other items for matching concepts and images, however, were found difficult, although the concepts occurred in art education regularly. Visual analysis and symbolisation tasks were of medium difficulty. Eye-tracking studies revealed that *test page design* was one of the most important factors influencing task solution. The arrangement of the text and image block and the *colour and size of the text and action buttons* affected viewing time and their use often resulted in an extra cognitive load on top of item solution towards the end of the test. *Familiarity of images* contributed to item difficulty, even if the question was not related to image content or authorship. Issues of *item complexity* analysed by eye-tracking resulted in an improved version for several tasks that are now divided into two or three more transparent and visually comprehensible items.

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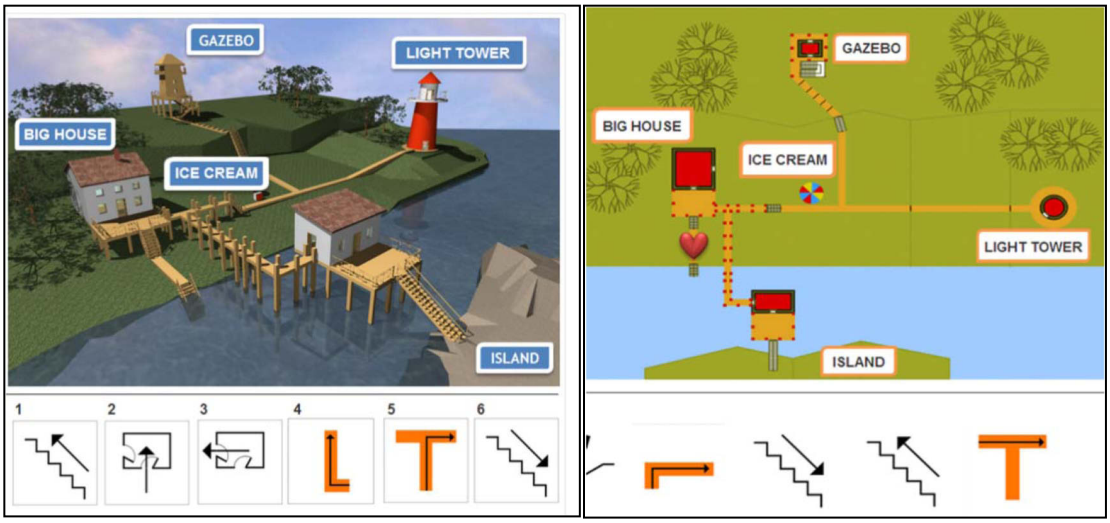

Figure 5. Two orientation tasks with different degrees of realism and symbolism for Grades 4 and 5 (left) and 6-7 (right) – A task from the eDIA testing environment. (Screenshot, September 2015)

Text comprehension level may also be an important influencing factor. Eye-tracking and post-hoc interviews with students and teachers revealed items with ambiguous or lengthy text and facilitated their improvement. In the next iteration of the tests, students will also take a verbal comprehension test in the online same testing environment to detect the influence of verbal skills on visual communication. *Reading skills* did not affect task solution, as an optional voiceover could be used by slow readers. *Comprehension strategies* of *visualizers* who quickly scan instructions, observe all images first and then look for matching concepts and *verbalizers* who carefully read and re-read the instructions and the concept list before observing the images also contribute to performance level in visual communication tests. Eye-tracking helps compile tests that include a proportionate number of items for both strategies. This result seems most relevant for pedagogy as both strategies can be modified through art education.

Dynamic imaging and modelling for the development and assessment of spatial skills

Spatial relations may best be observed during action in real space – but how can we integrate such experiences in a testing environment? The solution of this crucially important issue of authenticity was the inclusion of the GeoGebra dynamic mathematics software (http://www.geogebra.org) in the battery of testing tools to provide dynamic visualisation options (Kárpáti, Babály, & Budai, 2014). GeoGebra was created by Markus Hohenwarter and originally intended for use in secondary level science and mathematics education. It is available as an open source application and works with any platform that is suitable to run Java. The utilisation of GeoGebra's perfect visualisation functions for art education is one of the objectives of our research group. Its latest version, GeoGebra 5.0 includes 3D functionalities and is ideally suitable for digital creation in space. (Cf. the note on this functionality at http://wiki.geogebra.org/en/Release_Notes_GeoGebra_5.0) The software connects different representations of objects with their geometric display and algebraic description. Unlike designing on paper, the initial objects (points, straight lines) can be freely moved while the objects dependent upon them move along with them based on their

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geometrical connections. Thus, students practicing mental rotation can actually rotate a linear representation of a cube and see its shape changing according to the change of perspective in a discovery learning environment. The figure below shows how a spatial task can be solved through using the rotation functions of GeoGebra.

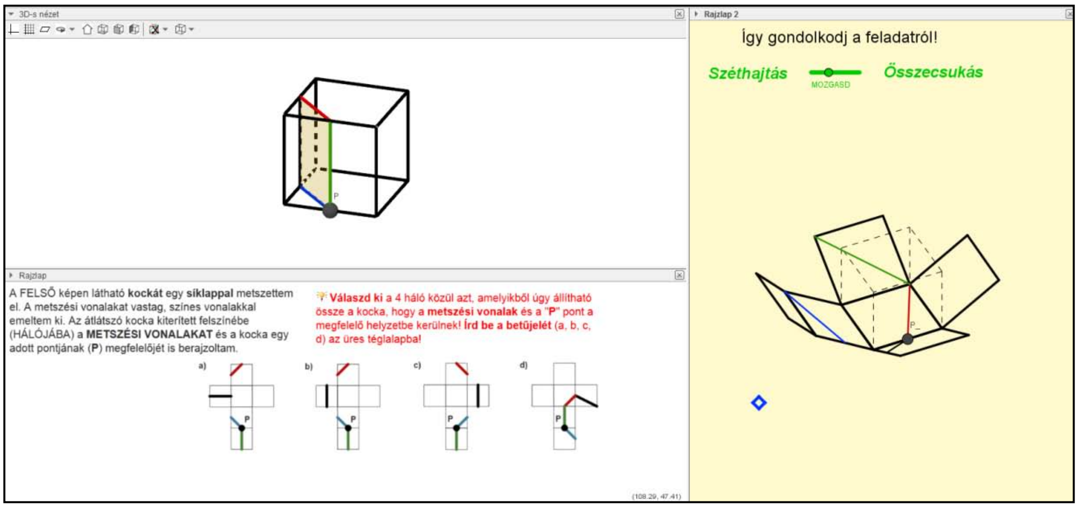

Figure 6. Sample spatial task in the GeoGebra software environment – On the right: help for the use of manipulating functions that facilitate the solution of the task through dynamic visualisation of the problem.

We compared task difficulty in a traditional paper based learning environment and in virtual space when objects can be moved and rotated. Student results were similar, but the dynamic digital environment was more suitable for demonstration and practice. Especially for girls, showing phases of a spatial manipulation makes it much easier to understand a spatial problem. In the current research phase we experiment with solutions to develop spatial skills through experimentation in digital space.

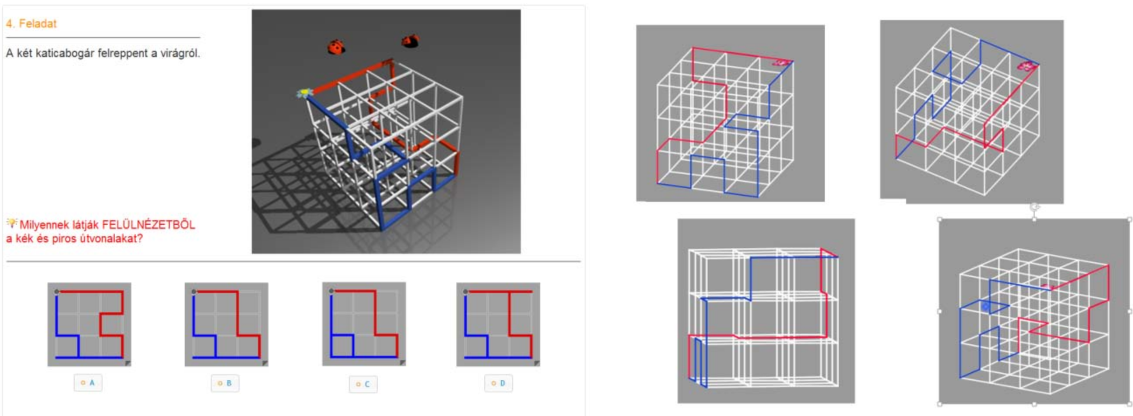

Figure 7. "Two ladybirds are flying above the labyrinth. Which bird's-eye view can they see? Choose one from among floor plans below!" On the left: the static version of the task. On the right: phases of movement using GeoGebra

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Further research

Between 2011 and 2015, a series of tests to assess visual skills of Hungarian 6-12-year-olds have been developed in three areas: spatial abilities, colour sensitivity and visual communication. Task response types in eDIA online testing environment include marking, colouring and moving images, entering text, joining text and picture or forming groups of items. Cognitive skills involved in perception, design and creation are targeted simultaneously, just like in real life. Visual skills are in focus, but other competences are also tested, revealing the interdisciplinary significance of art education. In its final form, the eDIA-system will monitor personal development, and offer tasks for individual skill enhancement based on previous results. Art teachers may thus design individualised teaching-learning processes that support talent development and caters for special need (like mental or psychomotor deficits) at the same time.

Phase two of our project will involve the correction of the system of tasks both for Spatial Abilities and Visual Culture, development of new items for Art Appreciation as well as Environmental Culture, and introduce them to a representative population of Hungarian 6-12-year olds. In parallel, a team of art teachers will use the tasks for development and diagnosis of gifts and deficits. Another major issue to research will be the comparison of creation with digital and traditional tools. Do we lose important aspects of creation and perception if we substitute paper and pencil with digital tools? What is the role of multimedia in the contemporary visual language of children? (As for adolescents, we have revealed its important impact, cf. Freedman, Hejnen, Kallio, Karpati & Papp, 2013). In all our future efforts, we will focus on a synergy of everyday visual language use in education. Our testing processes not only model, but also directly involve creative and design practices as we confront them in real life, interlinking assessment, education, and (self)improvement.

References

1. Babály, B., & Kárpáti, A. (2015). Téri képességek vizsgálata papír alapú és online tesztekkel. (Research on spatial abilities through paper based and online tests). *Magyar Pedagógia, 115*(2), 67-92. Retrieved from http://www.edu.u-szeged.hu/mped/document/Babaly_MPed2015267.pdf
2. Boughton, D. (2013). Assessment of performance in the visual arts: What, how and why? In A. Kárpáti & E. Gaul (Eds.), *From Child Art to Visual Language of Youth – New Models and Tools for Assessment of Learning and Creation in Art Education* (pp. 119-142). Bristol: Intellect Publishers.
3. Duncum, P. (2002): Visual Culture Art Education: Why, What and How. *International Journal of Art & Design Education, 21*(1), 14-23.
4. Freedman, K., Hejnen, E., Kallio-Tavin, M., Kárpáti, A., & Papp, L. (2013). Visual Culture Networks for Learning: What and How Students Learn in Informal Visual Culture Groups. *Studies in Art Education, 54*(2), 103-115.

ISBN 978-615-5511-10-3

5. Kárpáti, A. (2011). *Digital Literacy in Education. Policy Brief.* Moscow: UNESCO Institute for Information Technologies in Education. Retrieved from http://iite.unesco.org/publications/3214688/
6. Kárpáti, A., & Simon, T. (2014). Symbolisation in child art - creation and interpretation of visual metaphors. In A. Benedek, & K. Nyíri (Eds.), *The Power of the Image. Emotion, Expression, Explanation* (pp. 143-160). Frankfurt/M.: Peter Lang Verlag.
7. Kárpáti, A., Babály, B., & Budai, L. (2013). Development of spatial skills through 3D, online, interactive tasks. In P. Gregory (Ed.), *Proceedings of the InSEA World Congress*, Canterbury, UK, 24-26 June 2013. Retrieved from http://insea.org/docs/2014.17/InSEACongress2013PROCEEDINGS.pdf
8. Kárpáti, A., Babály, B., & Budai, L. (2014). Authentic assessment of spatial abilities through interactive, online 2D and virtual 3D tasks. *International Journal of Arts Education, 9*(2), 94-124.
9. Kis-Tóth, L., Borbás, L., & Kárpáti, A. (2014). Táblagépek alkalmazása az oktatásban: tanári tapasztalatok, (Using tablets in education: teachers' experiences). *Iskolakultúra, 24*(9), 50-71.
10. Mohler, J. L. (2008). A Review of Spatial Ability Research. *Engineering Design Graphics Journal, 72*(2), 19-30.
11. Molnár, Gy., Greiff, S., Wüstenberg, S., & Fischer, A. (2016). Empirical study of computer based assessment of domain-general dynamic problem solving skills. In J. Funke, B. Csapó, & A. Schleicher (Eds.), *The Nature of Problem Solving* (pp. 123-143). Paris: OECD.
12. Moxey, K. (2008). Visual Studies and the Iconic Turn. *Journal of Visual Culture, 7*(2), 131-146.
13. Simon, T. (2015). Online assessment of visual communication skills of students aged 10-12. In T. Eca (Ed.), *Risk and Opportunities for Visual Art Education in Europe. Proceedings of the InSEA European Regional Congress, Lisbon*, 7-9 July 2015. Retrieved from http://www.insea.org/docs/inseapublications/proceedings/procedingsInSEAEuropeancongressLisbon2015.pdf

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