

Creating maths picturebooks and animated films

Antonija Balić Šimrak, Smiljana Narančić Kovač, Kristina Horvat Blažinović, and Dubravka Glasnović Gracin

Abstract:

This chapter presents an interdisciplinary project The Maths Picturebook – Artistic and Literary Activities as an Encouragement to Young Learners (MASLIK), which combines maths, literacy and art in an educational context. The project is conducted at the Faculty of Teacher Education, University of Zagreb, by a group of researchers, experts in various disciplines, i.e. mathematics education, art education, literature, media and picturebook theory. The project involves students of pre-primary and primary education who produce interdisciplinary and multimodal materials for young children which facilitate the understanding and learning of basic mathematical concepts and enhance their literacy skills, including visual literacy and media literacy. Young learners are the final beneficiaries of the project. The educational approach is holistic. Students design and produce picturebooks and animated movies which are appropriate for young learners, and which invite further creative activities. The student teachers also gain the needed educational competences to create similar artefacts with their future pupils. Two picturebooks and several animated movies are presented as the immediate outcomes of the MASLIK project.

Keywords: Maths Concepts, Young Learners, Picturebooks, Animated Movies, Literacy, Visual Literacy, Holistic Approach

Introduction

Young children learn playing and play learning. This is because “learning, like play, is a natural activity in childhood. There are biological and neurological impulses towards learning that children are not entirely conscious of but occur as part of growth and development” (Burke and Grosvenor 2015, 66). When education has a holistic approach, addressing the whole child, and when the activities are enjoyable for children, then work is like play, and children can understand even complex concepts and master various skills. Researchers often emphasise the need for creative play for the holistic development of children (Wilson 2012).

Abstract mathematical concepts are often difficult for young learners because they do not seem clear enough. One of the reasons for this can be the traditional approach to teaching maths, which rarely connects mathematical ideas with everyday life or with other disciplines (Freudenthal 2002). In order to develop materials which could meet the educational needs of young children and adopt the holistic approach, we established an interdisciplinary project around maths concepts, picturebooks and animated movies.

The project *The Maths Picturebook – Artistic and Literary Activities as an Encouragement to Young Learners* (MASLIK) combines maths, literacy and art in an educational context. It is in progress at the Faculty of Teacher Education, University of Zagreb, Croatia, and is conducted as part of in-service teacher education. The main goal of the project is twofold. First, the project aims at establishing the conceptual foundations for designing materials in the form of picturebooks and short animated movies to help young children in the process of acquiring mathematical concepts. Secondly, materials that combine mathematical ideas and aesthetic experiences are produced, which might help young learners develop their creative potentials in both areas.

This paper defines the starting points of the project, describes the procedure and presents the outcomes in its first year. The primary focus is on educating student teachers, young people on their way to becoming professionals capable of raising creativity and love of knowledge in their future pupils. They are supervised by an interdisciplinary team of university teachers, experts in art, mathematics, education, literature and/or language, including picturebook theory, and new media, who contribute the theoretical background and help students establish the basic principles. Students design and produce picturebooks and short animated movies based on mathematical content. The final products are piloted in schools and kindergartens and the results are disseminated among in-service teachers.

Picturebooks and animated movies offer an approach that is both appropriate and acceptable to young learners. The picturebook, as a multimodal form, becomes a complex and demanding game inspired by an aesthetic experience (Balić Šimrak 2014, 80). If it is well designed, it offers various levels of complexity of meanings for individual readers, and, because of this, never loses its appeal. The animated movie may not be as interactive as the picturebook from the viewpoint of its reception, but it adds movement and sound to static and silent pictures, offers direct mediation, and allows for a wider exploration of abstract concepts in new contexts. Both forms make it possible to achieve the set goals in an entertaining and easy way. Geometrical shapes and numbers become characters that children can relate to, and therein lies the potential for comprehending these abstract ideas, now turned into concrete, specific entities.

Starting Points

Maths Concepts for Young Learners

The first encounters of a young child with mathematical concepts in early childhood need to be challenging and guided through carefully thought-out activities because this is the foundation for learning mathematics in the future. The basic mathematical concepts young children face are: numbers and operations, measurement, geometry and spatial visualisation, patterns, and data analysis. These concepts are not presented in isolation, but appear as part of various maths activities. At an early age, the most important pre-maths activities include matching, comparing, classifying/sorting, patterns and symmetry, counting and measuring, as well as those based on plane shapes, solids, space and position relations (Glasnović Gracin 2013). Bringing mathematical ideas close to children through manipulatives and media is a great challenge for educators. Picturebooks belong to such materials.

Picturebooks

The picturebook is a multimodal and playful form, interactive by definition. It encourages its readers to read it in their own way and at their own pace. It also prompts multiple re-readings. The picturebook invites its audience into a dialogic process of meaning-making and rewards the special effort it requires by the joy of comprehension and accomplishment (Narančić Kovač 2015).

The picturebook conveys its contents by means of two separate semiotic modes, words and pictures, and combines them into a new artistic whole, fully intermedial and multimodal in its nature. Printed or written text always has a visual dimension (Kress and Van Leeuwen 2006, 41), and the multimodality of the visual discourse is reinforced by its potential to perform tasks and produce meanings traditionally related to language, such as storytelling and figurative language. Thus, the picturebook is multimodal in both of its discourses (Narančić Kovač 2015, 440). Being interactive and intermedial, a maths picturebook relates visual representations of mathematical concepts to their names and makes it possible for young children to adopt new ideas while playing a meaning-guessing game.

One of the prominent features of picturebook reception is re-reading, which is stimulated by the very structure of the picturebook. The need to re-read lies in the impossibility to read picturebook discourses simultaneously, and the reader needs to decide whether to read the words or pictures first on every page. The reader necessarily skips information, and the first reading is unsatisfactory and sketchy; hence the need to read the picturebook again. Lawrence Sipe explains: “As we alternate our attention between words and pictures in a picture book, [...], we may be representing the verbal and nonverbal information in separate cognitive structures; following this, through the complex referential connections between these two cognitive structures, we construct an integrated meaning” (1998: 101).

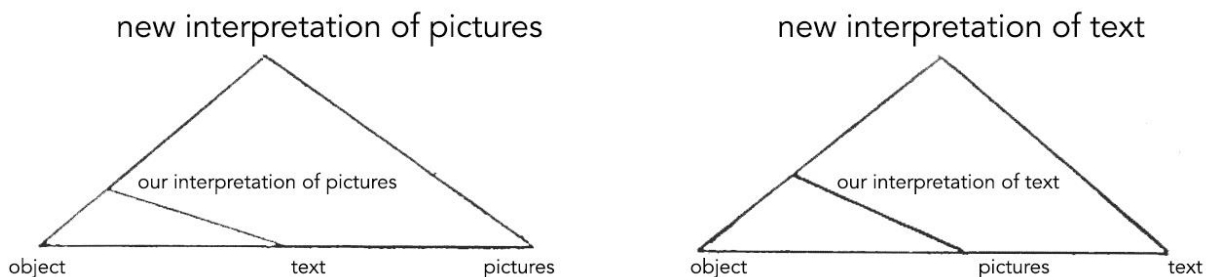


Figure 1: Sipe's combined triads in the process of transmediation in picturebooks.
Sipe 1998, 103.

Every new reading follows a new reading trajectory and relies on the information collected in previous readings. Sipe adopts the term of transmediation to describe this process, based on the semiotic triad represented as a triangle, where the peaks are: the represented object, text (or pictures) and our interpretation of text (or pictures). Thus he obtains two complex triads (Fig. 1), and explains: “When we [...] move from the sign system of the words to the sign system of the pictures, the semiotic triad with the words as representamen becomes the object of a new triad, and the interpretant for this new triad changes accordingly. [...] Conversely, when we interpret the pictures in terms of the words [...] the interpretant for this new triad changes as well” (102-103).

Further, Sipe points out: “The resulting process is a type of oscillation, as we adjust our interpretation of the pictures in terms of the words, and our interpretation of the words in terms of the pictures. And, because the meanings of the signs are always shifting (due to their adjustment and readjustment as each triad becomes the object in a new triad), this oscillation is never-ending” (1998, 103). This process is repeated as many times as the picturebook is read, and the reader’s attention shifts from words to pictures and back many times during every reading. It is possible to represent this process in a single scheme, which embraces the possibility of a “never-ending” cycle. Thus we offer a combined model of reading picturebooks (Fig. 2) based on Sipe’s model. It also shows that many re-readings take place. Picturebooks give children “the opportunity to engage in an unending process of meaning making”, and readers of picturebooks “have multiple experiences as they engage in creating new meanings and constructing new worlds” (Sipe 1998, 107). All this happens in a vivid dialogue the reader establishes with picturebook discourses.

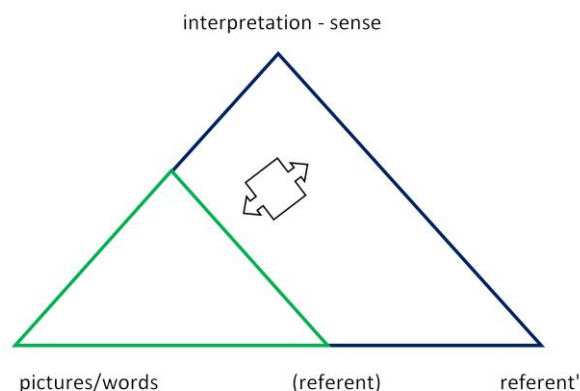


Figure 2. A combined model of transmediation in picturebooks based on Sipe’s model.

Re-reading is not only a structurally induced process characteristic of picturebooks, but it is also the typical behaviour children adopt when they encounter a story or a book they like: they ask for another reading. This makes it possible for children who explore maths picturebooks to revise newly adopted concepts over and over again, in an enjoyable and playful way, until they remember them and, finally, adopt them.

Animated Movies

Animated movies combine words, pictures and motion to convey meanings. As Donald Allen points out, “[o]ne of the more powerful enhancements to almost any teaching function is motion” (2003). This form is now available through many free online platforms. Making animated movies in the MASLIK project provides student teachers with an ability to produce materials with their future pupils and with the experience of movie-making as an efficient way of learning mathematics.

Literacy as Multiple Skills

Both picturebooks and animated movies contribute to the development of literacy skills, including visual and other forms of literacy; literacy understood as a notion “beyond the limitations of print-based concepts”, which means “reading and writing photographs, music, movies, advertising, popular culture and also printed books and magazines” (Garcia et al. 2013: 115).

This approach requires plenty of preparation by teachers, who need to combine various pieces of knowledge related to different aspects of multimodal literacy, and demonstrate a proper understanding of the learning process, of the potentials of the media involved and of the specific characteristics of young learners. They also need to recognise and respect the learning styles and interests of individual children. The regular education of teachers provides student teachers with a sound foundation for these tasks. The project MASLIK adds to this by developing their understanding of the need to introduce both mathematical-logical thinking and creativity into everyday teaching practice. It reveals the interdependence of these two aspects, because each of them is deficient without the other. There is no science without creativity and no art without basic mathematical concepts and logic.

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Procedure

The themes selected for individual projects in the first project round were basic counting skills and combining the ideas of circle and disc. The project activities were divided into four main stages: (1) establishing the content – writing a text or a script about mathematical concepts; (2) developing the form and practical work – designing the storyboard and making a picturebook/movie; (3) testing the accomplishments – piloting the picturebook/movie; (4) reflection and establishing new principles for future practice.

The first stage involved brainstorming and selection based on mathematical, instructional, literary and linguistic aspects. Students were encouraged to think about mathematical concepts, their occurrences in everyday life, and the specific relations among individual forms, such as circle and disc, in order to develop ideas and approaches to them which would be appropriate to young children. Teachers guided student teams by various questions and prompts. Selected student proposals were discussed and then modified, when needed, by students. The second stage focused on media exploration and on discovering appropriate artistic (visual or combined) expression techniques. Two picturebooks and several short movies were made.

The next stage involved primary and kindergarten children. Young learners shared their thoughts with student teachers who piloted the materials, offering invaluable feedback. Children's reactions were recorded and later submitted for qualitative analysis. The responses were extremely encouraging. Both children and their teachers adopted the picturebooks with enthusiasm. Children took the picturebooks home to share with their parents, and teachers found them a welcome enrichment of the teaching process.

In the final stage, all the participants exchanged experiences and evaluated the instructional and artistic values of the presented materials. The expert team also reflected on the process, considering its implications for teaching practice and for teacher education.

Outcomes

Two Picturebooks

The picturebook *Kako je Leo upoznao brojeve* [*How Leo Got to Know Numbers*] by Ana Marija Klarić, text, and Kristina Kalić, art¹ is based on soft sculpture, involving techniques such as sewing, embroidery and crochet (Fig. 3). The finished arrangements were photographed and prepared for publication using computer design techniques.

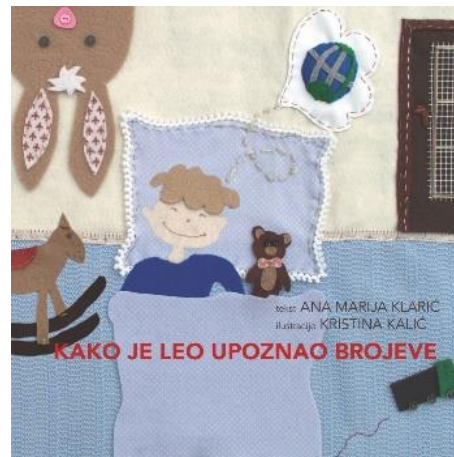


Figure 3: The front cover of *Leo*.
Klarić and Kalić 2016

The picturebook introduces and revises numbers from 1 to 10 (Fig 4), ordinal numbers and numerical words (Fig 5), develops understanding of the concept of quantity, and adding one by one (Fig 6) and encourages children to

¹ Ana Marija Klarić and Kristina Kalić. 2016. *Kako je Leo upoznao brojeve* [How Leo Got to Know Numbers]. Zagreb: Učiteljski fakultet. This is a pilot edition printed in 25 copies. The picturebook will be published soon.

practise counting (Fig 7). From the angle of teaching art, this picturebook involves designing the composition of a visual display, gaining familiarity with various techniques of illustration, and enhancing creativity as an element of competence in the field of the visual arts. In terms of art and multiple literacy skills, it is similar to the other picturebook presented here.



Figure 4: From 1 to 10.
Klarić and Kalić 2016



Figure 5: Numbers, numerical words, and revising maths concepts; two double-page spreads from *Leo*.
Klarić and Kalić 2016



Figure 6: Adding one by one. Kinds of flowers.
Klarić and Kalić 2016



Figure 7: Counting with Leo.
Klarić and Kalić 2016. Photograph taken by Vesna Marjanović.

Krug i kružnica [*The Disc and the Circle*], illustrated by Tea Nucak² (Fig. 8) explores various combinations of the two shapes in the title, inviting the reader to participate, for example, by fitting in cut-out shapes (Fig. 9). It

² Tea Nucak. 2016. *Krug i kružnica* [*The Disc and the Circle*]. Zagreb: Učiteljski fakultet. This is a pilot edition printed in 25 copies. The picturebook will be published soon. The initial idea for the picturebook was proposed by a group of students, i.e. Matea Milobara, Lucia Matas, Marijana Nikić, Sara Beljan, Viktorija Makarun, and Martina Bača.

introduces geometrical concepts, combining a mathematical approach to the disc and the circle and their presence in everyday life (Fig. 10).



Figure 8: The front cover of *The Disc and the Circle*.
Nučak 2016



Figure 9: Filling in the empty slots with cut-out discs: a flower, a frog, a cherry and an alarm clock.
Nučak 2016



Figure 10: “Using a disk and circle we can draw all kinds of things. You try, too!”
Nučak 2016

This picturebook invites interactivity in many different ways (Fig. 11) and also instigates awareness of creative freedom in expressing multiple meanings (Fig. 12). It is an example of a picturebook which tests its limitations and conventions, and activates its three-dimensional qualities, another common feature of the picturebook as a form: its basic features are “the word-picture relationship, interactivity, specific readership, the reading process, the semiotic aspects of picturebook discourses, and its existence as a three-dimensional object” (Narančić Kovač 2015: 439-440). *The Circle and the Disk* represents a picturebook as an object/sculpture, which opens up the theme of the relationship of form and content and brings the direct experience of its theme to the child reader (Fig. 13).

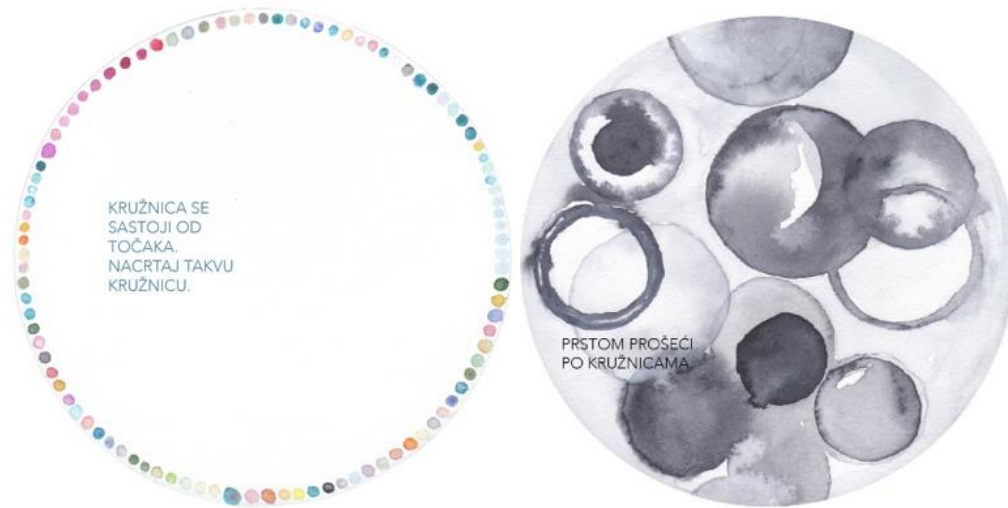


Figure 11: Interactivity; “A circle consists of points. Draw such a circle”; “Move your finger along the circles.”
Nucak 2016



Figure 12: Creative freedom and the possibility of different readings.
Nucak 2016



Figure 13: Sharing and exploring *The Disc and the Circle*. Photograph taken by Vesna Marjanović.

The Circle and the Disk in Animated Movies

A special elective course titled *Creative Approaches to Film and Video* was introduced for this segment of the project. None of the 30 students of primary education that attended it had any previous knowledge of or education in animation or movie production. The group was divided into teams of different sizes, and they produced as many movies as there were teams.

The students understood that their main goal was to facilitate the young children's process of acquiring mathematical concepts. They became acquainted with the basic principles of animation, and went through all the stages of making an animated movie, acquiring the necessary experience of working with appropriate computer programmes and using a camera and other technical equipment.

The conceptual frame was set by identifying the mathematical concepts of the disc and the circle as the main agents in the students' animations. The movies needed to help children distinguish between these two geometrical shapes, which are similar and often used interchangeably in everyday conversation. The task was to tell a story using visual language that would be close to children, using film-specific expression. Students found inspiration by studying and discussing different examples of animated movies which demonstrated various approaches and techniques. The collage technique was selected for most of their own movies.

After learning the basic principles of animation, the students made nine-picture segments for practice. Then they formed teams and brainstormed ideas and art solutions.

The teacher's guidance included hints and questions to inspire and encourage students in developing ideas, such as: How can a disk and a circle appear (e.g. traces of a cup on a table)? What would a meeting between a disk and a circle look like? Where can we spot them in our surroundings? Imagine a circle and a disc playing on a piece of paper! How can we change a disc? What happens if we put many discs (or circles) on top of one another? What would an imaginary mathematical landscape look like? Continue the story: "Once upon a time there was a circle/disc...". The next step was making storyboards (Fig. 14).

Petra Herceg US5. UTORAK 12:00

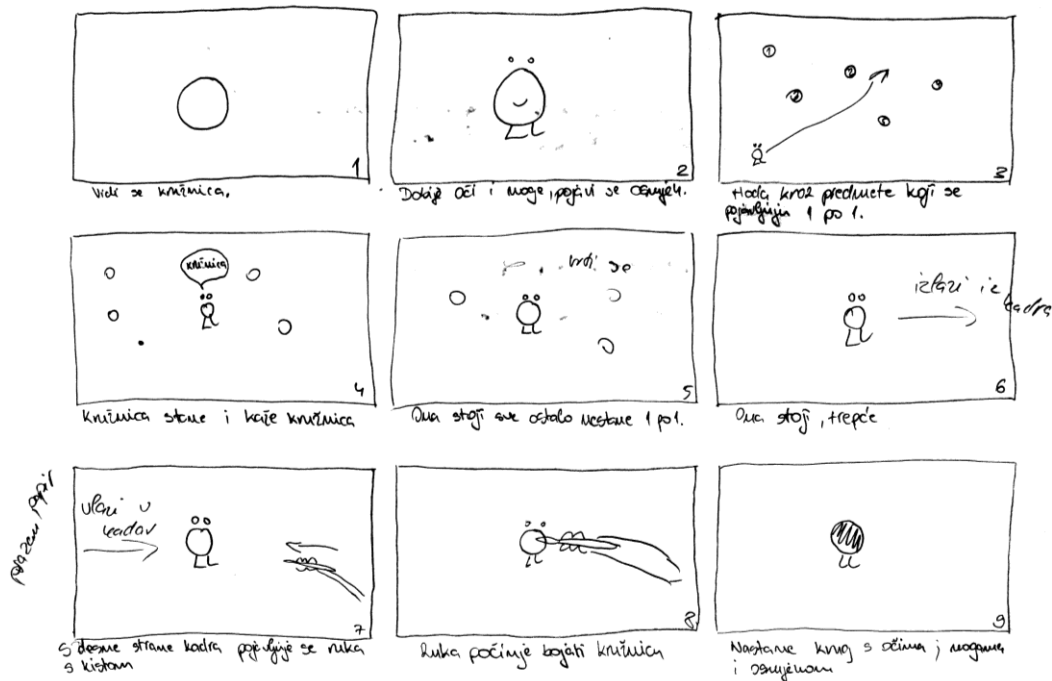


Figure 14: A storyboard section for the animated movie *Kružnica i krug* (The Circle and the Disc) by Petra Herceg, a student of primary education.

After that, student teams made individual pictures and shot them with a Canon EOS 600D camera, using Dragonframe software and lighting equipment. They selected sound and music clips and edited the movies. After the class evaluation, five selected movies were published online (http://ed2.ufzg.hr/projects/math_picture_book/)³: *Od točke do crte do kruga* [From a Dot to a Line to a Circle], *Kružnica i krug* [The Circle and the Disc], *Pizza, Krug* [The Disk], and *Vunena kružnica* [The Woollen Circle]. The movies all explore the relationship of the circle and the disc as mathematical concepts (Fig. 15). One of the movies shows how the circle and the disc transform into each other (Fig. 16) and another (Fig. 17) presents them as characters who, while sharing some adventures, reveal their distinctive features.

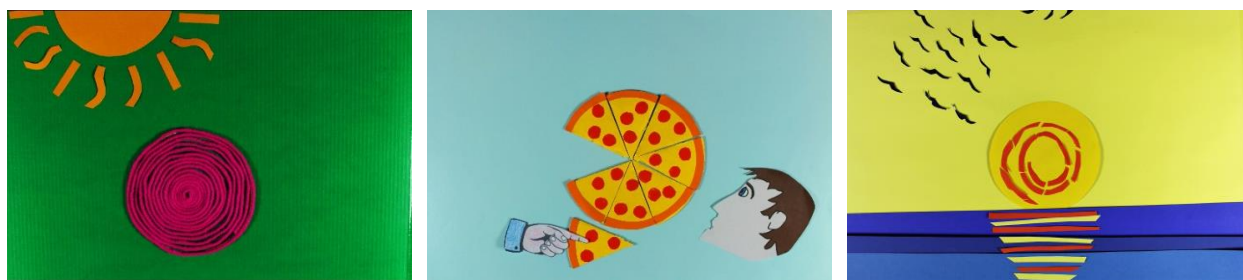


Figure 15: Screenshots from animated movies made by student teams: a disk in *The Woollen Circle*, cuts in *Pizza*, a sunset in *The Disc*.

³ Links to individual movies:

http://ed2.ufzg.hr/projects/math_picture_book/From_a_Dot_to_a_Line_to_a_Circle.mp4

http://ed2.ufzg.hr/projects/math_picture_book/The_Circle_and_the_Disc.mp4

http://ed2.ufzg.hr/projects/math_picture_book/Pizza.mp4

http://ed2.ufzg.hr/projects/math_picture_book/The_Disc.mp4

http://ed2.ufzg.hr/projects/math_picture_book/The_Woolen_Circle.mp4



Figure 16: A screenshot from *The Circle and the Disc* by Petra Herceg, edited by K. Horvat Blažinović.



Figure 17: A screenshot from *Igra (The Play)*, created by a group of students.

Once finished, the animated movies can be shared on social networks on the web or saved on personal electronic devices. In comparison to the experience of traditional movies, this new experience can be interactive. Children can manipulate the movie in time, rewind it and explore certain spots several times, connect with the characters, and even change them visually or connect their actions with different sounds, using various applications and software.

Final Remarks

Aesthetic experiences in the field of the fine arts, design and new media on the one hand, and developing literacy and helping young learners acquire mathematical concepts on the other hand, empower the student teachers in new ways. They explore possible approaches to teaching content and interdisciplinary activities, participating in the creative process and improving their own artistic and educational skills, and experiencing holistic education which supports various aspects of literacy. The MASLIK project encourages creative and divergent thinking. Students acquire the knowledge and self-confidence to produce quality didactic materials in the form of picturebooks and short animations. They also master the basics of the teaching methodology required to guide children in creating animated movies and picturebooks themselves.

Picturebooks and animated movies raise and then deepen the child's sensitivity for aesthetic experiences, refine and open the child's personality, and expand the child's general appreciation of artistic creations. They stimulate children to improve their creativity and their observation and reflection skills.

Maths picturebooks and movies bring mathematics closer to children, help them learn concepts and adopt a positive attitude towards mathematics. The project outcomes also contradict the common belief that children find mathematical concepts such as numbers or geometric shapes too difficult because of their abstract nature. Even abstract concepts become evident and concrete when turned into words, pictures, movement and sound. Multimodal materials easily attract children's interest, especially as today they are surrounded with digital technologies and new media. If children are involved with them in a proper way, both picturebooks and movies put them in the role of active co-creators, and not merely passive consumers. They contribute to children's literacy skills, and to their openness to different ways of mediating meanings. MASLIK shows that linking the world of the arts and the world of science offers many opportunities.

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Brief Bio (Max 200 words)

Antonija Balić Šimrak was born in 1969 in Patna, India. She graduated from the Department of Sculpture at the Academy of Fine Arts in Zagreb in 1992. She has had seventeen solo exhibitions at various renowned galleries. She has also participated in numerous group exhibitions in the country and abroad. She has received several awards and acknowledgements. Her work is featured in art collections in Croatia and Slovenia. Her publications include books on art and papers in the field of child artistic expression, and four picturebooks for young children. She is a founder of the Mandala Studio, an organisation focusing on education and the promotion of art in education.

Smiljana Narančić Kovač, PhD, teaches children's literature in English. She has participated in several research projects in literary studies, children's literature, and applied linguistics. She has also taken part in several interdisciplinary projects related to education. Her publications include two monographs in Croatian and chapters in *Alice in a World of Wonderlands* (2015) and *The Routledge Companion to Picturebooks* (2017). She serves as the principal investigator of the project BIBRICH on children's literature translations, funded by the Croatian Science 'Building Interdisciplinary and Intercultural Bridges: Where Practice Meets Research', www.bibacc.org

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Kristina Horvat Blažinović teaches art education and film and video courses at the Čakovec Department of the Faculty of Teacher Education, University of Zagreb. She completed the School of Animation during her secondary education and then graduated in Painting at the Academy of Fine Arts, University in Zagreb. She received an MA in Video Art from the University of Ljubljana, Slovenia. She is at present a doctoral student of Fine Arts at the University of Zagreb. Her artistic work includes pictures, three-dimensional objects, puppets, multimedia, computer graphics, video, scenography for videos, animated movies and performance. She has created several music videos.

Dubravka Glasnović Gracin, PhD, teaches Mathematics Education at the Faculty of Teacher Education, University of Zagreb. She has participated in several projects related to mathematics education (e.g. the PISA project for mathematics in Croatia, Croatian national exams for mathematics). Currently she is involved as a member of the project JobSTEM, on raising primary school children's interest in STEM school subjects (science, technology, engineering and mathematics), funded by the Croatian Science Foundation. Her publications include topics on research on mathematics textbooks. She is Editor-in-Chief of *Matematika i škola* [Mathematics and School], a professional journal for improvements in mathematics education.