

Developing Interactive Environments for Play at School with Students of Art Education

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Abstract: The paper is based on the research project *MediaArtLab@School* which deals with the support of creative media competence using hypermedia- and Mixed Reality-systems in the context of aesthetic research projects at school and university level. The project aims to support media competence which goes far beyond the pupils' familiar use of a machine that computes. The media education approach in the school scenario described in the paper, intends to mediate an understanding of the programmable algorithmic machine in an aesthetic shaping context. The pupils of the *Laboratory School of Art and Media Education* (Kunst- und Medienpädagogische Laborschule) at the UNESCO-Project School in Flensburg, Germany, an elementary and lower secondary school, work together with art students of initial teacher training at the university. The 6th graders involved in the model scenario develop, transform, programme, control and present digital and other media in an integrated way. They participate in complex shaping processes, developing interactive objects which *behave* in an overall environment for play. The school scenario described in the paper is one example of the school projects initiated in the framework of the research project. It was realised at lower secondary school.

The MediaArtLab@School-project is funded under the German "Hochschul- und Wissenschaftsprogramm," a programme of the German Bund-Länder-Commission and the Land Schleswig-Holstein. The Laboratory School of Art and Media Education is an experimental learning space bringing together initial teacher training and school practice. The project is endorsed by the International Society for Education through Arts (InSEA), the German association for media pedagogy and communication culture (GMK e.V.) as well as the German Association for Art Education (BDK e.V.)

Key words

Interactive environment for storytelling and play

Interdisciplinary project-based learning

Media literacy through programming computers in aesthetic contexts

Laboratory School of Art and Media Education

Interdisciplinary and practice-oriented teacher training

Pupils as designers and producers of digital media

Evolution of the project

The model scenario described in the following is based on the research project "MediaArtLab@School - Creative Media Competence with Hypermedia and Mixed Reality-Systems in the Framework of Aesthetic Research Projects at School and University" which is funded under the research programme Hochschul- und Wissenschaftsprogramm (HWP) of the German Bund-Länder-Commission and the Land Schleswig-Holstein. The project is co-ordinated by the department of Department of Visual Arts at the Institute of Aesthetic and Cultural Education (Prof. Dr. Manfred Blohm, Dr. Daniela Reimann). It is realised in co-operation with the UNESCO-Project School Flensburg¹ in co-operation with the art teacher Eva Heim. The MediaArtLab@School project is co-operating with the Institute for Multimedia and Interactive Systems at the University of Lübeck and the co-operation project project "Kids in Media and Motion". The project aims to link aesthetic strategies to the creative use of interactive media and Mixed Reality systems in an innovative art and media education.

Rather than teaching computer applying skills, the project's approach is looking at learning processes which are based on a differentiated perception, use and reflection of computers and digital media technologies and their specific added opportunities as interactive media. In the project, the following fields in the area of digital media systems were identified:

- Interactive 3D-Worlds (VR) and identities (avatars) in extended communication spaces/ Mixed Reality-game design
- Hypermedia storytelling
- Programming interactive systems with microcomputers (sensor-based systems) as well as interactive environments for play
- Mobile systems in media art education (using handheld devices/PDA/GPS systems) for mapping context in the framework of aesthetic projects and learning)

The school scenario described in the following is placed in the area of programming interactive systems in a Mixed Reality²-environment for play. The project aims to support media competence which goes beyond the pupils' familiar use of a machine that computes. The media education approach intends to mediate an understanding of the programmable algorithmic machine in an overall aesthetic shaping context. It was realized at the *Laboratory School of Art and Media Education* (Kunst- und Medienpädagogische Laborschule) at the UNESCO-Project School³. The pupils involved in the project were tutored by students of art education in the framework of initial teacher training at the university. It deals with the development of an interactive environment which was designed and programmed by the pupils themselves – 6th graders at lower secondary part of the UNESCO-Project School. The model project intends to bring together the programming of computers by the school kids in the context of aesthetic research processes integrating body performance through acting in an overall concept of play.

Rather than simply using multimedia applications for art education, the pupils are asked to develop their own storytelling-environment including the programming of the interactive elements, which were designed co-operatively by the kids. During the whole project the pupils were tutored by students of art education initial teacher training. From an education perspective, the complex project-based learning and shaping processes are crossing the borders of curricula and integrate different subjects such as art, design, computer science and play.

¹ An elementary and lower secondary school

² The originally technical term of Mixed Reality which stems from computer science is defined in a wider sense of augmentation of the physical space integration a variety of dimensions, such as imagination, and other virtual dimensions of human life (cp. Reimann, D.; Winkler, T.; Herzog, M.; Höpel, I., 2003)

³ It was initiated by Manfred Blohm, professor of art education at the University of Flensburg, Germany.

Aims and objectives of the model scenario

The project intends to embed the computer into the art education processes by integrating new extended human-machine interfaces as such implemented in the Tangible Media. The latter allow for a more natural and bodily interaction with the (micro)computer which can be graspable, wireless, mobile and shapable. The environment itself becomes the tangible interface to communicate with the computer. The project aims to mediate the computer as a programmable machine rather than a static and closed system. The media literacy to be achieved by the pupils is defined to go beyond the software applying skills usually taught at school, targeted on a simple familiarity with a machine that computes. Art education and complex interdisciplinary shaping processes are used as a didactic tool to make the pupils explore the black box of the computer from the inside and to look behind the screen. Furthermore, the iconic programming is perceived as a part of the creative process which allows to model behaviour and to control robotic systems. As he works by Druin and Handler (2000) have shown, the development of robotic toys such as emotional robots of their imagination was proved a good means to get them involved in programming.

Research interest and methodology

The research interest is focused on innovative education scenarios to link digital media technologies to art education in order to mediate an understanding of the algorithmic machine in an aesthetic context. Its aim is to facilitate the development of media skills based on an understanding of the programmable computer. The qualitative research approach is based on the school scenarios developed, realised and reflected in co-operation with students, teacher, pupils, as well as researchers in the framework of the research project.

The formative accompanying evaluation shaped the whole process of the project. An active and participative observation of the lessons⁴ in terms of the direct and personnel supervision of the pupils was realised by the students and researcher who provided both aesthetic advice and technical support. The participative observation of the lessons was coined by active support rather than passive observation in the traditional sense. The issues to observe included the handling and the use of the given digital and non digital tools as well as the communication, collaboration and the overall motivation of the pupils to be perceived in the project when designing and testing interactive systems of their imagination.

The participation of the lessons was amended by semi-structured group interviews after the project. Interview areas were addressing the perception and reflection of the project in order to bear in remembrance concerning the iconic programming tool.

The software used

The project was based on an iconic programming tool of the LEGO® Mindstorms group. (Robolab Inventor) The software allows for visualizing the programme developed on the desktop, that is, the programme is represented by icons and developed by the drag-and-drop-technique rather than on a text (code) basis of the traditional programming languages. The didactic approach of the software development is based on constructivist pedagogy and Seymour Papert's work Mindstorms (1982) and the LOGO® software. However, the software used in the project contains a complex programming system for the development of interactive systems by programming microcomputers (LEGO® RCX, see fig. 13, 14), sensors identifying e. g. haptic click pressure and actuators such as motors, lights and sounds (s. fig. 14).

⁴ Translation of the German term *Teilnehmende Unterrichtsbeobachtung*

Developing and programming behaviour of interactive

The shaping of the interactive environment for play includes the development and reflection of sensor- and actuator-based system development. Feed-back concepts are reflected using different sensors for input (e.g. pressure, intensity of light) as well as output modalities (blinking lights, sounds, rotation of an engine and the like). Such elements are programmed by the kids themselves and reflected in a wider context of a story embedded in as scenery for acting and play. Programming the microcomputers allows the kids for controlling robotic elements and the development of some kind of *robotic toys* (cp. Patten, J.; Griffith, L.; Ishii, H., 2000) for drama.



Fig. 1 Carbots build with microcomputers (LEGO® RCX)



Fig. 2 Program developed by the pupils (iconic programming realised with LEGO® Robolab)



Fig. 2 Two girls drawing the main elements of the story



Fig. 3 Photos of the under water world are shown to the pupils for inspiration purposes

The subject of arts constitutes the link to shaping processes with any media available for the design, such as traditional materials and classic design activities. Apart from building objects, and selecting the forms as well as the colours, the kids developed high and low-tech objects and artefacts, prototypes which *behaved* in specific ways, that is, the pupils were modelling the behaviour of interactive objects. The kids developed robotic conceptions embedded in an overall environment for story telling equipped according to their imagination by using and bringing together a variety of media, with the programming and controlling of robotic elements.



Fig. 4 Developing and painting objects (fish models)



Fig. 5 The space shuttle is developed

The work processed contained a variety of complex activities carried out by the pupils themselves in three thematic working groups 8 (as shown in fig. 4-6). They firstly were introduced to the issue of programming motion as an overall process of activity guidance⁵. Therefore the art work entitled “Lauf der Dinge” (the tide) by Fischli und Weiss (1987) which addresses the issue of chain reaction was shown on video tape.

The first main activities were centered on the development of a story for play based on the drawings as well as on short texts of the pupils.

In the following part the children developed and painted the stage elements from pasted board and paper-mâché and wire (as shown in fig.4, 15). After that, the possibilities of the hard and software⁶ as well as input and output modalities such as sensors for identifying pressure (haptic click), or the intensity of light as well as actuators such as engine rotation, light, and sound, were introduced. In the objects which were to become interactive a microcomputer was integrated. Further, the sounds to be integrated in the play were produced and selected by means of the software *Environs*. The overall story consisted of three parts: The space shuttle, the new planet discovered and its' under water world. All such scenes were linked to each other by the off tone speaker.



Fig. 6 Objects made out of paper-mâché



Fig. 7 Practicing the drama in the presentation room

⁵ Translated from the German term of *Handlungsanweisungen*

⁶ Based on the LEGO® Mindstorms.

Fig. 8 Activities of pupils in the interactive environment for play

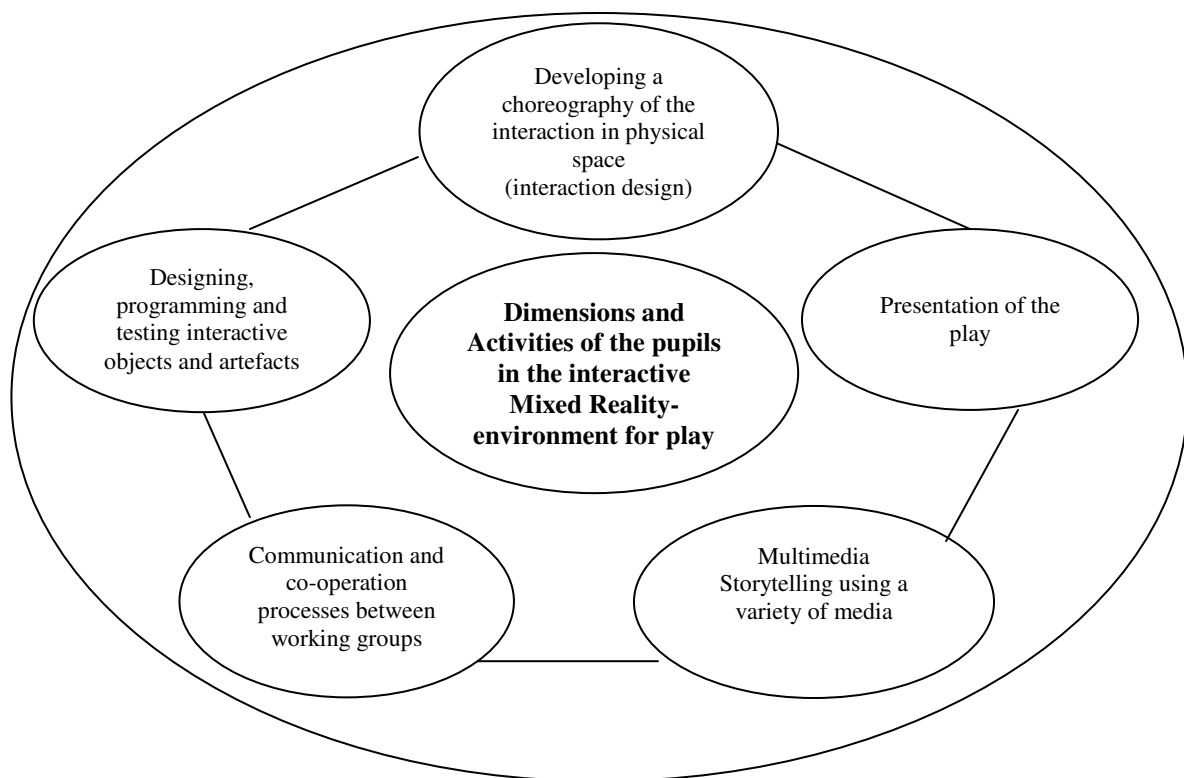




Fig. 9 Drawing the underlying story of the play



Fig.10 Presenting the ideas of the working groups



Fig. 11 Developing objects using paper-mâché



Fig. 12 Painting for the scenery



Fig. 13 The alien is build using a static dragon toy



Fig. 14 The microcomputer makes the alien get two blinking eyes

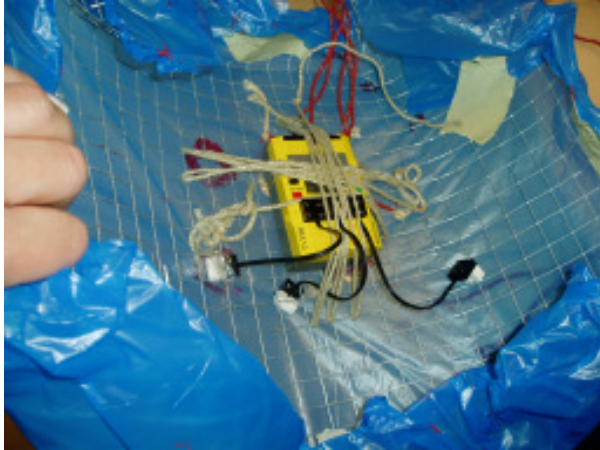


Fig. 15 Lightening jellyfishes are supposed to show the kids the way out of the danger in the underwater world



Fig. 16 During the presentation pupils follow the interactive and multi media elements of the story



Fig. 17 Moving mussel built with a microcomputer inside



Fig. 18 Programmed mussel with implemented microcomputer on wheels inside, is moving in the underwater world

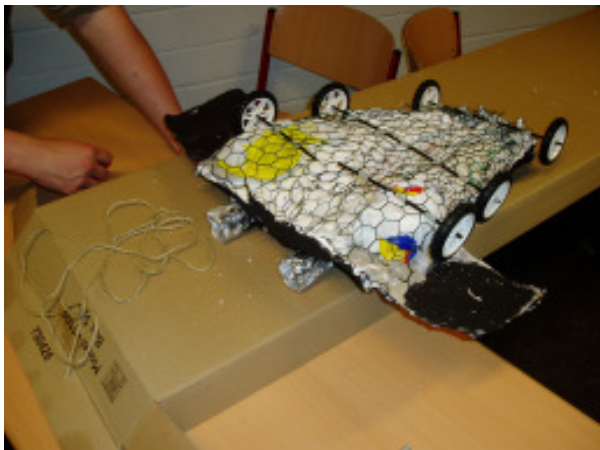


Fig. 19: Prototype of space ship is equipped with a micro computer



Fig. 20: Spaceship was supposed to be controlled by a computer during the presentation



Fig. 21 Painting elements for the scenery



Fig. 22 Models of fishes for the underwater world



Fig. 23 Academic tutors are responsible for a working group



Fig. 24 The environment has been equipped with the objects



Fig. 25 Developing and recording sounds



Fig. 26 Working with in the Mixed Reality environment

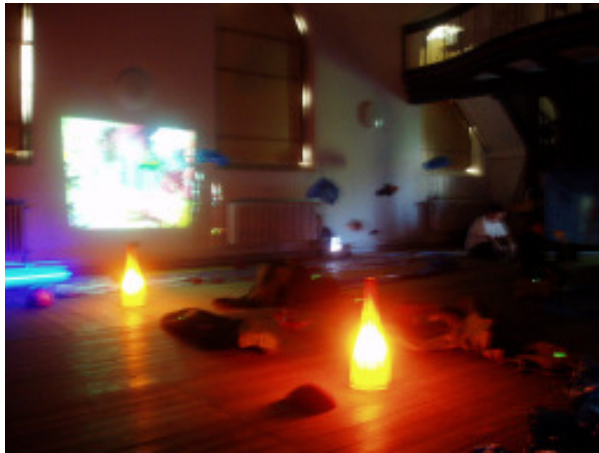


Fig. 27 The Mixed reality environment during the presentation

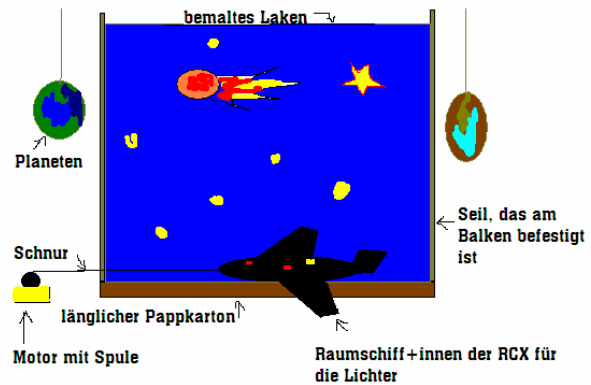


Fig. 28 Technical drawing of the functionality of the space shuttle

Competences and skills gained in integrated media art education

In the project, the pupils gained a variety of competences and skills in the framework of the different activities. The Mixed Reality environment for play developed, realised and tested with the 6th graders⁷ was proved a good context for children's motivation to learn by developing interactive systems of their imagination. During the project, all children had carried out a variety of activities such as the design, development and programming and testing of the robotic objects. They developed specific strategies of hiding and implementing microcomputers inside of their self-made stage elements, which behaved according to the programme developed by the kids. A variety of competences and skills which the pupils had to develop and apply in the complex shaping processes by developing digital models for the interactive objects, can be identified: During the project, the pupils were exposed to basic principles of prototyping on both the aesthetic and the engineering level. They had to promote an interest in logic thinking when programming the interactive systems as well as they had to develop ideas for realizing the aesthetic appearance of their objects. From an education point of view, the letter shows the integrated character of the interdisciplinary education scenario, bringing together arts, design as well as computer science and engineering in an overall holistic aesthetic project context. It was realized without inventing a hierarchic order of the disciplines.⁸ The kids had to initiate awareness concerning the basic elements of programming and controlling computers and had to develop programming skills by using an iconic programming tool. By testing the programmes and prototypes realized, the children had to develop problem solving skills, as most programmes would not work in the first run. In this

⁷ The time frame of 6 weeks with a weekly amount of two lessons of 45 Minutes as well as one project week of 4 hours a day was perceived as being too less time. At least half a school year was considered to work well by the students, teacher and researcher involved.

⁸ As usually know from school practice with the hierarchy between subjects of natural sciences and human science.

context the importance of bugs of the programmed algorithms can be highlighted (cp. Papert, 1982). The more bugs the children have to solve the more they have to, the more they have to look into the programme. The problem solving skills were developed in team and communication processes inside of a team as well as between the working groups.

In the following a list of activities of the pupils as well as issues for learning are presented:

Table

Activities of the pupils	What the pupils learn
Developing a story in the thematic field of “worlds of the future”	Pupils are asked to develop and express their ideas and imagination
Drawing the main elements of the story to be developed	Visual expression skills are sharpened
Inventing an overall idea of the appearance of the environment (under water world, planet, space shuttle)	Transforming knowledge of single areas to an overall whole which is integration the different fields
Inventing prototypes (interactive objects) on the level of <ul style="list-style-type: none"> • aesthetic appearance • programming • engineering principles 	Basic awareness and skills in computer programming (how does the machine work) Shaping skills Engineering skills Problem solving skills (after testing the programmes as well as the prototype) realised through teamwork and communication processes about the object
Developing an interaction design and choreography for the play.	Experiencing the issue of choreography in a play
Getting familiar with the software/ Modelling behaviour and programming motion of interactive elements Controlling robotic systems	<ul style="list-style-type: none"> • Getting an understanding of the characteristics of programmed interactive media which are programmable • Exploring the magic black box of the computer as a programmed and programmable machine
Developing and recording sounds for the play	Exploring the computer as a tool for recording self made sounds
Linking different sorts of media to an overall concept of play and acting	Developing an understanding of the different characteristics of the media
Writing a text to be read during the presentation (text for off tone speaker).	Developing further the writing and reading skills.
Communication processes about the shape of the play between working groups	Social skills by co-operating and exchanging with others

The programming to instruct micro computers and to develop three-dimensional prototypes of interactive nature which *behave*, includes the development of skills linked to computer science such as modelling as well as aesthetic thinking and acting. Such skills can be applied in the project context in an integrated and holistic way. Neither the shaping of physical objects and materials, nor the development of robotic programmes are seen or mediated separately from each other. They are brought together in the aesthetic project context. In the learning and design processes, the prototypes became a tool for communication and can be perceived as objects stimulating discussion and reflection between the kids. They discussed the design and engineering issues realised by verifying the appearance and behaviour of their self-made objects.

As shown in the table above, a variety of activities have been carried out by the pupils in the framework of the project. Media competence⁹ became a key word in the context of educational goals to aspire to. The definition in this paper is based on the integration of aesthetic and computer science skills (cp. Reimann, D, 2006). In the project, such term is defined in the framework of facilitating expertise to perceive, reflect, shape, transform, and present the digital media in a choreographic context through the design, production and combination of media, actors and stage elements.

Rather than reducing the focus on the pupils' competences to handle the software tool and its functionalities familiarly, the kids experienced the constructability of the interactive media through the active design processes on both the aesthetic construction level as well as on the programming level. Programming and controlling robotic systems imply the opportunity to immediately test the programmes developed, which are applied in physical environment. The latter can be identified as a main driver of motivation for the kids.

During the project, the technical skills in handling the software were not perceived as an educational goal, rather than a basic means to creatively use the software tool in order to construct and shape the digital media in a Mixed Reality context for play. The pupils were asked to help others and explain the functionalities of the software to them.

Students of art education as academic tutors

The project *worlds of the future* developed was realized by linking a seminar at university level to school lessons. It was developed with students of art education. The students had to achieve programming skills as well as the didactic concepts to mediate such competences to the pupils in the context of design processes during the art lessons.

⁹ The translation of the German term "Medienkompetenz" is media skills rather than media competence as the term skill implied a higher level of expertise than the term competence does.

The students were asked to develop a specific didactic for mediating the iconic programming tool. The students developed expertise in programming with the software and became academic tutors responsible for a particular working group. The students had to plan, prepare and realise the lessons at school in the framework of a more practice-oriented initial teacher training approach realised at the Laboratory School of Art and Media Education.

In terms of initial and further teacher training, the project has shown that an innovative media art education has to respond to both the technological developments and their impact on learning. Media Art Education has to critically test digital media and link it to artistic strategies as well as other media and communication processes of any kind.

Responsive media art education in the 21 century

In the model scenario described, art education is becoming a key for interdisciplinary shaping processes realised and communicated by the pupils themselves. Responsive art education has to open up towards the digital technologies in order to examine, test and critically reflect its potential for learning and art education as well as their effects and side effects. Art education addresses the sensory perception as well as it reflects the different media to be used, exploring the characteristics of a particular medium which can be programmed. What are the specific opportunities opening up using the digital, programmed media? How can the programmed media get mediated as programmable rather than black boxes? How can they get embedded in traditional techniques used in arts and education? An integrated art and media education links together the disciplines involved in digitalisation such as computer science, engineering, design as well as the arts. An innovative media art education has to integrate interaction design and new extended interface cultures, such as Tangible Media and acoustic interfaces. Digital technologies are ubiquitous and grow in an enormous speed. However, the kids of today have to get prepared to shape and understand the nature the digital, media technologies. Art education processes can help making them active designers rather than passive users of technologies.

Apart from researching new software tools to support creative processes to shape technology rather than simply using edutainment applications and the like, an innovative media art education has to open up and build links not only to the area of arts such as performance, play and music but towards other disciplines concerned with media and technology, such as computer science. The latter allows for a subject crossing and interdisciplinary approach to learning about the characteristics of the interactive media.

From a media education point of view, the pedagogy of media art has to respond to the technical skills of the pupils and link it to aesthetic projects which allow for applying such skills in a creative context. The art and media educator has to facilitate processes of communication and co-operation to make the pupils share meanings and design content and scenarios for play by themselves. Supporting the development of software applying skills can not be seen as an end in itself. We have entered a further phase of the media age which includes the differentiation of media skills and educational goals to aspire to.

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