Creating digital augmented multisensual learning spaces
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Transdisziplinary education at school between aesthetic creating and building concepts in computer science

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Abstract

This paper is about the rehabilitation of aesthetics in the context of teaching computer science at school. It explains how interdisciplinary, digitally extended learn-environments can be created with the help of free or low cost applications; these learning environments focus especially on the idea that sensorial perceptions and co-construction of knowledge should be an integrated part of a creative learning process.

1   Introduction

Although more and more learn-media manufacturers appeal to constructive components, one of the most important moments in constructive oriented pedagogy is lost from site: the importance that complex sensorial perceptions and co-operation in real physical world have in the learning process.

A creative, collaborative learning which involves all senses, even when the process is digital media supported and computer science teaching oriented, constitutes the linchpin in the *ArtDeCom*[1] project, in which the authors of this paper are involved.

One of the seven teaching experiments of the last 1½ years, in the ArtDeCom project will be used as an example here. The teaching experiments try, in different approaches, to create a digitally enriched learn-environment where teaching goes beyond subject segmentation. In a eighth grade of a Comprehensive School children created a 3D hybrid space which they could all enter together. In this space 3D real/physical objects can be found as well as 3D virtual objects, embedded in and projected with self constructed 3D virtual spaces *in* real/pysical space.

Although the hybrid spaces are extremely complex, we worked on extreme low cost level; we succeeded doing that mainly by using freeware and otherwise using low cost materials.

Working with the interfaces between the real and the digital world was especially picked out as a central theme; this work included observing and reflecting about the interaction between children and computers in the real space and in the digital space as well as in the interfaces between the digital and the real space.

Because the linking of real/physical worlds with digital ones has a growing importance in all domains of human activity, in our opinion, the pedagogical orientation towards comprehending and decision making in aesthetics (self creation) as well as in computer science (self programming) is very important for us.

We think that introducing digital media in teaching should not be reduced to engrafting of digital technology in the different courses. Under no means should it lead to students solving assignments following obsolete learning patterns. Teaching, especially if supported by digital media, should be perceived as co-construction of inter-subjective reality. In this co-constructive process the models existent in computer science can be used as a teaching ground for interdisciplinary courses in sensual, aesthetical, practical oriented context.

2 Misunderstanding of constructive pedagogy – especially in the context of using digital media in the learning process

2.1 Constructivism and Senses

Already during the pedagogy reform in the 1920's (Piaget)[2] and in the new pedagogy reform after 1968 (especially Beck and Wellershof)[3] a new definition for the use of our multitude of senses in the learning process was born. Our understanding of constructive pedagogy theories begins here.

However the poor constructivism reception not only in pedagogy, but also and more in pedagogical tools which imply the use of digital media is a big problem. Constructivism is mainly reduced to cognition theory considerations. This is evident when we analyze the computer dominating input devices: keyboard and mouse. The results of the actions performed by the user through these devices are usually rendered on the screen (sometimes additional through speakers or earphones). But the screen lets us experience the world as spectators. That what we see behind the screen's glass is an allegory of the world and it is not something that we experience in the middle of the world with our body. After all the input devices (keyboards and screens) are descendants of the analogue media and of the world seen through the Cartesian system: the typewriter with the linear codes of written language and the framed Picture of an opposite world.

The important thing is though the correlation to the „*Aisthesis*": the senses and the perceptions and the actual experience that one has, as handler, in the middle of the physical world.

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[2] Piaget, J. (1975): *Das Erwachen der Intelligenz beim Kinde*, Stuttgart.

[3] Beck, J. / Wellershof, H. (1989): *SinnesWandel. Die Sinne und die Dinge im Unterricht*. Frankfurt/M.

The perception of an active handling process was already accentuated by phenomenologist *Merleau-Ponty*[4] and the constructivists *Maturana* and *Varela* later formulated it in their most important work[5] *"Each act is acknowledging and each acknowledgment is acting"*.

2.2 Linking aesthetical experience and construction of models in pedagogical context

The programs that are usually installed on our computers segment our experiences and reconstruct them for a narrowed clearly delimitated purpose. Most learning software (which limits to the traditional input and output devices) falls back on obsolete pedagogic methods, like frontal instruction (chalk and talk), external motivation and working by oneself. Even the more experience orientated game software usually reduces us to "the ones who sit in front of the computer". As such we training the same behaviour pattern over and over which is characterized through a lack of independence and therefore a pedagogically narrowed one. This is also the reason why we focus on aisthesis, the sensual perception in ArtDeCom.

The pedagogical approach described here is therefore a consequence of the critical constructive oriented pedagogy as represented in Germany by Michael Göhlich[6] or - more specifically, in relation with the use of new digital media in teaching – in the USA by Seymour Papert[7] and Mitchel Resnick.[8] What they all have in common is the special attention they give to the aisthetic (physical perception) and of the creative deed in the learning process (especially in what abstract informatics model construction is concerned).

Following their approach, we assume that self education of informatics competencies, as we know it today, is much better accompanied by self handling of the concepts in a real context. This is how the children themselves created digitally enriched, real-physical 3D rooms based on creative-artistic criteria. In these rooms, they have at their disposal a set of different computer interfaces which support the use of our natural senses in order to achieve learning in group interaction.

We also denominate these rooms as Mixed Reality Learning Environments. Let us first see how 3D interactive rooms (for learning purposes also) look like.

Wir bezeichnen diese Räume auch als Mixed Reality Learning Environments. Doch schauen wir uns zunächst einmal an, wie interaktive 3D-Räume (auch für Lernzwecke) andernorts aussehen..

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[4] Merleau-Ponty, M. (1966): *Phänomenologie der Wahrnehmung*, Berlin.

[5] Maturana, H. / Varela, F. (1990): *Der Baum der Erkenntnis*, Bonn.

[6] Göhlich, M. (1996): *Konstruktivismus und Sinneswandel in der Pädagigik*. In: *Aisthesis/Ästhetik – Zwischen Wahrnehmung und Bewusstsein*. Weinheim.

[7] Papert, S. (1990): *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books.

[8] Resnik, M., Berg, R., Eisenberg, M, Turkle, S., and Martin, F. (1999): *Beyond Black Boxes: Bringing transparency and aesthetiks back to scientific investigation*. International Jurnal of the Learning Sciences.

3   Creating digital 3D spaces for educational purposes

3.1   CAVE-Technologie in pedagogical context

The CAVE-Technology is fascinating: it gives the possibility to connect the user with the interactive, digitally produced, 3D worlds.

In the pedagogical context a set of problems reveal themselves.

- The CAVE-technology is very costly. Besides the cost of the IT-specialists who have to program the projection, the user must usually wear some technical equipment, like stereo-glasses or a data-glove, sometimes even more uncomfortable, a head mounted display

- One of the first steps towards an interface that does not molest the user in such a way and that will allow interactive access for more than one person is, for example, users wearing caps; these would be detected by an infrared based device which could, this way, identify users' positions and movement. The system can create than an interactive projection on the floor which can so be controlled by the users, just like in the Animax in Bonn[9].

- Both methods have an important deficiency, seen especially from the point of view of a responsible pedagogue: usually the user only follows a program with a predetermined outcome. Not him, but others are the creators of the application which is used by a single user. The technology he uses remains unknown to him – it remains unreachable in the black box of the computer which creates the outcome for the user in an unexplainable way.

3.2   Interactive, pedagogically valuable 3D experience rooms, beyond costly and strange technology

We set out from this critique points and we want to show:

- that the use of digital technologies for introducing interactive, hybrid rooms is also possible with little effort and expenses and that it must not include the use of top digital technology;

- that the use of "natural" interfaces is possible and that these interfaces come close to communication and handling situations;

- that the technical system can be brought closer to the user in this way, so that they can understand it and they can use it to create their own creative playroom, in which they learn how to interact with the system in order to program it themselves.

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[9] *FX Factory Interactive installation for children.* A project of the Bonn Development Workshop for Computer Media in connection with the intention of establishing the model MEET (Multimedial Theater Education Environments). (2002), see: http://www.animax.de/animax_web/fxfactiry02_eng.htm

4 Learning collaboratively in hybrid space at low cost

4.1 Freeware for creating immersive environments

It is very amazing, that excellent applications for creating immersive 3D spaces by students himself, are free for download in the InterNet.

With the freeware PhotoModeler Lite you can create 3D models of real-world objects and scenes through the use of photographs simply and easily.
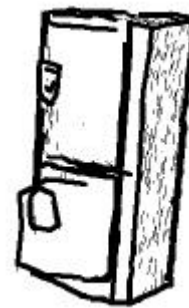

Figure 1: Digital 3D model
made with FotoModeler Lite

Figure 2: Digital 3D drawing made with Teddy

With the sketch-based 3D modelling freeware "Teddy"[10] you can create 3D models by drawing several 2D freeform strokes interactively Teddy automatically constructs plausible 3D polygonal surfaces.

And with the freeware "chameleon"[11] or "Alice Paint" you can paint these 3D models.

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[10] Takeo Igarashi, Satoshi Matsuoka, Hidehiko Tanaka (1999): *Teddy: A Sketching Interface for 3D Freeform Design* ACM SIGGRAPH'99, Los Angels, 1999, pp.409-416

[11] Takeo Igarashi, Dennis Cosgrove (2001): *Adaptive Unwrapping for Interactive Texture Painting*. 2001 ACM Symposium on Interactive 3D Graphics, I3D2001, Research Triangle Park, NC , March 19-21, 2001.
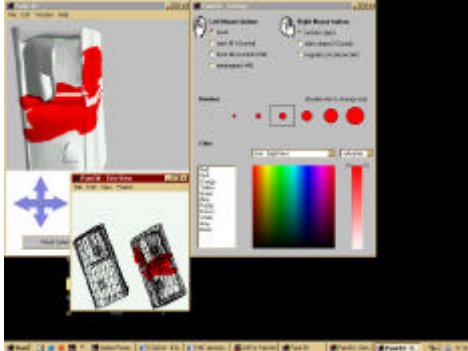
Figure 3: Painting a 3D model with Alice Paint

Figure 4: Converting a 3D model with the Viewpoint Builder

Then you create an immersive environment that offer 3D spaces with Adobe's *Atmosphere Builder*. Atmosphere permits you the import of 3D viewpoint objects, converted with the freeware *Viewpoint Builder*. These objects and other objects created with Atmosphere can be animated with movement or sound by means of JAVA-script within self created Atmosphere 3D spaces for publishing in the InterNet.
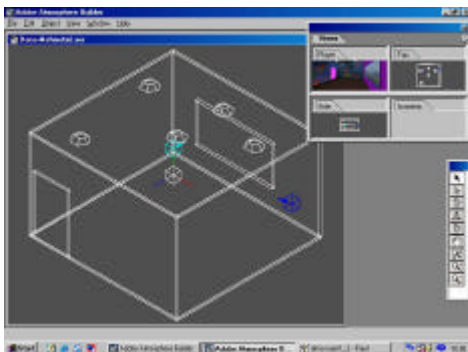

Figure 5: Building a 3D space for the InterNet with Atmosphere

Figure 6: Imported viewpoint objects in Atmosphere

Finally the students can enter together these co-operative created digital space. For this purpose they can incorporate the form of avatars, which they created by themselves after their image or freely by their fantasy.
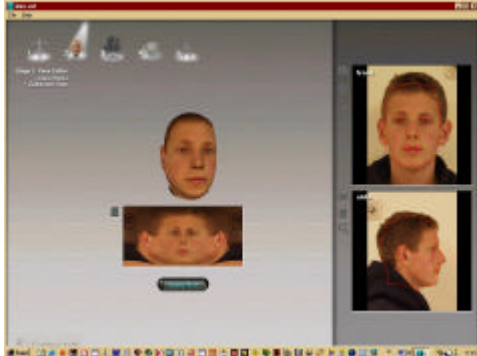
Figure 7: Creating an avatar of his own appearance with AvatarLab

Figure 8: Assigning gestures for communication

4.2   Self made hybrid Spaces in School

Taken only in itself, the work with the here presented digital tools and their combination already represents a new challenge. But our work it is not only heading for combining the singular applications. On the one hand it is the necessary *relation to real objects within the process of production.* And on the other it *turns* the projection of the *virtual InterNet space back into the real/physical space*. This use of the digital in the physical augments first of all the individual possibilities offered by these digital tools giving a total larger than the simple sum of the elements. This way an immersive, out reaching hybrid room of high pedagogical value is created.
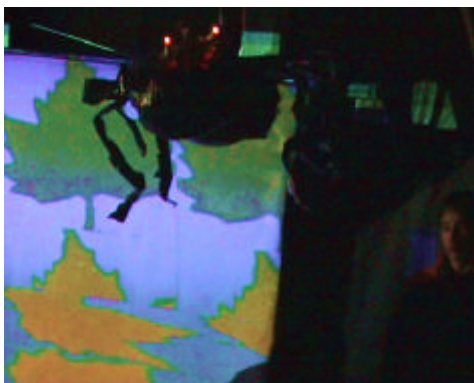

Figure 9: Seized by sensors of a microcomputer hidden in a real object (spider), a student causes the movement of this object

Figure 10: Projection rehearses in the hybrid space

- With the use of image recognition software from the *LEGO-Mindstorms®*, the interface between reality and the digital world is picket out as a central theme in the *interaction between the children and the computers* in the real room.

- The projection of InterNet world created with *Atmosphere* (among other things including 3D objects created out of digitalized photos using *Photo Modeler Lite* and digitally drawn objects using *Teddy*) has as central theme the *difference* between digital and physical world *behaviors*.

- *Verbal* and *gesture communication* using avatars (programmed in JAVA-script) has as central theme new digital means of communication via Internet.

- Because the 3D Internet world and the possibilities to communicate appear again *as projection within the real space* with real objects of digital models, the central theme here is the possibility of the *extension of the reality* by digital means in the physic world.

The central point of our project is the fact that children build de facto hybrid spaces themselves. They do this using freeware and/or low cost applications and creating the digital objects and models, again, themselves.

Figure 10: Students in a projection of an InterNet space

Figure 11: Real, 3D objects as master and point of reference for digital models in the Mixed Reality environment

5   Conclusions

The focus on sensuality and perception has far reaching consequences, especially for the digitally supported learning: these promising teaching attempts clearly show that learning by digital means is fascinating for the children and, at the same time, eased when multisensual, natural interfaces are used. Deep understanding of highly abstract relationships can be promoted through the direct connecting of program code and sensorial input respectively system output.

Returning to the senses and natural perceptions as ground for experience oriented learning makes learning a creative process and connects it to natural forms of communication and cooperation. This is what co-constructivism means from the point of view of constructivist pedagogical theories.

Besides co-construction of knowledge, working in projects near to real life makes students learn reading, writing and calculation as well as sense of independence, teamwork, sensibility and the ability to express oneself; these are all important pedagogical goals.

The advantage of using freeware and low cost applications is not only ideal for the low budgets existent in schools but it also offers the possibility of creative, independent use of digital technologies. An very important consequence is that the children grasp the essence of digital media.

Figure 12: Visitors in an interactive hybrid environment

Acknowledgements

References

Beck, J. / Wellershof, H. (1989): *SinnesWandel. Die Sinne und die Dinge im Unterricht*. Frankfurt/M.

Göhlich, M. (1996): *Konstruktivismus und Sinneswandel in der Pädagigik*. In: *Aisthesis/Ästhetik – Zwischen Wahrnehmung und Bewusstsein*. Weinheim.

Merleau-Ponty, M. (1966): *Phänomenologie der Wahrnehmung*, Berlin.

Maturana, H. / Varela, F. (1990): *Der Baum der Erkenntnis*, Bonn

Papert, S. (1990): *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books.

Piaget, J. (1975): *Das Erwachen der Intelligenz beim Kinde*, Stuttgart.

Resnik, M., Berg, R., Eisenberg, M, Turkle, S., and Martin, F. (1999): *Beyond Black Boxes: Bringing transparency and aesthetiks back to scientific investigation*. International Jurnal of the Learning Sciences.

Takeo Igarashi, Satoshi Matsuoka, Hidehiko Tanaka (1999): *Teddy: A Sketching Interface for 3D Freeform Design* ACM SIGGRAPH'99, Los Angels, 1999, pp.409-416

Takeo Igarashi, Dennis Cosgrove (2001): *Adaptive Unwrapping for Interactive Texture Painting*. 2001 ACM Symposium on Interactive 3D Graphics, I3D2001, Research Triangle Park, NC , March 19-21, 2001.

FX Factory Interactive installation for children. A project of the Bonn Development Workshop for Computer Media in connection with the intention of establishing the model MEET (Multimedial Theater Education Environments, 2002). URL: http://www.animax.de/animax_web/fxfactiry02_eng.htm

All pictures, except the one referring to the PhotoModeler Lite software, show aspects of an teaching attempt by ArtDeCom with eight grade students at the German comprehensive school *Integrierte Gesamtschule Schlutup* in Lübeck.

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