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Evaluation of a Mixed-Reality and High Interaction Media Project in the Classroom: Strategies and Methods

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Abstract: The procurement of media literacy is an educational challenge that has to be met in order to cope successfully with the prevailing complex technological social reality. Pedagogical approaches concerning the implementation of digital technologies in the classroom require careful and continuous evaluation. The present paper introduces the "Kids in Media and Motion" (KiMM) Initiative, an ongoing research and knowledge transfer project at the University of Luebeck, Germany. It promotes an innovative approach concerning the use of digital technologies in an action-based and body-based form of instruction. One of its goals is to implement a streamlined evaluation process that focuses on effects on different aspects of cognition, behaviour and emotion. We describe the combination of various observation methods, which we will continually use over a two year period of time. This process procures data from multiple target groups (e.g., teachers, students, parents, and the KiMM project members).

Introduction

There is a general consensus that media literacy represents the essential skill, an important prerequisite, needed to succeed actively and participate constructively in versatile forms of social interaction. In the light of the ever accelerating technological evolution it is essential to acknowledge that media literacy includes print literacy, media content literacy, grammar and reading literacy, as well as computer literacy (Groeben, 2004). This broader definition has implications as far as target dimensions (e.g., media awareness, media skills, knowledge of the possible impact of media), their operative translation and the empirical indicators on how to achieve these goals.

The KiMM Initiative (Kids in Media and Motion) is a research and transfer project of the University of Luebeck, Germany, which is dedicated to the aforementioned holistic approach of media literacy. KiMM promotes action-based and body-based forms of instruction for students and teachers in the classroom environment. Different forms of mixed reality learning spaces are used in the schools (grade 1-13). Computer skills (cognitive), storytelling skills, musical (artistic) abilities and individual talents (e.g., technical thinking and acting) are simultaneously promoted using both conventional materials and digital media (e.g., digital video cameras, PDAs, 3D-modelling software).

All of the application methods used in KiMM are evaluated in a streamlined evaluation process with regard to how cognition, behaviour, and emotion is influenced positively or adversely through these mixed-reality and high interaction media projects. In this paper we describe the combination of different observation methods (e.g., video analysis, questionnaires, and logs) which we will continually use over a two year period of time. This process procures data from multiple target groups (e.g., teachers, students, parents, and the KiMM project members).

Mixed-Reality and other High Interaction Media Projects

Many computer projects in K-12 and similar education systems consider computers as standardized devices consisting of a computer box, VDT, keyboard, and mouse. The applications run on these computers are generally either turn-key applications like office software, simulators and games or they are programming environments providing some general purpose programming language used to implement some small algorithms with input from keyboard and mouse and output to the screen. With this kind of computer usage and related computer literacy stemming from the early days of computing, an important part of the future Computer Galaxy, compared to the

Gutenberg Galaxy coined by McLuhan (1962), will neither be seen nor pedagogically addressed. This mostly overseen part of computer applications is the world of mixed reality, process control systems, computer vision systems, robotics, and other, still unnamed concepts, where computers are connected to the physical world by having various kinds of sensors to perceive and actuators to react to the physical world.

Systems like these can create dense interaction structures between people, their physical space and the digital models within the computers. The better the physical and the digital space are coupled in a naturals way, the more we will get patterns of mixed reality connecting people and their environment to computer models and their algorithms. In respect to the coupling of single objects and digital models the notion of “tangible media” has been used (Ishii & Ullmer, 1997). The importance of mixed reality and tangible media can be expected to be even more important and influential to our modern society than the old and well-known model of desktop computing and the like. Intelligent buildings, smart cars and highways, information devices, robots and embodied conversational agents, mobile applications, combined communication and computing devices will be all over (and are already in many contexts). This idea of tightly related physical and virtual spaces is more than just computing everywhere like discussed in the field of ubiquitous and pervasive computing, since it connects human and machines more deeply and densely by more natural, i.e. physical forms of machine perception and actuation, or seen from the other side, is more natural, i.e. physical forms of computer usage by humans.

Concept of the KiMM Initiative

Since 2001 we have been following a situated learning approach which promotes the use of digital media for successful contextualisation of curriculum material in various learning scenarios in collaboration with more than 20 schools starting from the first grade onwards (e.g. Reimann, Winkler, Herczeg, & Höpel, 2003; Winkler & Herczeg, 2004; Winkler, Kritzenberger, & Herczeg, 2002). The KiMM Initiative continues and extends this work.

Children set up room-filling multimedia installations with dense forms of interactions by using tactile, video and audio input and output channels. School children from the age of 8-10 years are starting to program computers vision systems and large displays, audio systems and computer controlled motor systems. They work independently, though in collaborative environments, on complex problems. They learn to understand that the computer is more than a symbolic processor, but also a sensor processor and actuator machine connected to their physical environment and themselves. This induces a deep understanding of the potential role a computer plays in their present and future worlds.

Knowledge that must be communicated can not be a one-to-one objective transfer of facts, but rather an individual, thus highly subjective, exploration of reality. The knowledge is acquired in an iterative learning process. The students gain a construction competence in building and mastering systems by working iteratively through several complexity levels. Essentially, we must encourage students to develop autonomous learning, problem solving, creative thinking, and their self-identity, instead of just transferring information and procedures.

The educational field is still dominated by an instructionist view: computer games, for example, are expected to provide extrinsic motivation for traditionally unpleasant subjects. Results indicate that this strategy does not pay off, because children rarely gain knowledge from the game content (Robertson & Good, 2004). However, computer games have been found useful to induce other creative activities, for example, problem solving or deductive reasoning skills.

The KiMM initiative follows a constructivist/constructionist view (Papert, 1980) that sheds a different, and more promising, light to the effects of active creativity (rather than *using* or *playing*). It is known that creating games, for example, entails creating storylines, which, in turn, is an opportunity to exercise the imagination and to explore thoughts and feelings. Robertson and Good (2004) thus argued that games as a non-textual medium may be helpful especially for those children who have difficulty with writing to express their ideas. Successfully creating something which can be enjoyed by other people, for example, interactive mixed reality theater, will be rewarding, increase children’s motivation, and therefore even positively affect their self-esteem and promote learning performance in school.

The procurement of media literacy is one of the main objectives of the students' active use of media and their creation of (multi-)media applications within the KiMM concept. On the one hand, students are introduced to different media types and technologies (e.g., PDAs, digital video cameras, iconographic programming software). Step by step they learn to handle these systems. Thus, they experience what people can do with media as individuals or in teams. They use action-based and body-based forms of instruction to explore their world in mixed-reality and mobile learning environments. On the other hand, students are also introduced to the important issue of the various media effects. That is, they become aware that media may be used in a planned or strategic way as tools for certain purposes. In addition, they learn that the use of media may also affect thoughts, behaviour, and emotions – both on individual and social levels.

Examples of School Projects with Mixed-reality and Mobile Learning Environments

Currently the KiMM schools encompass both primary and secondary schools with children between the ages of 6-18 years. Hereby follows a description of two school projects, which represent the broad approach to the procurement of media literacy.

In the interactive theatre play, "The Magic Cauldron", a 2nd grade class worked in a mixed-reality learning environment (Fig. 1). The play's scenario concerned a magic cauldron, which possessed the power to make all the children's worries and sorrows disappear. The central theme of the play was how to express various emotions; happiness, sadness, joy, worry, fear, anger, etc., and what associated colours, body gestures, and sounds do these emotions have. The goal of the play was for the children to become aware of the entire spectrum of the emotions they normally experience. The ability to recognize emotions correctly is also essential in everyday social interaction and is an important part of the school curriculum.

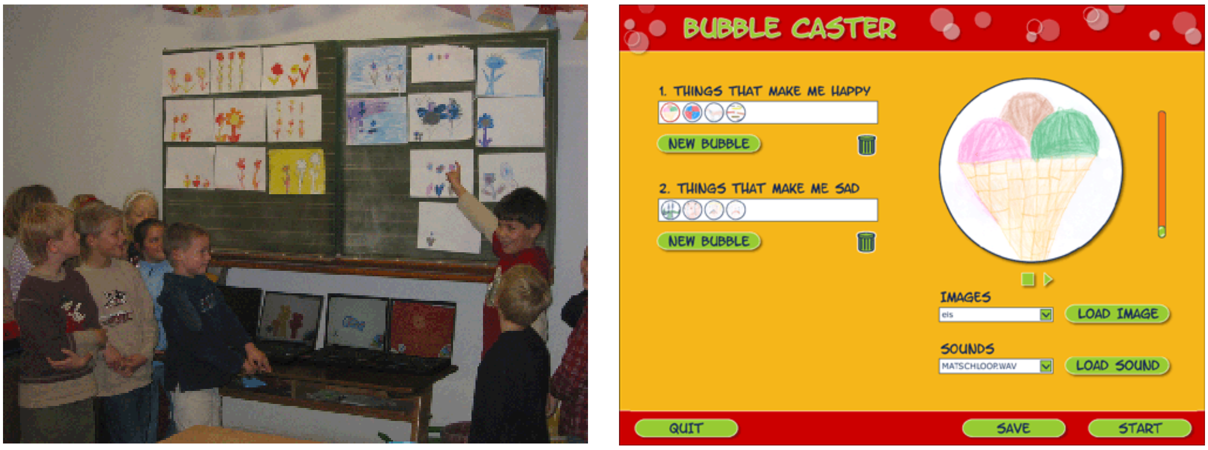

Figure 1: Grade 2 children preparation work for the theatre production of the "Magic Cauldron" (left), the KiMM Initiative's Bubble Maker interface (right).

This interactive theatre production allowed the children to write their own script, draw collages and graphics (ArtRage software), compose music, and take photographs and film. The children created "bubbles", which were filled with their own photos, drawings, and music, using a KiMM programmed interface, called Bubble Maker. The Fire Caster software (copyright © 2001, C. Forman, Setpixel) projected these bubbles onto a wall and the children had to chase the bubbles and "push" them into the magic cauldron.

The children in a 5th grade class participated in a mobile learning project (Fig. 2), where they used navigational information and tools to travel various routes between assigned destinations (e.g., the theatre, the nearest police station, and the city library) and their classroom. The children learned to read maps (from satellite topography and map router sites on the Internet), measure and document time (using stop watches and PDAs), calculate distances, define and document orientation points (e.g. monuments or specific landmarks using digital photo cameras), and made their own collages/maps/rally guides using sketches, photos, and inscriptions. This specific project was part of a larger project which was intended to further their understanding of “Who am I?” by posing the question “Where am I?”, thus spatially locating the physical position of their classroom within the nearby lying environment.

Figure 2: Two grade 5 children recording their route with the help of a PDA and stopwatch (left) using photos and maps to make up posters of their city rally (right).

Evaluation concept of the KiMM Initiative

Studies of computer based learning in a classroom situation have been repeatedly demonstrated to yield positive effects, though meta-analyses indicated that the effectiveness of the studies is often disappointing (Hattie, 1990, 1992). With regard to a constructivist/constructionist view, however, we know of no meta-analysis that might be used to predict the effects of a classroom implementation of the KiMM approach. This is due to the general approach of constructionism that focuses on active and creative interactions with complex learning material (Papert, 1980). These interactions result in the procurement of skills that often lack exact criteria and thus prevent quantification. However, we adopted a suggestion by Jonassen (1996) to evaluate learning progress by means of a broad repertoire of evaluation methods that includes objective data (e.g., video analysis), as well as subjective data (e.g., questionnaires for teachers, parent and students (grade 4 onwards), interviews for grades 1-4 students, teachers’ logs, KiMM project members’ logs).

Paradigm

The quintessential paradigm of the evaluation method used in the KiMM Initiative is the experimental between-groups comparison of KiMM classrooms (i.e., digital media) and control groups (i.e., classroom not using KiMM resources, but conventional material/didactics). Though important aspects have to be considered (e.g., matching of classes in terms of overall intellectual status and gender ratio), this between-group design is well-suited to assess the specific benefits of computer learning and the use of digital media per se. To evaluate changes over time, data from at least two different measuring times have to be compared (i.e., analyses of deviations from baseline measurement).

Target Dimensions

Due to the holistic approach of the KiMM concept the evaluation incorporated various target dimensions concerning cognition, individual and social behaviour, and emotion of both the students and teachers. In this regard, high interaction media projects have already been shown to yield positive effects (LEGO, 1999, 2001). However, these studies used the LEGO Dacta material (i.e., LEGO bricks, motors, sensors, and the LEGO software developed at the MIT Media Lab) in grade 1-6 classrooms. The scope of the KiMM Initiative includes all of the aforementioned target dimensions, yet we are not reduced to LEGO Dacta devices. Target dimensions presented below were then transformed for the different objective and subjective observation methods (e.g., converted to specific items in the questionnaires).

Cognitive Aspects

Evidence for a general improvement in scholastic performance is an important prerequisite to embedding teaching methodologies using digital media in the school's curriculum. Both LEGO studies (1999, 2001) indicated an intellectual gain, an increase in students' perseverance, and a creative use of technology. Playing computer games has been shown to improve the development of complex problem solving skills, while game authoring was found to improve complex verbal literacy, as indicated by an increase in general storytelling skills (Robertson & Good, 2004). However, it has been suggested that because the preference for using computers is far greater than for reading and writing, computers might thus have a negative impact on young people who are still in a process of learning and developing their basic language literacy skills (e.g., Radi, 2002).

Motivation and Emotional Aspects

On the basis of a literature survey Schofield (1997) reasoned that computer based instruction consistently resulted in positive effects on students' motivation, as well as positive effects on affective variables. As a result, students became more interested in learning and more strongly enjoyed learning. Moreover, their increase in commitment resulted in stronger persistence of pursuing the learning matter and a decrease in times absent. The strong motivational effect was also reported by Robertson and Good (2004) for a computer game authoring workshop. In addition, creatively developing a computer game was found to be self-reinforcing and therefore led to bolstering the participants' self-esteem. A similar finding was reported in the two LEGO studies (1999, 2001) both for the students' ratings and the teachers' reports.

Social Aspects

Robertson and Good (2004) reported that both students and teachers agreed on the benefits of team work associated with playing computer games. In addition, teachers' evaluations of classroom interaction further indicated that peer tutoring, co-operation and collaboration skills were developed as the children interacted with their peers on the computer. One of the LEGO studies (1999) also found pro-social behaviour to be increased after using the LEGO Dacta material.

In addition, it is necessary to acknowledge that social processes mediate knowledge acquisition. This is due to the dependency between social situations and context. Jonassen and Rohrer-Murphy (1999) incorporated social processes, context, and multiplicity of perspectives in their activity theory. In this regard, it is important for the teachers and the KiMM project members to be sensitive to the fact that the studies reported difficulties with the handling of teamwork. The use of highly attractive material in these studies caused monopolising of the use of elements by the class leaders and reduced the possibilities of manipulation by shy students (LEGO, 1999, 2001).

Media Literacy

One of the main objectives within the KiMM concept is the procurement of media literacy. With regard to the evaluation, students in the KiMM classroom should demonstrate a deep understanding of the specific operation mode for the different types of media and technologies and especially interactive media. More importantly, because students are also introduced to the important issue of various media effects, they should also become aware of the potential of media for planned or strategic use. Students should therefore indicate that, for example, media may influence the recipient's emotional state or perception of self (e.g., Cattarin, Thompson, Thomas, & Williams, 2000).

Evaluation Tools and Target Groups

It is unlikely that different media technologies and applications will have similar, or even identical, effects. Thus, we developed an evaluation framework (i.e., questionnaires and interviews) that may be adapted to the various material being used in the specific classroom project (e.g., digital video, PDA, 3D-modelling). The evaluation methods comprise both fixed core elements, for the detection of (general) changes from one measurement point to another, and these adaptable parameters (i.e., items). The results yielded from the adaptable parameters give access to the effects of the above mentioned specific material.

This framework is also adaptable to each of the different target groups (e.g., teachers, parents, and students). For example, one of the questionnaires' items concerned with communication and social interaction required teachers' *observation* about the frequency and intensity of problem solving discussion within the work groups, whereas the children *reported their subjective estimation* about how often and how intensely their discussion were. Both groups are required to enter their choice on a Likert scale (from 1 − *I don't agree at all*, to 6 − *I totally agree*). Table 1 illustrates the different target groups, together with the evaluation tools and target dimensions used in the KiMM Initiative.

Target Group	Evaluation Tool	Target Dimension
Teachers	KiMM questionnaire	• Students' performance • Students' behaviour • Students' experiences • Media (e.g., handling, applicability) • Expectation and apprehension (concerning the KiMM concept) • Judgment of KiMM support • Rating one's own behaviour (e.g., handling of students' teamwork) • Rating one's own experiences (i.e., satisfaction, emotional stress)
Students	Video data (in extracts)	• Handling of media and technology (i.e., frequency of target actions) • Social interactions: frequency of specific target actions
	KiMM structured interview (grades 1-4) KiMM questionnaire (> grade 4)	• Rating one's own performance (e.g., performance compared to other subjects) • Rating one's own cognition and emotion (e.g., creativity, motivation, satisfaction) • Rating one's own behaviour (e.g., teamwork) • Handling of media and technology (e.g., ease of use) • How the teacher acted (e.g., handling of teamwork when problems occurred)
Parents	KiMM questionnaire	• Expectation and apprehension (concerning the KiMM concept) • Changes in child's performance • Changes in child's behaviour • Changes in child's experiences

Table 1: Target groups, evaluation tools and target dimensions in the evaluation process of the KiMM Initiative.

Initial Motivation, Expectations and Results

The KiMM concept began to be implemented in schools in August 2004 based on experiences gathered in school contexts since 2001. The initial results are derived from the teachers' and KiMM project members' logs and teachers' interviews. The school children working in the KiMM Initiative had previously minimal or no exposure to digital media within their daily classroom learning environment. Initially, the different target groups (e.g., teachers, parents, and students) varied substantially in terms of motivation and expectation of the potential benefits for their children to participate in the program.

The teachers' principal motivation was based on their belief that the children's learning, social, and problem solving skills would be positively influenced. Their expectations differed on how difficult it would be to implement action-based and body-based form of instruction in a meaningful context in their normal classroom environment. Teachers with well-grounded media literacy had noticeably lower expectations. Overall, their initial concerns were not related to the benefits for the children, rather to their own ability to handle the hardware and software, uncertainty on how to instruct the children in a "digital" learning environment, and whether they would be able to fulfill their curriculum teaching requirements.

The parents' expectation and motivation swung as a pendulum between two extremes. They either felt that their children already were over-exposed to digital media (e.g. television, computer games, and mobile phones) on the home front and, therefore, did not need more in the classroom. There was the other extreme, which believed that their children were going to receive the full spectrum state-of-the-art education and turn into computer wizards.

The children initial motivation and expectations were high. Even those children who had previously never used a computer were enthusiastic about using the various digital devices and software.

The initial results show a high level of acceptance and motivation on the part of both the children and the teachers to continue with the work. Besides the obvious increase in computer literacy, the children also showed co-operative behavior and peer tutoring, as well as development of collaboration skills. These results are based on informal interviews and logs. In February 2005 the first of a series of formal evaluation procedures (i.e., questionnaires and video studies) will be carried out in four grade 5 classes (i.e., two KiMM classes and two control groups) and three grade 2 classes (i.e., two KiMM classes and one control group). (*Author's note:* The results of these studies will be presented at the ED-MEDIA 2005).

The teachers' initial concern about their own lack of computer literacy has led to continued teach-the-teacher sessions − an aspect that has already been shown to be crucial for the handling of teamwork and thus for the success of related projects (LEGO, 1999, 2001).

Since the different projects are carried out within the classroom situation the logistics of setting up the digital media and instructions of use of the different software and hardware programs created an element of complexity that is not present in the traditional classroom atmosphere. Also the technical glitches which occurred tended to throw teachers and the KiMM project members out of equilibrium, whereas the children seemed to accept them with a healthy portion of fatalism. Rather, the focus of their attention on their tasks was not deterred by such glitches.

Conclusion

In the present paper we introduced the scope of the KiMM Initiative. The concept is devoted to procurement of media literacy in schools, which is not confined to computer literacy. Rather, while being based on a situated learning approach the KiMM initiative follows a constructivist/constructionist view that promotes active and creative processing of complex learning material. A broad range of digital media is used for successful contextualisation of curriculum material in various learning scenarios. The different forms of digital media used, represent a transparent bridge connecting the learning material and the students' physical environment.

The goal of the initiative is not to implement solely various forms of instruction or applications in the classrooms, but to practice a holistic approach. This approach encompasses a streamlined evaluation process studying the positive or adverse influences through these mixed-reality and high interaction media projects. The assumption is that these projects, as pedagogical interventions, affect different target dimensions, such as cognition, motivation, social interaction and emotion. To analyze these influences, we developed an adaptable evaluation framework (e.g., questionnaires) for the various material being used in the specific classroom projects (e.g., digital video, PDA, 3D-modelling) and for the different target groups (e.g., teachers, parents, and students) and this is currently being implemented in the schools.

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