Kindergarten Children Programming Robots: A First Attempt

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***Abstract*— Using robots to teach programming is a method to enthuse young people about computer sciences. They are applied by colleges as well as by schools. To rouse young people´s enthusiasm for technology, the Department of Computer Science – University of Applied Sciences Technikum Wien offers robotic classes at a kindergarten for pre-school children (aged five to six years). Simultaneously, they are given an understanding of scientists´ profession. All activities with the robots are documented by the children themselves, processed and reflected about in complementing talks. To cater to all learning types, a high value is put on using different methods of teaching and the children work actively in workshops. Thus, a strong sense of identification with the project can be ensured in both children and lecturers. The collaterally conducted case study demonstrates the gained findings and enables multipliers to apply this concept adapted to their own needs. Complementing this case-study we recommend using this procedure in kindergartens with a high number of children with migratory background. Also, we point out the limitations of constructivist educational concepts in kindergartens.**

***Keywords*— kindergarten, robotics, programming, children as scientists, finite automata**

I. Introduction

Following the basic idea of familiarizing children with the world of science and technics, the pilot scheme „Wissensakademie" was created in cooperation with "Kinderfreunde Wien" and the Department of Computer Science at the University of Applied Sciences Technikum Wien.

The Department of Computer Science has been an active part of the RoboCup initiative in Austria for many years and hosts the "Regionalzentrum Wien" for the RoboCupJunior initiative.

The RoboCupJunior "Regionalzentrum" offers trial courses for programming Lego Mindstorms® NXT robots, hosts advanced courses, days for practice and coaching-sessions. Additionally, week-long introduction classes in robotics were held for ten to 16-year-old students. The goal of these summer classes is to motivate students to participate in the RoboCupJunior´s Austrian Opens and winning teachers as multipliers to continue the project.

A. Motivation

After building up a stable core of participants for the RoboCupJunior initiative it appears reasonable to us to extend the chance to engage in technics actively and under guidance to children as early as kindergarten. This way they can sample and experience the contact with technics. We hope that in this way, fear of contact with technical products and informatics will be minimized or, ideally, will not arise. Children could link everyday knowledge to technics and we hope to offer them first chances make and check their own assumptions. A high value is put on the method of teaching that allows children to gather knowledge themselves. The robots´ immediate reaction to their actions shows the little scientists the consequences of their acts. Thus, creativity and concentration, which are also called for in numerous other kindergarten projects, can be simultaneously improved. Over the last years, a downright environment of projects has developed in kindergartens and children seem to be used to occupying themselves with new matters continuously. "[…] when children are still in the stage of understanding their surroundings by grasping things but also develop first thoughts about logic relations, the foundations for programming should be set. It is very important to foster this as early as possible, because everything a child really understands can later be applied to similar problems." [1]

B. Advantages

We consider it a great advantage, that children in kindergarten can learn and experiment without exam pressure. This gives them the freedom to try a lot and to identify their own interests. A playful approach to exploring the world of robotics helps them to engage in the subject at ease and with no pressure. Conveying facts is not in the foreground and the acquisition of generic skills in the field of speech, counting, orientation in space, phrasing and checking of assumptions as well as breaking down complex courses of action into single steps happen almost casually and effortlessly. As in Schweikardt and Gross, we are „motivated by the idea that experimentation and play with robots exposes students to many subject areas within science, math and engineering." [2] Rapeepisarn et al. cover the aspect of „learn through play" and „entertainment" at length. [3] Even more, robotics can form the basis for an education in programming and engineering „via the back door". [4], [5] Another advantage lies in our chance to learn from the children. In 2006 Schweikardt and Gross thought that robotics was going to lead an insular existence, and would profit from „increased interdisciplinary collaboration with designers, materials scientists, psychologists, and other creative people.” [2]

In addition to an excursion with the children to the college´s laboratories, the variety of learning methods provides a vast support of different learning types. The use of a digital camera that is appropriate for children offers a possibility for them to document their own activities. Drawings can visualize procedures, discussions can activate new links.

C. *Structure of the paper*

At the beginning, we introduce the robots they come to use, as well the underlying educational concepts. Afterwards we present the tutorials held at the kindergarten in the course of the pilot scheme “Wissensakademie” regarding their contents. Following a short description of our research method, we go into detail of our findings and discuss them in context of an extension of the pilot project to a number of kindergartens with a high number of children with migratory background.

II. BACKGROUND

A. *A Short History*

Froebel coined the term kindergarten and already developed strategies for hands-on learning, supported by toys and activities, in the 19th century. [6] [7] According to Kafai et al., analogies to his approach can be found in the concept of Lego Mindstorms®. [6] Based of these experiences, the use of robotics in kindergartens appeared reasonable.

„Currently, interest has shifted from whether technology should be used with young children, to how it should be used in order to provide effective learning experiences.” [8] Granting a playful approach, according to Rapeepisarn et al., enhances the development of children in all aspects. [3] „The focus has shifted from technology to pedagogy.” [9, p. 11] The right choice of robots that rather support the process of learning than cause frustration through complex handling is anything but trivial. Robotic Toys appear to be suitable for kindergarten children.

B. *Robotic Toys*

Robotic Toys are gaining notice increasingly in IDC-research (Interaction Design and Children), as Fernaeus et al. noted. „We define robotic toys as robots intended for basic leisure activities such as play, creativity, playful learning, entertainment, and relaxation. […] A robot is an active tangible artefact that interacts directly with the world around it.” [10]

From a Development Psychology point of view, the use of robots in kindergarten is well justified. Development Psychologists, headed up by Piaget, emphasize the importance of the use of physical objects during childhood for the development of cognitive skills. [11] In doing so, children should in no case be overstrained. As one technological learning goal, Alexander and Rackley name the process of switching on and off a computer. [12]

C. *Bee-Bot*

Simple user interfaces are extremely important for children, since common user interfaces of computers are too complicated and form a barrier in the learning of the technology. [13] The fact that computers can generally be operated only by one or two people blocks the cooperation between children, because they cannot work on solving problems together. [1]

Over the last years, there have been increasingly more robotic toys developed to resemble pets in behavior and appearance. [10] Because of the positive experiences in the work with children (e.g. [14]) and the numerous availability of educational material [15], we decided to use Bee-Bots as robots for our exercises. The possible didactic applications of the Bee-Bot and its functioning can be looked up at Pekárová [14]. For better understanding, **Fehler! Verweisquelle konnte nicht gefunden werden.** shows a state diagram of the functionality of the Bee-Bot.

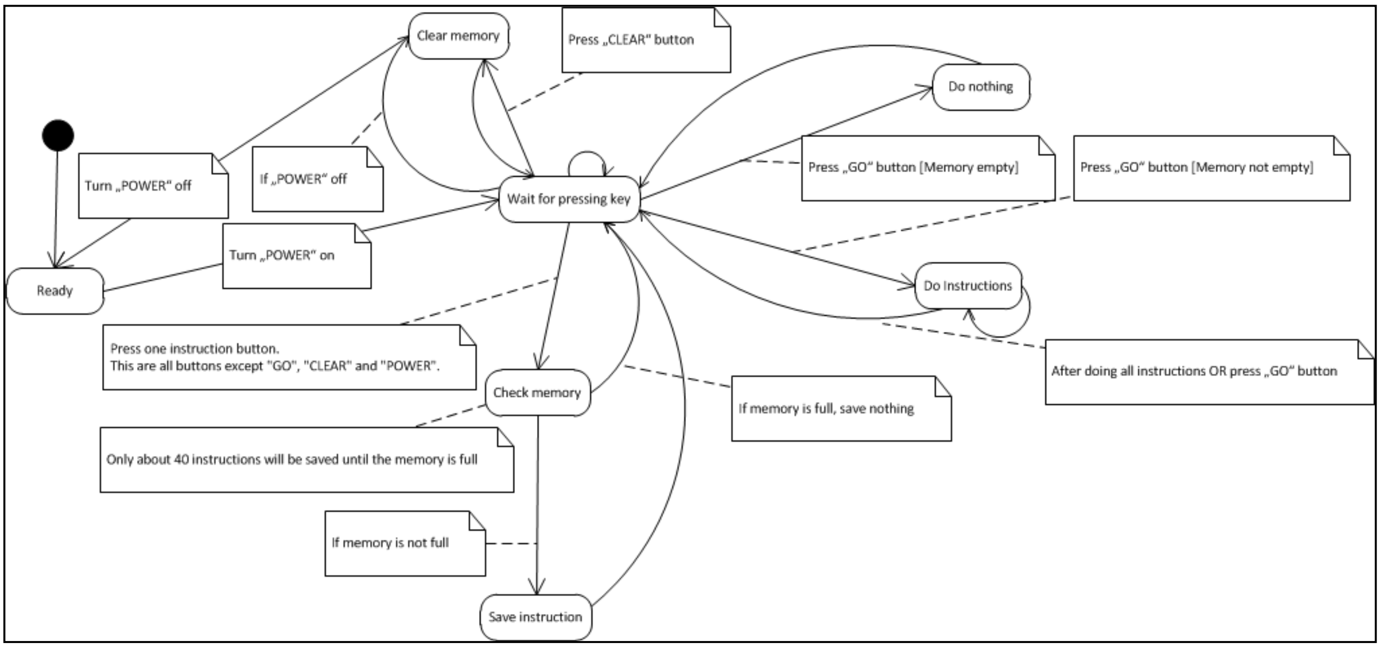

Fig. 1 State Diagram of the Bee-Bot (own modeling)

D. Constructionism

Constructionism was founded by Papert and is based on constructivism. As opposed to constructivism, constructionism only applies to learning and teaching with technologies. Furthermore, Papert is considered to be the developer of the Lego Mindstorms® robotics concept (see [16]). [9, p. 4] The concept of constructionism can be looked up at length at Umaschi Bers [9].

E. Similar Projects in Kindergarten

In 2003, Gibbs and Roberts conducted a project with 10 children aged four to five, in which they were allowed to experiment with computer games developed especially for kindergarten children on CD-ROMs. In doing so they were supported by a scientific team member. With the help of an especially developed smartboard, the children's interactions (or non-interactions) with the CD-ROMs were logged. The project´s goal was to find out how young children interact with technologies, CD-ROMs in particular, and what they learn from their experience with the technology. [8]

At Fernaeus et al., children aged four to 17 were watched handling robotic toys, in particular, Pleo, inside their families. This was primarily to study the interactions and the effects of the use of technology in familiar surroundings. [10]

Because of the complex handling of computers, Khandelwal and Mazalek worked with a „Teaching Table: A tangible mentor for pre-K math education." developed especially for the cause. [13] Scharf et al. developed Tangicons, „non-electronic physical programming cubes", that were suitable for children in kindergarten to gain first experiences in programming. [1]

III. THE PROJECT "WISSENSAKADEMIE"

A. The Project Concept

As described in the introduction, the idea for this project derived from our activities with RoboCupJunior[1]. Children are given the opportunity to get in touch with technics and science by means of fun and playing. To document their experiences, and to internalize the importance of good documentation in a scientist´s daily work, they are given digital cameras suitable for children. The pictures taken during the pilot project are to be put into a research-booklet for documenting the laboratory work and to be complemented by drawings. By becoming engaged intensely in their work, we want to enhance the children's enthusiasm for technics and prolong their questioning of the courses of actions taken.

[1] RoboCupJunior is part of RoboCup, a worldwide initiative focusing on research in the fields of Robotics, Artificial Intelligence and Computer Science. RoboCup provides standardized challenges such as Robotic soccer and the vision of beating the human soccer world champions with humanoid robots by the year 2050 [19]. Until then it is a long period of time and some of the todays' interested children will be the postdocs by then doing research in this field. Therefore the RoboCupJunior initiative was born as a discipline for RoboCup. The mission statement of RoboCupJunior is described by Sklar & Eguchi as follows: "To create a learning environment for today, and to foster understanding among humans and technology for tomorrow." [20]

B. Differences

Pekárová [14] conducted a similar project in Slovakia. She takes role play activities as a basis for her work. In four tutorials, she and her team used Bee-Bots to familiarize 26 children with robotics and programming. The class we offered was different in the following aspects:

- We tried to explain additional topics of computer science like finite automata and algorithmic thinking.
- Each child can be provided with a Bee-Bot.
- Our pilot scheme is meant for ten children instead of 26.
- Each child is provided with a digital camera for documentation.
- The pictures can be printed out by the children themselves on photo printers.
- Each child is encouraged to keep a research-booklet for the lab work and use the pictures for it.
- In our pilot scheme we scheduled an excursion to the robotic laboratories of the University of Applied Sciences Technikum Wien in order to give the children a deeper insight into the matter.
- The contents of our classes are aimed not only at robotics and programming, but at the profession of technical scientist as well.

C. Project Contents

The contents of the project in kindergarten were split into 10 units of 50 minutes each. Referring to Gelderblom and Kotzé, who state „if a child can solve a specific kind of problem in one domain that they cannot necessarily transfer that skill to a different domain" as one of their design-lessons, our pilot project tries to enable the children to internalize knowledge by continuously repeating the most important concepts in various settings. [17]

1) Interaction with children and teachers

One teacher and two to four students supported the kindergarten-class. In this setting, the teacher held the short lectures in each unit, while the students were coaches and tutors to the kindergarten children. They supported the children individually by repeating und explaining the specific content. So, it was possible to realize many learning settings. In single-learning-settings the kindergarten children had to solve individual programming tasks, to draw robot pictures, to take pictures and to keep records of their own learning activities in their research-booklets. Some exercises were authored in pair-work-settings, whereby the children assigned programming tasks for each other. To form a framework for the single and pair-activities, we carried out group activities like discussions and presentations, demonstrations, dancing, singing and playing.

2) Used Concepts of Programming

Hubwieser and Aiglstorfer [21] distinguish between basic process units and combined process units. Basic process units are indivisible process units, which are running without any conditions. There are three kinds of combined process units

- Sequences,
- Conditional process units, and
- Repetitions (loops). [21]

In our course setting we focus on the basic process units and the sequences. Basic process units which are processed consecutively can be combined to a sequence. Conditional process units and repetitions could not be part of a users` Bee-Bot program but the state diagram in figure 1 shows that these two concepts are part of the finite automat Bee-Bot. While working with the Bee-Bots children use these two principles automatically and sometimes unconsciously.

Examples for tasks where children need basic process units are in the context of the Bee-Bot: moving one step forward, one step backward, turn right or turn left. In order to move one step right or left we need a sequence of the following two instructions: turn right/left and move one step forward. Another simple sequence: two steps forward.

3) Tutorial Contents

The following table lists contents and goals of each tutorial. It aims to offer an insight into the work with children and the tasks, they should solve.

TABLE I
TUTORIAL CONTENTS

Unit	Contents	Goals
1	Initiation, introduction of the research-booklets and activities; The children are to draw a robot, explain, what they know about it and finally enact the behaviour of robots in a „play“.	Activating previous knowledge, gaining knowledge about the build-up of a robot (sensors, computer, mechanics, electronics); Expressing heard information creatively by drawing and acting; Presenting and defending one´s own conclusions.
2	Introducing the work and activities of a scientist; Giving out digital cameras to become acquainted with without guidance of instructors! Presentation of a vacuum cleaner robot and explanation of its operating mode (sensors, drive mechanism etc.); Taking pictures as scientists and presentation of conclusions.	Recapitulating of what was learned in one´s own words Getting to know the profession: Scientist; Use of digital cameras; Getting to know various areas of use for robots.
3	Handing out digital cameras for documenting the entire tutorial; Presentation of a lawn mower robot and explanation of its operating mode (sensors, drive mechanism etc.); Taking pictures as scientists and presentation of conclusions.	Recapitulating of what was learned in one´s own words; Use of digital cameras; Getting to know various areas of use for robots.
4	Visit at the University of Applied Sciences Technikum Wien – explanation of NAOs (humanoid toy robot) and viewing of other robots on the premises	Recapitulating of what was learned in one´s own words; Getting to know various areas of use for robots; Getting to know a university
5	Introduction of the Bee-Bots (without live demonstration); Presentation of their operating mode; Letting the children try out the Bee-Bots without guidance or assignment. First exercises on a CVC-Mat (Consonant Vowel Consonant Mat)	Recapitulating of what was learned in one´s own words; Getting to know various areas of use for robots; Handling of a simple robot
6	Personalization of the Bee-Bots (naming, dressing up etc.); Letting the children tell their Bee-Bots´ story; Singing a Bee-Bot song; Dancing along with the Bee-Bot song; Each child is in turn assigned a task of programming their Bee-Bots; Meanwhile, the others are training or taking pictures	Recapitulating of what was learned in one´s own words; Working with various materials and techniques; Training of (linguistic) creativity; Handling and programming of robots; Working autonomously with technic; Getting to know creative work with technic
7	Building groups with free choice of a mat and coach; Coaches assign problems to be solved by the children; Holding a competition on one mat with identical requirements for all	Recapitulating of what was learned in one´s own words; Handling and programming of robots; Working autonomously with technic; Playful interaction in a competition

8	Entrance talk: The children explain the Bee-Bot and its operating mode themselves; The children work in pre-defined pairs and assign problems to each other; Building new pairs to construct a mat for each Bee-Bot.	Recapitulating of what was learned in one´s own words; Constructing solvable problems; Autonomous solving of problems in teamwork; Creative work with materials.
9	Completion of the Bee-Bot mats; Constructing problems for one´s own mat and having them solved.	Recapitulating of what was learned in one´s own words; Creative work with materials; Constructing solvable problems and solving problems constructed by others.
10	Retrospect; Collective viewing and completion of the research-booklets; Outlook on computers and programming.	Recapitulating of what was learned in one´s own words; Presentation of one´s own work; Getting to know computers.

The ten units were held at weekly intervals. Merely between units seven and eight there was a gap of three weeks because of the Christmas holidays. At the beginning of each unit we spoke about the last unit. While each unit children gained skills of autonomous documentation of events.

D. *Participants*

Nine children, four girls and five boys, all in pre-school age (aged five to six years) participated in the project at hand. All children are part of the same organizational group in kindergarten and are familiar with each other. The leader of the involved group was interviewed and both she and the kindergarten administration supported us in the execution of the project as well as in the care for the children from the beginning. [18]

The "Wissensakademie" was conducted by a scientific member of the Department of Computer Science in the role of teacher, coach and presenter. In doing so she was supported by six students in their first and third semester of their study of computer science. They filled out the observation templates as well as act as personal coaches for the children. The presenter took care of the organizational progression of events and the contents and execution of each unit.

E. *Empirical Study Procedure*

1) *Our main questions*

a) Can handling robots create a wish to be a technician already in children in kindergarten?

b) Does handling robots have an influence on children´s estimation of their own skills?

c) To what extent can children in kindergarten already grasp the basic ideas of programming?

2) *Methods*

As scientific methods, we chose interviews with guidelines as well as observation templates. Short interviews with questionnaire A were meant to be held with all nine children before start of the ten units and to be compared afterwards. Since unfortunately some children were missing already during the first unit, unfortunately only seven children could be interviewed in the beginning.

After a 4-week-window after closure of the ten units, the participating children were again questioned with questionnaire A, immediately followed by another questionnaire B. In addition, individual interviews were held. Unfortunately only four children could be interviewed because the others were not present for various reasons. For organizational reasons, the missing interviews could not be held later on. Since it is hard to make appointments with five-year-olds, the appointments were arranged with the kindergarten administration, which could not always make sure that the children to be interviewed were present at the appointed time.

Of the other 15 children in pre-school age of this kindergarten who did not participate in the project „Wissensakademie", eleven children – nine girls and two boys – could be questioned as a control group.

In addition, as scientific method of qualitative recording, standardized observation templates were filled out during the tutorials and complemented with photographic documentation.

3) *Interviews*

Besides collecting demographic data, the following four questions from questionnaire A were important for this case-study:

1. What do you especially enjoy doing?
2. What are you especially good at?
3. Have you ever played games on a computer?
4. What do you want to do later? (profession)

In questionnaire B, eight questions of evaluation were asked, one half referring to the works of scientists, the other to the discussed contest.

1. What is a robot?
2. What are robots needed for?
3. Do you believe that we will soon have more robots in our everyday life? What do you think they will do?
4. What do you think you learned in the workshop „Wissensakademie"?
5. What does a scientist do? (Do you want to engineer, invent something someday?)
6. Do you want to work as a scientist?
7. What is the research-booklet for documentation of the laboratory work used for?
8. Which way of recording conclusions do you find the most practical?

IV. RESULTS AND DISCUSSION

Question a) and b) were dealt with by the means of the interviews held. The answering of question c) is based partly on the outcome of the interviews and the first partial results of the observation templates. The other results are based mostly on the presenter´s and students´ observations.

A. Question a)

Before start of our class, none of the children in the participating group expressed the wish to one day become a technician respectively scientist. Two of the girls in the control group expressed a wish to work in technics. One even said she wanted to „make computers“.

After taking part in the „Wissensakademie” class, none of the children expressed a wish to be a technician respectively scientist as an answer to the question about their career aspirations on questionnaire A. Two of the children said they „didn´t know”. The answers given on questionnaire B partly contradicted this. One child who according to questionnaire A wanted to be a „football star“, answered to questionnaire B he wanted to be a scientist. It should be mentioned that unlike on questionnaire A, in the course of this talk, the job of a scientist was worked out. After talking about questionnaire B, children liked the idea of becoming a scientist.

We noted that four out of eleven children (36%) of the control group owned a computer. One of them was the girl who´s wish was to work in the computer sector. 54% of children in the control group wanted to be doctors. According to the head of this kindergarten, this was probably due to a health care project held shortly before. Why this development did not take place as such in our analysed target group can only be guessed. To evaluate the power to influence the children’s career aspirations it is necessary to observe their engagement during the next 10 to 15 years. At this moment, we develop a concept to realize this study. But abstract terms like technician or scientists – unless practiced by someone in their personal surroundings – seem to take time and continuous repetition to be internalized by children.

B. Question b)

The questionnaire A contains two questions, which are used to find out children´s estimation of their own skills. Furthermore, we tried to find out, if there is a correlation between the mentioned skills and talents and their favoured activities. Before taking part in our course program, most of the interviewed children answered with “playing with friends” to the question “What do you especially enjoy doing?” six out of seven interviewed children answered to the question „What are you especially good at?” - “I do not know”.. Only one girl answered with “I am good in drawing” These results suggests that on the one hand, children do not know what skills are and on the other hand they do not know to articulate their talents. It was very interesting to see, that children did not see any coherence between these two questions. The children mentioned social activities as their favourite activities. They seemed to have the opinion, that these social activities – like “playing with friends” – are not an answer in the right meaning, when talking about “What are you especially good at?”. After closure of the ten units, 100% of the participating children answered to the same question immediately. Mostly they mentioned sportive or creative activities. One child mentioned it was good at „calculating“, and said “thirty times thirty gives nine hundred”.

It appears that the participating children became aware of what they were subjectively good at and were able to articulate this. Increasing self-confidence seems to be a result of handling robots.

C. Question c)

Two of the children of the participating group stated that they owned their own computer. In the control group, four children own one. Five children of the participating group and nine of the control group play computer games.

The observation templates show that all of the participating children at once had a feel for the programming of the Bee-Bots. Also, all basic process units the Bee-Bot offers (e.g. first steps backward and forward) were no problem after a few tries. However, the changes of direction of the Bee-Bots presented a challenge. There was no problem understanding the concept of sequences – as described above – but children did not understand the usage of the turn right/left button.

A change of direction of a Bee-Bot is made of two commands at least. A step to the left is made of a turn left followed by one step forward. This led to the biggest problems in understanding the Bee-Bots´ programming. The children mostly triggered steps into a different direction manually: The Bee-Bots were turned around by hand. None of the children could handle more complex motion sequences consisting of at least three different directions.

Grasping and autonomously developing simple courses of program presents a serious problem for most children. An even bigger one was the language, especially when explaining more complex motion sequences. It appears to be possible to convey more complex sequences, but calls for a lot of time and patience in doing so.

D. Further findings

1) Self-confidence

Generally we noticed that during the interview after taking the class, the children were a lot more eager to talk and give information. This is partly due to the now familiar surroundings (coach respectively presenter). These findings correspond with those of Alexander and Rackley. [12] The active participation in class – presentation of tasks and the reflecting talks – surely help to enhance linguistic skills.

2) Paradox

The children themselves pointed out the paradox of the Bee-Bot – a robot in form of a bee that can neither fly nor sting. Quite contrary, it rolls on the floor, is a lot bigger and friendly.

3) Cameras and Printers

The use of cameras was accepted very positively by the children – this also showed in the big number of very good pictures. The children were able to handle the cameras by themselves almost without mistakes and in course of time found all the cameras´ functions. However, the childrens´ attention was often so consumed by the cameras; they were often distracted from the workshop. In the future, we will only provide cameras at specified times in order to be able to better channel their attention.

Unfortunately, the printing of the pictures failed because, unforeseen, the printers were incompatible with the cameras. The children understood the simple handling of the photo printers at once, but unfortunately the photos on the memory card were not shown on the display. Thus, navigation and selection of the wanted pictures for printing was impossible. The printing was done by the students after each tutorial.

4) Absence

It was very problematic for us, that some of the children did not show up at the workshops regularly and thus missed essential contents. The absence of the children was in the responsibility of the parents or legal guardians, since they have to see that the children appear at the kindergarten regularly and timely. It is necessary to find strategies to work against these circumstances. The kindergarten direction confirmed that the missing or being late of children is not a problem of the services the kindergarten offers. Often it is because of misunderstandings between the kindergarten direction and the parents, because they often read and understand information in form of letters only partly because of language barriers.

5) Pedagogical Considerations

The sixth unit should be closer looked at from a pedagogy point of view. First signs indicate that the boarders of the constructivist paradigm of learning are reached very soon in kindergarten – at least in the area of technics. Autonomous learning without guidance or assignments with new and unknown technologies seems to be almost impossible.

Something similar can be gleaned in Gibbs and Roberts: „It was found that though the children enjoyed themselves, they appeared to learn very little, particularly in terms of content. The most significant factors influencing this outcome were the pedagogy […] and the scaffolding support provided.” [8] For older children, especially at secondary school, it is easy to work on RoboCupJunior-assignments successfully in teams under the constructivist paradigm of learning. [4]

But the example of the digital camera mentioned above shows, that familiar technologies can indeed be used autonomously and intensively.

In conclusion it should be mentioned that during our class, there were no differences between the approach to technics of girls and boys worth mentioning.

V. CONCLUSION AND FUTURE WORK

The project „Wissensakademie“ has – from our point of view – proven to be very successful. The children were enthusiastic, interested in programming and robots and are looking forward to a sequel to this project.

The small group of nine children was ideal to work (inter-) actively with the children and explore the world of robots playfully. The children were easy to be enthused about going on this new exploration. Under the presented setting, a top quality promotion of the children was possible.

We do not think that the children can be cared for individually in bigger groups with the same resources of support. But the positives of our setting are at the same time limitations: we cannot give any general statements for the following reasons. First of all: Our group of children was too small – nine children are to less, for making general conclusions. Also a problem: Only sometimes we were lucky, to see all children in our robot-sessions. Too many times children were absent. Even in the small group it was not always easy to take all the language barriers, attention deficits, different speeds of learning and the varying previous knowledge into account, in order to offer the ideal amount of promotion to each child. Also, we were not always able to fully consider all cultural differences of acting and social interaction.

Animated by the kindergarten educationist, we developed learning materials for reinforcement in order not to decelerate the process of curiosity and the eagerness to experiment with technics in the children. These materials are not only meant for revising the last workshop-unit, but also to prepare for the next one. This way, a continuous gain of knowledge or a consistent occupation with the new filed of knowledge can be secured. In addition to this it is important to mention that we did not notice differences in the approaches to or handling of the robots between boys and girls.

One critical point of our study could be the circumstance that we used many different materials and methods in our classes – considering the duration of each session (50’). This fact and medium- and long-term suitability need to be subject to further research.

Besides a detailed analysis of the observation templates, the program will be continued with the same children by means of an advanced class in the summer of 2011. After a few revising units to consolidate their knowledge, ten more units with easy programming exercises with the popular Lego Mindstorms® NXT’s will be held in summer. For this, the children will be allowed to build up the robots in order to establish a personal relationship to them as well as to gain their first experiences in programming with the graphic user interfaces.

Another kindergarten could be won for a repetition of the program. This time, we will use our gained experience, offer even more intensive single coaching.

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REFERENCES

[1] F. Scharf, T. Winkler and M. Herczeg, Tangicons: “Algorithmic Reasoning in a Collaborative Game for Children in Kindergarten and First Class.” *Proc. of the 7th International Conference on Interaction Design and Children* (Chicago, Illinois, USA, June 11-13, 2008). IDC’08. ACM, New York, NY, pp. 242--249. ISBN 978-1-59593-994-4, 2008.

[2] E. Schweikardt and M. D. Gross, “roBlocks: A Robotic Construction Kit for Mathematics and Science Education.” *Proc. of the 8th International Conference on Multimodal Interfaces* (Banff, Alberta, Canada, November 2-4, 2006). ICMI’06. ACM, New York, NY, pp. 72--75. ISBN 1-59593-541-X, 2006.

[3] K. Rapeepisarn K. W. Wong, C. C. Fung and A. Depickere, “Similarities and differences between "learn through play" and "edutainment".” *Proc. of the 3rd Australasian Conference on Interactive Entertainment*, 4-6 December 2006, Perth, 2006.

[4] M. Petre and B. Price, “Using Robotics to Motivate ‘Back Door’ Learning.” *Education and Information Technologies* 9:2. Kluwer Academic Publishers, pp. 147-158, 2004.

[5] M. Bers, C. Rogers, L. Beals, M. Portsmore, K. Staszowski, E. Cejka, A. Carberry and B. Gravel, “Innovative session: early Childhood Robotics for Learning.” *Proc. of the 7th international conference on learning sciences* (ICLS '06). International Society of the Learning Sciences 1036-1042, 2006.

[6] Y. B. Kafai, K. A. Peppler, Q. Burke, M. Moore and D. Glosson, “Fröbel’s Forgotten Gift: Textile Construction Kits as Pathways into Play, Design and Computation.” *Proc. of the 9th International Conference on Interaction Design and Children* (Barcelona, Spain, June 9-12, 2010). IDC’10. ACM, New York, NY, pp. 214--217. ISBN 978-1-60558-951-0/10/06, 2010.

[7] H. Raffle, “Kinesthetic media: touch, toys & interactive materials.” *ACM SIGGRAPH 2006 Educators program* (SIGGRAPH '06). ACM, New York, NY, Article 8, 2006.

[8] D. Gibbs and S. Roberts, “A Jump-start in Learning? Young Children’s Use of CDRom Technology.” *Proc. of the IFIP Working Group 3.5 Conference: Young Children and Learning Technologies.* (Parramatta, USA, July, 2003) IFIP’03, pp. 39-47, 2003..

[9] M. Umaschi Bers, *Blocks to Robots: Learning with technology in the early childhood classroom.* New York, NY: Teachers College Press, Columbia University. ISBN 978-0-8077-4847-3, 2008.

[10] Y. Fernaeus, M. Hakansson, M. Jacobsson and S. Ljungblad, “How do you Play with a Robotic Toy Animal? A long-term study of Pleo.” *Proc. of the 9th International Conference on Interaction Design and Children* (Barcelona, Spain, June 9-12, 2010). IDC’10. ACM, New York, NY, pp. 39--48. ISBN 978-1-60558-951-0/10/06, 2010.

[11] J. Piaget, *Play, dreams, and imitation in childhood.* New York: Norton, 1962.

[12] T. Alexander and C. C. Rackley, “Integrating Information Assurance (IA) Into K-5 Curriculum.” *Proc. of the Information Security Curriculum Development Conference* (Kennesaw, GA, USA, September 23-24, 2005). InfoSecCD’05. ACM, New York, NY, pp. 1--3, ISBN: 1-59593-261-5/05/0009, 2005.

[13] M. Khandelwal and A. Mazalek, “Teaching Table: A tangible mentor for pre-K math education.” *Proc. of the 1st International Conference on Tangible and Embedded Interaction* (Baton Rouge, Louisiana, USA, February 15-17, 2007). TEI’07. ACM, New York, NY, pp. 191--194. ISBN 978-1-59593-619-6/07/02, 2007.

[14] J. Pekárová, “Using a Programmable Toy at Preschool Age: Why and How?” *Workshop Proceedings of SIMPAR 2008, Intl. Conf. on SIMULATION, MODELING and PROGRAMMING for AUTONOMOUS ROBOTS,* Venice(Italy) 2008 November,3-4, ISBN 978-88-95872-01-8, pp. 112-121, 2008.

[15] L. Turja, “Best practices for technology education in early childhood – background and some examples.” *Project Report D2.2 Description of best pedagogical practices of the Project UPDATE,* Project no. 042941, 6th EU Framework Programme, 2008.

[16] S. Papert, *Mindstorms: Children, computers, and powerful ideas.* New York: Basic Books, 1980.

[17] H. Gelderblom and P. Kotzé, “Ten Design Lessons from the Literature on Child Development and Children’s Use of Technology.” *Proc. of the 8th International Conference on Interaction Design and Children* (Como, Italy, June 7-9, 2009). IDC’09. ACM, New York, NY, 52--60. ISBN 978-1-60558-395-2, 2009.

[18] M. Tomitsch, T. Grechenig, G. Kappel and T. Költringer, “Experiences from Designing a Tangible Musical Toy for Children.” *Proc. of the 5th International Conference on Interaction Design and Children* (Tampere, Finland, June 7-9, 2006). IDC’06. ACM, New York, NY, 169-170, 2006.

[19] H. Kitano, M. Asada, Y. Kuniyoshi, I. Noda, E. Osawa and H. Matsubara, “RoboCup: A Challenge Problem for AI” *AI Magazine*, 18(1):pp. 73-85, 1997.

[20] E. Sklar and A. Eguchi, “RoboCupJunior - Four Years Later.” *RoboCup 2004: Robot Soccer World Cup VIII*, number 3276 in Lecture Notes in Computer Science. Springer, 2005.

[21] P. Hubwieser and G. Aiglstorfer *Fundamente der Informatik Ablaufmodellierung, Algorithmen und Datenstrukturen*. München, Wien: Oldenbourg, 2004.