# Assistive Technologies Summer School: STEM-subjects and robotics

**Lena Hoffmann, Sven Franz, Thomas Eilts, Frank Wallhoff**

Institute for Technical Assistive Systems
Jade University of Applied Sciences, Oldenburg, Germany
{lena.hoffmann; sven.franz; thomas.eilts; frank.wallhoff}@jade-hs.de

**Abstract**

The MINTOL project envisaged a Summer School about robotics and computer science in relation to the STEM-subjects in Oldenburg. The participants, German high school pupils, got a structured approach to concepts of assistive technologies and got to know specific practical examples, respectively with a view to functionality and appliance. The contents of the project program were introduced theoretically and deepened by dint of practical exercises. Main subjects to be worked on were basics of technical assistive systems as well as basics of communication and information technologies, potentials of robotics (primarily basic concepts, assembling and programming), methods of image processing, and finally technical potentials of building systems engineering and its crosslinking.

**Keywords:** Engineering education, STEM, Summer School, technical assistive systems, conjunction of theory and praxis, problem-based learning

## 1. Introduction

The subject robotic does have a certain fascination – especially for adolescents. The examination of this new technology motivates pupils to raise new and especially interdisciplinary topics and encourages them to succeed in creative problem solving. This is an opportunity for knowledge amplification and self-fulfillment.

In line with the program *Zukunft und Innovation Niedersachsen* (Future and Innovation in Lower Saxony) of the *Ministerium für Wirtschaft, Arbeit und Verkehr* (Ministry of Economy, Work and Traffic) the Jade University of Applied Sciences participated in a call of proposals. The idea was a Summer School which was meant to treat the STEM-subjects in connection with robotics and computer science.

The Jade University of Applied Sciences disposes of appropriate requirements to accomplish a suchlike project. For this reason, the Summer School's contents imply most advantageous features as to the recent study program *Assistive Technologies*. The Jade University disposes of good technical infrastructure, such as PCs with specific programs, the humanoid research robot NAO [1] and programmable construction sets e.g. qfix *Crash Bobby* kits [2] or Lego *Mindstorms* [3].

Our ambition to impart the intended knowledge to the pupils was completely successful. A Summer School project with STEM-subjects in this range, and in view of informatics and robotics, has so far not been offered in Lower Saxony. MINT[1] being the German equivalent to STEM, a word combination of the main topic and the venue, namely Oldenburg, led finally to MINTOL Summer School.

[1] MINT stands for Mathematics, Informatics, Natural Sciences and Technology

 

Altogether nine pupils at the age of 16 and 17 were participating at the summer school. The most important, respectively the sole criterion for participation was the personal interest and the drive to learn more about robotics.

## 2. Method

### 2.1. Publicity

First of all the high schools were contacted and informed about the project via email and pupils were encouraged and invited by their teachers to participate. At the same time an advertisement was taken out in a regional newspaper informing on the opportunity to participate in the Summer School on a voluntary basis, which was ment to address pupils specifically motivated and eager for knowledge. At the same there was the social component in the project making sure the pooling of firstly pupils of different Oldenburg schools, and secondly pupils of this age group envisageing the start of study and on this occasion become acquainted with a high school environment.

### 2.2. Planning

Right from the planning stage it was our utmost concern to offer a theoretical fundament which provides basic knowledge and background information for a brief but deep understanding of machinery and functionality of the discussed subjects and tools. These contents were to be deepened practically for the biggest learning success possible.
The timetable envisaged each day a new topic. After theoretical introduction of the different subjects, the pupils got to know vivid examples. In the practical periods of the Summer School, the exercises were accordingly to be solved in small teams, based on the newly gained knowledge, methods and tools – thus the contents could be deepened and by talking to the mentors, the pupils could, depending on their interest, even enhance their knowledge. In addition, it was a main purpose to realize problem-based learning: through problem solving the pupils had to learn about a subject – namely by seeking solutions to real problems. Practical relevance, as well as the support and the attendance of the mentors are targeted to facilitate learning [4].

### 2.3. Contents

The project had the mission to promote high-quality undergraduate education in science, technology, engineering and mathematics through a miscellaneous offer. As Assistive Technologies is a largely interdisciplinary study which combines technical and social components, it was adequate that we proceeded this way and offered as much different insights as possible.
Table 1 shows that first of all the pupils got a theoretical introduction of Assistive Technologies, an idea what that is and whom it may help. In the practical period they got to know assembling the qfix robot kit with differential actuation. The second day pupils learnt the basics of informatics, solved an exercise about distance measuring. Afterwards the pupils could start with programming the assembled qfix *Crash Bobby* and at the end of the session present their results. Especially the use of this robot technology has turned out to be an efficient way of introducing embedded systems effectively [5]. Wednesday was emphasized by communication: in the morning it was worked on the basics of image processing and face recognition, in the afternoon Mister Stefan Goetze from the *Fraunhofer Institute*, Project group hearing-, speech- and audio-technology, introduced the recognition and syntheses of speech.

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| 8:00 – 9:30 | Welcome, round of introductions, inquiry, course objectives | Basics of informatics | Basics of image processing | | Basics of building systems engineering | Group work with mentoring |
| 9:30 – 9:45 | PAUSE | PAUSE | PAUSE | BEGINNING 10:00 h | PAUSE | PAUSE |
| 9:45 – 11:15 | What are assistence systems and who is in need of them? | Task about linearisation of distance measuring | Draft of a programme of cognition of faces, *in Octave* | Presentation of humanoid robot NAO | Actuation of devices via *KNX* | Presentation of group work's results |
| 11:15 – 11:30 | PAUSE | PAUSE | PAUSE | PAUSE | PAUSE | PAUSE |
| 11:30 – 13:00 | Cont'd.. what are assistance systems and who is in need of them? Basics of information and communication technology, presenting the TGM building | Programming/practical course with the qFix-Robot, introduction theory of *State Machine* | Introduction of methods of speech recognition and synthesis (from creation of speech to digital processing with demonstrations) | Presentation of humanoid robot NAO | Cont'd .. Actuation of devices via *KNX*, and towards end presentation and assignment of 5 subjects for the group work (e. g. LEGO, ect.) | Evaluation and finally Awarding results of group works |
| 13:00 – 14:00 | NOON | NOON | NOON | NOON | NOON | approx. 13:00 END |
| 14:00 – 15:30 | Engineering: presentaiton, assembly of the qfix-Robots with differential actuation | Programming/practical course with the qFix-Robot, introduction theory of *State Machine* | Generation of a query-reply system with *DialogOS* | Programming of NAO in *Choreographe* | Gropup work with mentoring | |
| 15:30 – 15:45 | END | PAUSE | PAUSE | PAUSE | PAUSE | |
| 15:45 – 17:15 | | Programming/practical course with the qfix-Robot, introduction theory of *State Machine, towards end presentation of results* | *DialogOS* / Programming of qfix on voice command | Programming of NAO in *Python* | Group work with mentoring in the end, approx. 1 hour study information | |
| 17:15 – 17:30 | | Feedbackround | Feedbackround | Feedbackround | Feedbackround | |

Tab. 1: The timetable with its miscellaneous topics, adopted for the Assistive Technology MINTOL Summer School project at the Jade University of Applied Sciences.

Following the pupils got programming exercises. Thursday was the climax of the project week: The humanoid research robot NAO was presented. Mister Thomas Schiller from the German agency of Aldebaran Robotics (*LPE Technische Medien GmbH*) came to visit the Jade University and gave an extensive presentation of the functionality and potentials of the NAO robot. The pupils were fascinated by this little robot which has several technical outfits and the accompanying program offers numerous learning possibilities for the learners. Friday the pupils got a technical introduction about the potentials of building systems engineering and its crosslinking as well as the possibilities of application.

At the end of the project week a little competition took place in which small teams had to solve an open self-conceived problem. The groups presenting the most creative and ambitious solutions were awarded some equitable prices, handed over by the Jade University's Vice President.

## 2.4. Evaluation

At the beginning of the project week we asked the pupils about their expectations to the Summer School and the level of experiences and knowledge concerning the targeted subjects, as well as about their plans for their professional future.

At the end a more detailed evaluation took place where questions about the pupils' impressions of the Summer School, their plans for professional future (which could have changed during the one week workshop) and their favorite subjects were interrogated. In order to classify, respectively evaluate subjects, processes and working environment, multiple choice questions were asked, furthermore, remarks and/or comments were phrased for open questions.

Combining qualitative and quantitative methods, a good insight could be gained in the pupils' interests and impressions.

## 3. Results

The evaluation showed that the pupils learned a lot about the promoted contents.

They were impressed by the diversity of topics – always in connection with robotics and its possibilities of real-life use. Some of the pupils noted that the Summer School clearly confirmed their interest on STEM-subjects, some declared that their interest even increreased by working on the offered subjects. Figure 1 and 2 show a before-and-after comparision of curiosity in STEM-subjects. In figure 1 the high interest on scientific subjects is obvious, as all of the pupils were already enthusiastic about this domain when deciding to participate at the Summer School. In figure 2 the increased interest in the STEM subjects is/was evident and achieved a higher level at the end of the MINTOL programme.

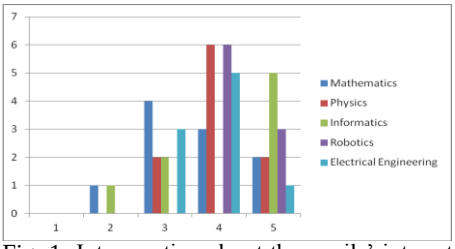

Fig. 1: Interrogation about the pupils' interest in STEM-subject at the beginning.

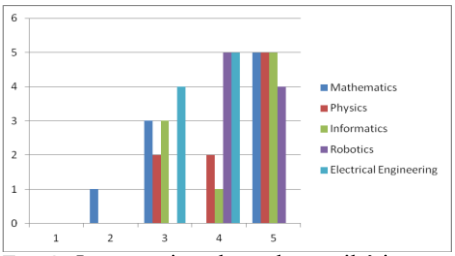

Fig. 2: Interrogation about the pupils' interest in STEM-subject at the end of the project.

## 4. Summary

In the project we could ascertain the pupils' appreciation towards the connection of theory and praxis. In regular debriefings after each project day, the young people expressed acceptance and appreciation for the program and its contents.

All in all the first Oldenburg Summer School about STEM-related subjects, robotics and informatics was prosperous and successful. In this spirit we are planning to iterate this project in the forthcoming summer so that the current age-group of pupils may benefit from this learning opportunity.

## 5. Acknowledgement

We want to thank Messrs. Thomas Schiller from *LPE Technische Medien GmbH* and Stefan Goetze from the *Fraunhofer Institute/Project group HSA* for their participation and support in preparation and accomplishment during the MINTOL Summer School. Especially we want to thank the *Innovationszentrum Niedersachsen* (Centre of Innovation in Lower Saxony) and the *Ministerium für Wirtschaft, Arbeit und Verkehr* (Ministry of Economy, Work and Traffic) for their funding and financial support of this project.

## 6. References

[1] Aldebaran Robotics, online: http://www.aldebaran-robotics.com/en/, last viewed 13th February 2013.

[2] qfix robotics; details for product Crash-Bobby, online: http://qfix-shop.de/downloads/Datenblatt-CrashBobby.pdf, last viewed 14th March 2013. Qfix robot kits are a learning tool for teaching robotics in education, they are also used by hobby robot builders.

[3] Lego Mindstorms, online; details for products: http://mindstorms.lego.com/en-us/default.aspx, last viewed 13th March 2013.

[4] Antonia Scholkmann, Bianca Roters: Progress in the development of a scale to rate the acquisition of professional knowledge through PBL, in Proceedings ECER 2009, Sept. 28th-30th, Vienna Network 22. "Research in Higher Education"

[5] Susanne Ihsen, Wolfram Schneider, Frank Wallhoff, Juergen Blume. Raising interest of pupils in Engineering Education through Problem Based Learning. International Journal of Engineering Education, Special Issue: Learning through play in Engineering Education Volume 27, No. 4, 789-794, 2011