Music as a vehicle to encourage girls' and boys' interest in technology

Anita Thaler
IFZ, Inter-University Centre for Technology, Work and Culture, Klagenfurt University
Schloegelgasse 2
8010 Graz, Austria
thaler@ifz.tugraz.at

Isabel Zorn
Universität Koblenz-Landau, Campus Landau
Bürgerstr. 23
76829 Landau, Germany
zorn@uni-landau.de

ABSTRACT
This paper will present first results of the research project „Engineer Your Sound!" (EYS; 2008-2009) funded by the Austrian Federal Ministry of Science and Research. EYS explores the potential of addressing young people's interest in music and music technology in order to raise their interest in technology and engineering. The project aims at developing didactic concepts for installing gender-inclusive technology education in Austrian high-schools. The concept and first results of the teenagers' projects will be presented.

Keywords
Technology design activities, gender, music technology, curriculum design, participatory technology design, inter-action design, high-school students, science & technology education

INTRODUCTION
While technology-related careers are expected to offer great opportunities, not just in the near future but already today, the percentage of female students enrolled in technology-related degrees in the German-speaking countries does not exceed about 25 % of all students [4]. Moreover, a decline in young people's interest for science studies and mathematics and therefore changes in science and technology education are stated [5].

Manifold studies on gender and technology have shown the gap in technology interest and experience between boys and girls (for an overview see [22]), and the gap in women and men employed in technology-related professions [13]. Many attempts to bring more women into the field have not been too successful. Currently, a shift in paradigms addressing the phenomena can be found: While for long women have been regarded to need to change and develop interest in technology, the technological culture has come more into the focus of gender analyses of technology [15].

Technology-related jobs are prognosticated to rise in the near future; however, a lack of skilled personnel has been predicted [11,20,29,32]. In Austria, too, a lack of qualified male and female professionals in the field of technology is expected. In order to meet the goals for research and development as announced by the EU (so called "Lisbon strategy", see: http://ec.europa.eu/invest-in-research), more young people need to be interested in a technology-related career.

The European Commission has even announced a crisis regarding young people's lacking interest in science and technology-related careers [3]. Unattractive and difficult science education in schools has been identified to be the main reason. The empirical international study on pupils' science performance PISA 2006 has shown that (not just in Austria) pupils have little possibilities to test their ideas, to set up experiments and to explore scientific knowledge in real life situations [23].

School and university students are more interested in interdisciplinary technology and various digital media than in mono-disciplinary technology topics. Among others, the INDECS and the WOMENG projects have shown that degree courses that offer a range of subjects that go beyond the classic traditional SET focus and have a more "interdisciplinary" design attract a broader range of students, both male and female, with a wider set of interests and talents [31].

These issues will be addressed with a school research project, which will be presented in the paper. The aim of the project is to raise female and male teenagers' interest in technology by allowing them to immerse in meaningful interdisciplinary technology design projects. Music and music technology will be used as topics for technology-related design activities.

Music technology is a classically interdisciplinary field of technology, which affiliates to youth relevant interests [16, 21].

Among the electronic devices owned by teenagers in Germany, musical devices are the majority [18].

Booming prime-time TV shows focusing on music (like "Pop Idol" in Great Britain, "American Idol" in USA, "Starmania" in Austria, "Deutschland sucht den Superstar" in Germany, "Nouvelle Star" in France), but also music video games (like the karaoke game "SingStar" or the simulation game "Wii Music") and computer games (like the editing game "Make My Video") symbolize the importance and the agency of music.

Music has a high potential for "self socialisation" and for many young people it is one of their main areas of interest and activities [21]. An interest in music can drive boys and girls into engaging with new technical media [24].

The purpose of the project „Engineer Your Sound! (EYS)" – as described in this article – is to explore the potentials of music technology as an interdisciplinary and for all genders equally interesting field that relates to teenagers' life world. Another important point of music is that it has been identified as unisex interest field among young people [8]. This should be a major advantage of music as an application field comparing to various other "heavily" gendered technology fields like for instance automobile engineering.

The approach of the research project „Engineer Your Sound!" is based on the observation, that music and music technologies are relevant and meaningful interest areas for teenagers. The underlying hypothesis is that thus music technology can serve as an entry gate for teenagers to develop technology-related interests and skills. The underlying approach is one that does not aim at changing teenagers' interest but to change the culture of technology education in schools. As other design projects have explored, engaging children in constructing digital artefacts can be a means to raise children's interest in technology [2, 33]. Based on these assumptions, the project aims at developing didactic concepts for innovating science and technology education in high-schools by involving pupils in design activities with music technologies.

RESEARCH QUESTION/OBJECTIVE

The EYS project is based on an action research approach (see below) that aims at both setting up learning scenarios and evaluating their outcomes and potentials. The realization of the project is geared at answering the following research questions:

- How can music technology become an entry gate to introduce technology fields to teenagers?
- How do boys and girls perceive, approach, and invent music-related technology design activities?
- How can a learning-by-teaching approach be successfully installed in regular high-school classrooms?
- Can music technology serve as a so called gender-neutral field for technology-education?

The question if and how interdisciplinary technology education in school can support young people in opting for technology degree courses will be an important evaluation point, as well as the growth of technology-related self-efficacy [1, 10].

METHODOLOGY

The process of teaching and learning is accompanied and evaluated in close co-operation between the project partners: The University of Arts in Graz, the IFZ Graz, the University of Landau, and the teachers of the participating music-focused high school. The 28 high school students are between 17 and 18 years old and have several years of experience with at least one musical instrument they are music experts, in a sense.

The research and design processes are based on an action research concept [7,14,17]. Teachers and pupils are involved as both actors and researchers. A concrete problem of a social group is the base of the research: Teenagers are hardly interested in technology-related education; and science and technology classes as taught in many high-schools do not relate to teenagers' everyday lives and lack a hands-on approach [5].

As opposed to other design procedures for empirical research, in action research the definition of the problem can be altered continually in the course of the research process, as new insights are gained. The distance between the researched persons and the researching persons which is geared at obtaining objectivity – as emphasized especially in quantitative standardized study designs – is waived and replaced by aiming at obtaining validity for the target group.

In EYS, we take the action research approach one step further and relate it with principles of the participatory software design approach, which aims at integrating diverse stakeholders into the design process [6,25]. In the approach used in EYS, students are seen and involved as experts.

In this way, such an action research approach is in line with ideas expressed in the so-called German critical-constructivist education: Klafki speaks of an emancipatory interest in knowing ("Erkenntnisinteresse"), which should be geared at in teaching [12]. Teaching and learning will as such extend an „education for practicability" ("Bildung zur Brauchbarkeit") and enables participants to perceive their learning as sustainable and as empowering [9].

As technology can be understood as a gendered field, with an underlying sub-text resulting from social constructions of gender, the gender dimension is

addressed in many aspects of the EYS project: The research team consists of men and women, the technology coach for the pupils is a female student enrolled in sound engineering. The group interactions among pupils are monitored with a gender perspective.

The project is designed on the basis of former results of studies and on suggestions on how to overcome the gender gap at technical colleges [26,27,28,30]. These guide the design of participatory methods in technology design and in the design of the action research process.

ENGINEER YOUR SOUND: THE CONCEPT OF THE PROJECT

The idea of the EYS project is to develop and test interdisciplinary, innovative teaching/learning settings in which relations between music and technology can be explored in order to give pupils opportunities to experiment and to discover their technical potentials, skills, interests and talents and to present the field of technology and digital media as an appealing career option.

In the project, pupils engage in participatory technology design processes in cooperation with sound engineers, computer musicians, and physics and music teachers. At the beginning of the project, the students were introduced to various fields of music technology, electronic composition, body and computer interaction, sound production and engineering, computer-supported choreography, etc. The pupils should get ideas to realize their own creative ideas, for example, compose and produce technology-based or -supported music using state-of-the-art technology.

In collaboration with a master student, enrolled at sound-engineering and electronic music degree course at the Technical University and University of Music and Dramatic Arts Graz (adding a role-model effect to the process), as well as with their music and physics teachers, high-school students are currently developing their music-technological projects.

In the course of the school year, pupils work on their projects and reflect on them in both music and physics classes. Discussion and exchange about their design processes and outcomes are enhanced via a "weblog" (see http://eys.twoday.net), which serves as an electronic content sharing system and as a collaboration and communication tool as well. In such a way, the girls and boys can become aware of their implicit technical knowledge and their tacit design and engineering skills, e.g. in the IT and (music) media realm. Pupils in such an empowering experimental setting thus become experts and consequently can support their teachers in the education process (as has been shown for other contexts by Meyer [19]).

The pupils are not only asked to design music artefacts, they contribute to the second research aspect of the project as well: Modernizing methods and topics for science and technology classes in high-schools are the second focus of the project.

The overall aim of the project is to develop teaching concepts for installing technology-related music projects in other high-schools. The participating music-competent pupils partake in the didactical design of such concepts, drawing on their peer experiences of teenagers' life-world related musical interests. Therefore they cooperate with music engineers, electronic music composers, education scientists, gender researchers, and teachers.

The research aspects of the project are thus threefold: They relate to music, technology and pedagogy.

PROJECT IMPLEMENTATION

For the participating students, teachers, music technology trainers, and education scientists, EYS has four main phases:

1. Getting to know the field of music technology;
2. Shaping own technology designs;
3. Developing didactical models in the field of music technology;
4. Presenting technology products and didactical concepts.

In the beginning, the 28 pupils made an excursion to the Institute of Electronic Music (IEM) to get an overview of the variety of music technology. Beside more typical parts of sound engineering like a sound studio and an audio engineering studio, the researchers of IEM presented also their current scientific project „Embodied Generative Music" (http://www.embodiedgenerativemusic.com). This research takes place in the so called "cube", an aesthetic lab with gestural interfaces. The cube installation allows to translate movement into sound via infrared sensors. The pupils could experience this impressive installation in various ways by trying out movements and dance and "composing" music by doing so. The aim of the excursion was to broaden their understanding of music technology and electronic music. Their interest was aroused as well, as is indicated by the number of all 28 pupils who - after the excursion - decided to take part in the EYS project.

In the following kick-off-workshop a multilevel brainstorming process – containing also music technology presentation elements – led to five pupil's groups with different technology projects.

As of the date of writing this paper, the project is in phase 2: These five groups work closely together with the sound engineering master student, their physics teacher, and one education scientist on their projects.

The first group develops so called "air instruments" with adapted "Wii"-technology. Wii is a home video game console with a wireless controller produced by Nintendo, and globally one of the most used game consoles among young people. The second group composes their own music and alienates their recorded sounds with "Vocoder" technology. Vocoders (*voice* and *encoder*) are electronic devices which were developed for military telecommunication. The aim was to code and decode human voice for transmission in radio communication. In EYS, vocoders are used as electronical musical instruments. The third and fourth group produce short movies and composes electronic music for the movies. One group aims at providing movie scenes with the best fitting music, the other group wants to prove their hypothesis that film music is mainly influencing the emotional perception of the movie. The fifth group has an ethnographic approach, producing a documentary movie about the project EYS.

The next phases of EYS will be carried out until July 2009. Based on the results of pupils' projects didactical models will be developed in close collaboration between pupils, technical and educational researchers. Pupils' will then present their projects and results. Didactical models for science and music classes will be disseminated.

In addition to these core topics of EYS as explained above, the authors of this article do various accompanying research:

- Quantitative evaluation
- Qualitative evaluation
- Gender research

The quantitative evaluation compares data from a pre- and post-survey which will be done through a standardized questionnaire. In the centre of this quantitative evaluation stands our hypothesis that connecting technology to music will increase interest in technology. Students filled in the questionnaire the first time in October 2008, when they made their first excursion to the Institute for Electronic Music. Questions covered the excursion itself, studnets' career visions, their possible future study majors, their experiences and interests in the field of technology and their self-efficacy in IT. At the end of the project, in July 2009, students will answer the same questions (except the excursion-related) in a post-survey.

The qualitative evaluation is mainly based on an ethnographic approach complemented with document analyses. The methodology comprises in detail, participating observations combined with interviews in workshops and students' group meetings during the technology design process and during phase 3 (developing didactical models), and analyzing material (photographs of flip charts and chalk board writings, weblog entries, etc.). Thus the qualitative evaluation can complete the quantitative evaluation in order to learn about the effectiveness of connecting technology to pupils' interests in music. And moreover, we can find out how technology design ideas are progressing and changing during the design process, for instance as a result of certain interventions.

The gender research follows the action research approach as well. Observations are permanently reported to involved teachers and scientists, in terms of continuous feedback about important issues and potential improvements.

This accompanying research, analysis and interpretation of the results will approximately be finished in October 2009.

EXPECTED OUTCOMES

EYS has different expected outcomes for the different project partners.

For the teachers in the cooperation team EYS can bring insights and involvement in current research. They learn more about youth, gender and technology, about innovative teaching methods and didactics, practical relevant references to their subjects and further education in music technology. Beside that their relation to the pupils will benefit, most notably because of the pupils' role as experts.

For the participating pupils we expect that they perceive themselves as technological competent, that they broaden and deepen their technology competencies and that their technology-related self-efficacy will be strengthened. The participatory technology design approach plus the philosophy of EYS to see the pupils as experts should rub off on their overall self-confidence and make technology-related job- and study-decisions more probable.

And for us researchers in the team, the chances are to experience applied interdisciplinary research, to accompany a group during their technology design and learning process, to not only test theories and concepts in practice but moreover to use continuous feedback to improve the project and develop the concept permanently, and last but not least to receive internationally relevant answers to questions of how pupils' – and especially girls' – interest in science and technology can be raised. Another side-effect could be to explore new potentials of existing technologies, as the experiments of some students groups with the Wii technology and the air instruments may show.

CONCLUSION

Although technology-related careers are expected to offer great opportunities, a decline in young people's interest and especially low numbers of female students in science and technology have been stated [3,4]. The presented research project "Engineer Your Sound" (EYS) is based on facts from previous studies, like students' higher interests in interdisciplinary technology topics, need of new didactical approaches, especially girl's lack of technology-related self-efficacy and bearing in mind teenager's interests. Therefore EYS connects technology to music, which is a both genders equally interesting topic, in order to present the field of technology and digital media as an appealing career option.

EYS works as a cooperation project between a sound engineering master student, an electronic music composer and researcher, music and physics teachers, education scientists, gender researchers and 28 music-competent high-school students.

In the first part of the project, the pupils realize and implement their own creative music technology ideas, for example, composing and producing technology-based or -supported music using state-of-the-art technology. After that phase, they will contribute to the second research aspect of the project as well: Modernizing contents and didactics of science and technology classes in high-schools.

First results can answer some of our research questions coarsely but promisingly. Thus we can reason that music technology could indeed be an entry gate to introduce technology to teenagers by consequently using a participatory approach. This means, using students' ideas and finding a balance between support and autonomy.

The achievement of the overall aims of the project – the development of technology-related music teaching concepts for other high-schools and the raise of the participating girl's and boy's technology interest – will be assessed after the finishing evaluation of EYS in autumn 2009.

ACKNOWLEDEMENTS

EYS is funded within the "Sparkling Sciences"-initiative by the Austrian Federal Ministry for Science and Research.

EYS is a cooperation project, therefore we want to thank Birgit Gasteiger and Gerhard Eckel (Institute of Electronic Music and Acoustics IEM of the University of Music and Dramatic Arts Graz, KUG), Birgit Hofstätter and Christine Wächter (IFZ Graz), Hermann Grießer and Ulrike Weitlaner and all 28 participating pupils of the high school "Gymnasium Dreihackengasse", Graz.

REFERENCES

1.Bandura, Albert (Ed.). (1997). *Self-efficacy in changing societies*. Cambridge University Press, Cambridge.

2.Dittert, Nadine, Dittmann, Katharina, Grüter, Torsten, Kümmel, Anja, Osterloh, Anja, Reichel, Milena, Schelhowe, Heidi, Volkmann, Gerald and Zorn, Isabel (2008). Understanding Digital Media by constructing intelligent artefacts. in *ED-MEDIA World Conference on Educational Multimedia, Hypermedia & Telecommunications,* Wien, 2348-2358.

3.European Commission (2001). *Eurobarometer 55.2 – Europeans, Science and Technology*. In: http://ec.europa.eu/public_ opinion/archives/ebs/ebs_154_en.pdf [22.5.07].

4.European Commission, Directorate-General for Research (2006). *She Figures 2006. Women and Science. Statistics and Indicators*, Brussels. http://ec.europa.eu/research/science-society/pdf/she_figures_2006_en.pdf [31.1.2009].

5.European Commission (2007). *Science Education Now: A renewed Pedagogy for the Future of Europe*. In: http://ec.europa.eu/research/science-society/document_ library/pdf_06/report-rocard-on-science-education_en.pdf [2.2.2008].

6.Ehn, Pelle (1993). Scandinavian Design: On Participation and Skill. in Schuler, Douglas and Namioka, Aki eds. *Participatory design : principles and practices*, L. Erlbaum Associates, Hillsdale, N.J., 41-77.

7.Gilmore, Thomas; Krantz, Jim; Ramirez, Rafael (1986). Action Based Modes of Inquiry and the Host-Researcher Relationship. In: *Consultation 5, 3*, 160-176.

8.Großegger, Beate (2005). *Schriftenreihe Jugendpolitik: Medien und Technologie*. Wien: BMSG.

9.Gruber, Elke (1997). *Bildung zur Brauchbarkeit? Berufliche Bildung zwischen Anpassung und Emanzipation. Eine sozialhistorische Studie*. Profil-Verlag, München, Wien.

10.Hackett, Gail (1997). Self-efficacy in career choice and development. In: Bandura Albert (Ed.). *Self-efficacy in changing societies*. Cambridge: University Press, 232-258.

11.Huber, Peter et al. (2006). Mittelfristige Beschäftigungsprognose für Österreich bis 2010. In: *AMS info 82*. Arbeitsmarktservice Österreich, Wien.

12.Klafki, Wolfgang (1976). *Aspekte kritisch-konstruktiver Erziehungswissenschaft: Gesammelte Beiträge zur Theorie-Praxis-Diskussion*. Beltz, Weinheim, Basel.

13.Kompetenzzentrum Technik – Diversity – Chancengleichheit e.V. (2007). *(Erfolgreicher) Einstieg in IT-Berufe! Untersuchungen zur Orientierungs- und*

Berufseinstiegsphase von Frauen und Männern. Kompetenzzentrum Technik – Diversity – Chancengleichheit e.V., Bielefeld.

14.Lewin, Kurt (1947). Frontiers in Group. In: *Human Relations, 1*, 5-41.

15.Lucht, Petra and Paulitz, Tanja (2008). Recodierungen des Wissens: Zu Flexibilität und Stabilität von natur- und technikwissenschaftlichem Wissen; Eine Einleitung. in Lucht, Petra and Paulitz, Tanja eds. *Recodierungen des Wissens - Stand und Perspektiven der Geschlechterforschung in Naturwissenschaften und Technik*, Campus, Frankfurt/M., New York, 11-27.

16.Martig, Charles (2006). 'Ich bin im Fernsehen, also bin ich'. Identitätskonstruktion im Music-Star-Format. In: *Medienheft Dossier 26*, 12. Dez. 2006, 16-19.

17.McNiff, Jean; Whitehead, Jack (2002). *Action Research: Principles and Practice.* Routledge, London.

18.Medienpädagogischer Forschungsverbund Südwest (2007). *JIM-Studie : Jugend, Information, (Multi-)Media ; Basisuntersuchung zum Medienumgang 12- bis 19jähriger*. Baden-Baden.

19.Meyer, Meinert A. (1997). Schülermitbeteiligung und didaktische Kompetenz. In: Ursula Drews (Ed.). Themenheft: Schüler als Lehrende. *PÄDAGOGIK. 11*/49/1997. Beltz-Verlag, Weinheim, 11-14.

20.Österreichischer Verband für Elektrotechnik (2007). *Fachkräftemangel in Österreich: Ingenieurinnen und Ingenieure – gefragter denn je*. Podiumsdiskussion 9.10.2007. In: http://www.ove.at/presse/9okt07.htm [30.1.2009].

21.Rhein, Stefanie; Müller, Renate (2006). Musikalische Selbstsozialisation Jugendlicher: Theoretische Perspektiven und Forschungsergebnisse. In: *Diskurs Kindheits- und Jugendforschung,1, 4,* 551-568.

22.Sanders, Jo (2006). Gender and technology: What the research tells us. in Skelton, Christine, Francis, Becky and Smulyan, Lisa eds. *The Sage handbook of gender and education*, SAGE, London, 307-321.

23.Schreiner, Claudia Ed. (2007). *PISA 2006 – Internationaler Vergleich von Schülerleistungen. Erste Ergebnisse (Naturwissenschaft Lesen Mathematik).* Leykam, Graz.

24.Schuegraf, Martina (2008*). Medienkonvergenz und Subjektbildung : mediale Interaktionen am Beispiel von Musikfernsehen und Internet*. VS Verl. für Sozialwiss., Wiesbaden.

25.Schuler, Douglas and Namioka, Aki (1993). *Participatory design: principles and practices*. L. Erlbaum Associates, Hillsdale, N.J.

26.Thaler, Anita (2006). *Berufsziel Technikerin?* Munich, Vienna: Profil Verlag.

27.Thaler, Anita; Wächter, Christine (eds.) (2005). *Conference Proceedings of the International Conference Creating Cultures of Success for Women Engineers,* 6.-8. 10. 2005, Leibnitz / Graz. IFZ Eigenverlag, Graz.

28.Thaler, Anita; Wächter, Christine (2006): Nachhaltige Ingenieurinnenkarrieren. In: Berger, Wilhelm; Lauritsch Robert (Hg.): *Wissenschaft und Nachhaltigkeit*. *Forschungstag 2005*. *Klagenfurter Beiträge zur Technikdiskussion 113*, 56-72.

29.Verband deutscher Ingenieure (2008). In Deutschland fehlen fast 100 000 Ingenieure. *Handelsblatt*, issue 21th April 2008. http://www.handelsblatt.com/unternehmen/industrie/in-deutschland-fehlen-fast-100-000-ingenieure;1420317 [30.1.2009]

30.Wächter, Christine (2003). *Technik-Bildung und Geschlecht*. Profil-Verlag, München, Wien.

31.Wächter, Christine (2005). A Gendered Look at Interdisciplinary Engineering Education. In Bammé, Arno; Getzinger, Günter; Wieser, Bernhard (Eds.): *Yearbook 2005 of the Institute for Advanced Studies on Science, Technology and Society*. Profil-Verlag, München, Wien, 469-493.

32.Wirtschaftskammer Österreich (2008). *Bildungsbedarf der Industrie – Fachkräftemangel nimmt existenzielles Ausmaß an*. In: http://portal.wko.at/wk/format_detail.wk?AngID=1&StID=373351&DstID=685 [30.1.2009].

33.Zorn, Isabel (2007). Technologiekonstruktion als Mittel zur Technikbildung für Mädchen und Buben. *Schulheft Ausgabe: Technik weiblich! 31(4),* 47-62.