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Marc J. de Vries (Ed.)

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Preface

Herewith I proudly present the electronic proceedings of the 28th PATT conference, held in Orlando, Florida, USA, in conjunction with the 76th Annual ITEEA Conference. I want to thank ITEEA for hosting another PATT conference and for making these Proceedings available on their website. I want to thank in particular Steve Barbato for the great cooperation on this. The longstanding tradition to have PATT special sessions at the ITEEA Conference again has proven to be a good formula. It allows non-USA colleagues to get to know what goes on in the USA, while also attending international sessions, and it allows USA colleagues to see somewhat of the effort being made in the rest of the world. I look forward working with Steve and ITEEA again on the next conference in Milwaukee, 2015. I hope these Proceedings will give those colleagues who could not make it to Orlando a good impression of the nice presentations we had during the PATT special sessions.

Marc de Vries

reviewing the curriculum and instructional practices trying to improve student learning in STEM subjects.

An area of concern regarding STEM education is what, by definition, it means and what curriculum reforms will be used to guide these beliefs. With the variations of interpretations of meaning held by individuals and nations, STEM means different things in different places. Countries will use what they believe will be advantageous for their students' performances and national economic reforms. Depending on the meaning that a country holds for STEM (improved learning in the stand-alone STEM subjects, integrative STEM content programs, or singular foci on science and mathematics) will determine the level of involvement in these reform practices. Many in the technology education school subject believe that technology education content and activities can be the integrator for STEM knowledge and learning. Technology education believes that the hands-on and project-based practices used in its instructional practices could aid learners in better understanding complex analytical concepts associated with STEM knowledge. The world community for technology education will need to participate within their individual countries to make its knowledge and practices included within their STEM reforms.

Overall, will STEM educational reforms increase student academic performances in science, technology, engineering, and mathematics and thus increase career interests in these areas? Many of the STEM reform actions focus solely on science and mathematics school subjects. Individual aptitudes and interests usually influence the selection of educational and career choices. Many STEM programs do not take advantage of real world problem solving activities that technology education bases their educational practices. If STEM reform lacks the practical activities found in technology education, will countries succeed in changing student's attitudes about STEM subjects and student academic performances in these areas?

Only time will show if the educational community continues to explore STEM reforms that have gained focus because of politician, government, business, and educator interest in changing how science, technology, engineering, and mathematics education is delivered during schooling. For technology education to be a part of a country's STEM practices, technology education teachers, administrators, and teacher educators need to be involved in the discussions of what STEM should become. If technology education leaders fail to participate in these discusses or show willingness to participate in the development of these practices, our content area will fail to be the great knowledge integrator for STEM educational reform.

Summary

Much has been learned through this international study on STEM educational reform. Technology education leaders from sixteen countries believe our school subject is active in their countries and they are attempting to have technology education become a part of STEM reform. Although politicians, government agencies, business leaders, and others have suggested that reforms need to take place in K-12 and university education science, technology, engineering, and mathematics, technology educators have taken on STEM reform as a problem that needs our subject's participation, knowledge, and ways of teaching to find good solutions to these educational problems. A finding of this study has shown that not all STEM reform involves technology education. Our profession has to determine if STEM practices will continue within individual countries and determine if and how technology education will be a part of this reform. Overall, much still needs to be done to improve the education of young learners in science, technology, engineering, and mathematics.

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Increasing Students‘ Affinity to Technology
The Teaching Model EXRETU – Explicit, Reflective Technology Education

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Introduction

In this paper a school development and research project is presented that took place from 2010 until 2013 in North Western Switzerland. Looking for possibilities to increase the affinity of secondary school students towards technology was one goal of the study. Therefore the teaching model “EXRETU” (Explicit, Reflective, Technology Education) was designed and a special teaching sequence of technology education following the model was carried out with 480 students of 7th and 8th grade. Following the design of a classical intervention setting with a pre-, post- and follow-up questionnaire, the effects of this teaching sequence were determined and the following parameters investigated: the interest in technology, the students’ conceptions of technology, their perceived self-efficacy, the beliefs of gender roles and students’ considerations about future vocational choices. In this paper some selected results on students’ conceptions of technology and students’ affinity for technology shall be presented.

Technology Teaching in Public Schools in Switzerland and the new Curriculum 21

Together with the fact that in Western countries there is an increasing lack of engineers and technologically educated people, diverse attempts have been made in Switzerland in recent years to augment the interest of young people in technology. A careful look at schools reveals the fact that technology is not anchored in the curriculum and there is no systematical build-up of technological competencies in public schools. Of course there are some teachers who show a special interest in this field and their students learn about technology, but most kids are confronted with technology only in informal contexts like random special public events, exhibitions or initiatives by the parents. In Swiss schools, students have the opportunity to learn about technology either within the context of science subjects (where technology is presented as applied physics, chemistry, biology) or within the craft subjects (technical craft or textile craft), but these subjects are not compulsory for everybody.

A serious attempt to change this situation is the new curriculum reform HarmoS and Lehrplan 21 (Curriculum 21). With HarmoS the first time standards were formulated giving a framework for a curriculum in science, mathematics and languages trying to unify the different curriculums of the 21 German- speaking cantons. (A similar attempt was made for the French- and Italian-speaking cantons.) Based on these standards from 2009 until 2013 a new Curriculum (called ‘Lehrplan 21’) was constructed. It is presently going through the political approval process and will be revised this fall before being introduced in 2016.

Concerning technology education there are a few important points to be mentioned about this new curriculum:

- The compulsory school time is grouped in three cycles: 4–8 years old, 9–12 years old and 12–15 years old. Preschool will be compulsory under this new regimen. Recent research findings emphasize on the importance of this early age for development of interest towards science and technology.

- After each cycle, national tests give data to monitor achievement of competence based standards, among them also standards for scientific and technological competencies.

- Technology Education will be anchored in the curriculum beginning in preschool in the subject areas of ‘nature-man-society’ and ‘textile and technical design’ leading to the subject areas in the third cycle with ‘nature and technology’. The standards in these subject areas name explicit goals and learning opportunities.

It is the hope that applied technological proficiency will improve, but there is a long way to go. Teaching material and teaching models have to be developed and teacher education will need to be revised.

The teaching model EXRETU, which is presented in the following section, is one of these attempts.

Characteristics of the teaching model EXRETU (Explicit, Reflective Technology teaching Education)

The idea for the teaching model EXRETU started out by putting together research findings of educational psychology with the characteristics of scientific and technological problem-solving. The so called key competencies in a socio-constructivist learning environment are similar to the competencies engineers need for solving problems in a specific practical context; for example, constructing and building technical tools or artifacts. In both situations problem-solving approaches have to be undertaken, wherein a rather open situation is explored by inquiry, social interactions and teamwork. These are important strategies for finding solutions and creating a specific orientation to the related context. The following characteristic features of the EXRETU teaching model were designed with the goal of promoting a deeper understanding and an appropriate use of technology as well as critical reflection of it:

1. **Problem orientation in a complex practical field.** Students act as ‘engineers’ finding solutions to real problems.
2. **Experiencing and doing technology.** Constructing, producing and optimizing technical objects or processes.
3. **Explicitness.** Talking about technology and technological processes; talking about the meaning of technological concepts; explaining technological processes step by step.
4. **Metacognition and Reflection.** Reflecting about working steps and strategies; reflecting critically about the products or effects; reflecting the learning and problem-solving processes.

These features had to be realized in a practical teaching model that could be applied to different thematic topics. Therefore six basic units were identified and standardized with a framework for the implementation in the schools (cf. figure 1). The core activity and main unit (unit 4) is designing, planning, constructing or producing a tool or an artifact meeting predefined criteria. In doing so technology has to be explored (unit 1), specific skills have to be developed (unit 2), problem solving strategies have to be followed (unit 3), the product or technological processes have to be evaluated (unit 5) and the product or construction process has to be communicated (unit 6). For the intervention study three topics were chosen together with the teachers:

- Designing, planning and constructing a functioning lamp/light

- Designing, planning and constructing a futuristic vehicle with recycling material such as PET bottles or old CD disks

- Designing and producing a piece of chocolate to given specifications by making a form using vacuum deep-drawing methodology and producing an appropriate chocolate mass.

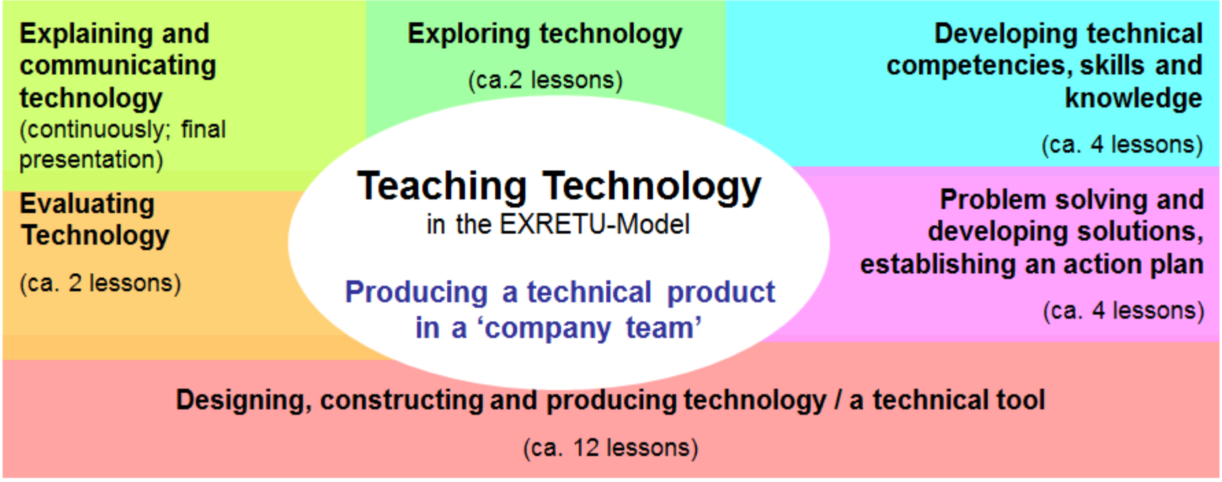


Fig. 1: Standardizing the teaching model EXRETU – Explicit, Reflective Technology Teaching with six teaching units.

Methodology and General Study Design

Within the framework of the SNF-Project (Swiss National Science Resarch Foundation) EXRETU there are two parts:

Part 1: The project of **school development** to create a program to expand use of technology in schools and to put it into general practice. This involved also teacher training.

Part 2: Investigation of the main **research questions** such as students' affinity to technology and students' conceptions of technology with an online questionnaire. (Another research question was studying the effects of the intervention on the gain of technological competencies by analyzing the answers in the students' competency tasks prior to and after the intervention. This study cannot be presented in this paper).

The implementation of the model of EXRETU in schools was accompanied by the design of a classical intervention study with an experimental and control group design in order to gather quantitative and qualitative research data (see Fig 2).

Instruments	WB	F1	K1	Intervention	F2	K2	Int	F3
Experimental group	x	x	x	x	x	x	x	x
Control group		x	x		x	x		x

Fig. 2: Experimental and control group design of the intervention study: WB: Teacher education; F1 and F2 Pre- and Posttest with questionnaire and competency task tests (K1 and K2); Intervention with 30 lessons of technology education according to the EXRETU model; Int: Interviews with students and teachers; F3: Follow-up questionnaire (in 2012)

Results I: Student conception of technology

Students' conceptions of technology might be an important factor influencing students' attitudes toward technological professions or their affinity to technology. In addition, with the well-accepted idea of the value of constructivist learning processes, it is important to know about these conceptions in order to be able to find adequate teaching approaches to engage the students in learning about technology.

In the online questionnaire the students had to state an answer to the open question, “How would you explain what technology is?” The answers to the sample (a total of 375 students, experimental group n = 200, 53 % female and 47% male) were analysed by the method of qualitative content analysis by Mayring (2000) using the software MAXQDA building categories. The categories were formed on one side inductively with the student answers directly and on the other side matched deductively with current definitions of technology (Ropohl, 2009).

The findings show that the following six categories represent the main aspects of the students’ conceptions of technology:

1. Technical objects (artifacts)/ technical systems: Students name a concrete tool, a technical object (artifact) or a technical system to explain the term ‘technology’.
“*Technology are electronic devices, e.g. a computer“; “Technology is a motor”*.

2. Function and functional processes: Students name the interaction of elements in a technical or physical system pointing out that this interaction attributes to the functioning of the system.
“*Technology makes that something works“; “Technology is the moving of wheels”*.

3. Production: Students term either the process of production or the product itself as an important feature of technology.
“*Technology is the invention of objects“; “Technology is making, building something”.*

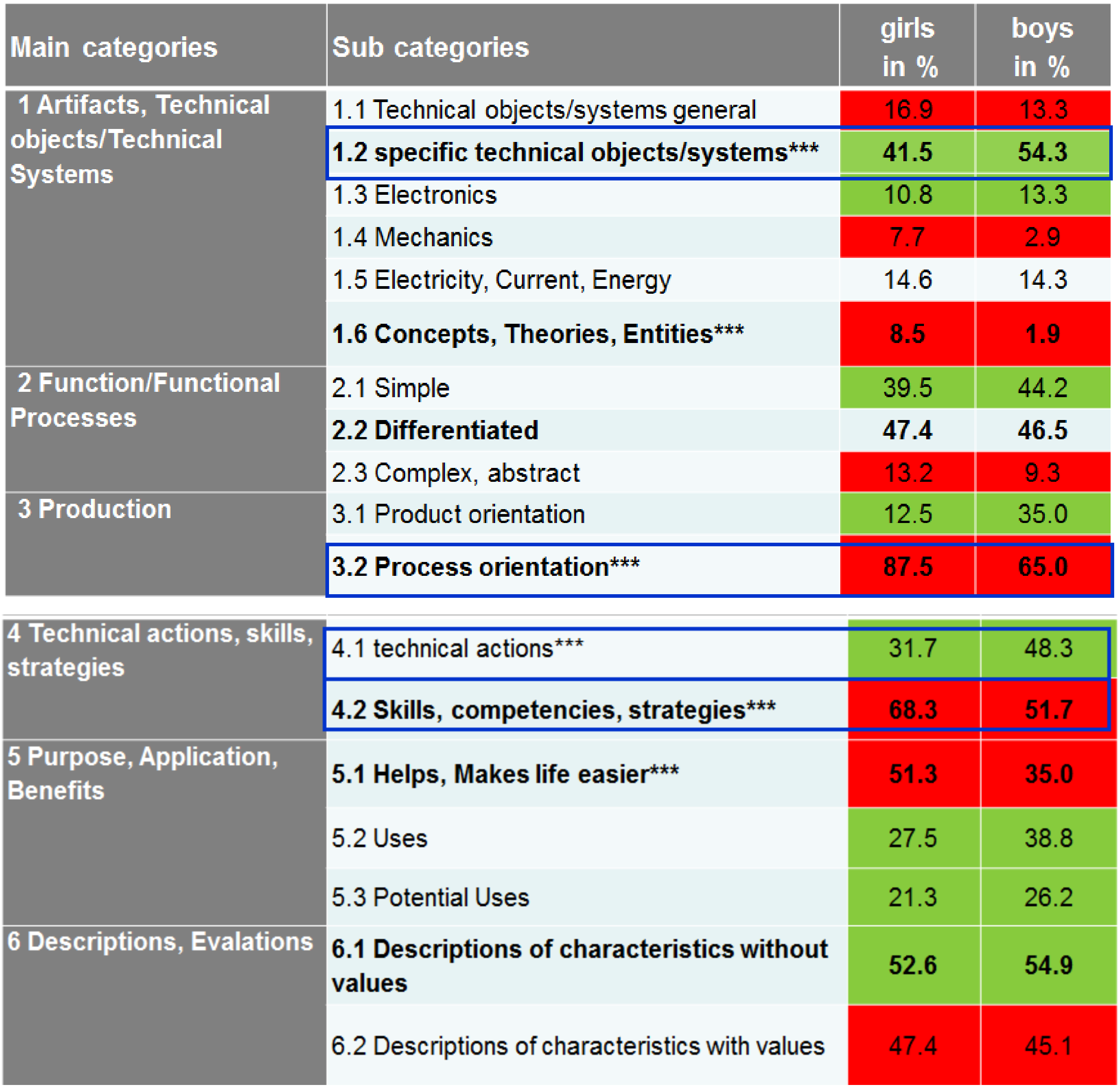
4. Actions (technical actions, skills, strategies): Students name the technical activity itself or the know-how to do so or they relate it to strategies to explain the term technology.
“Technology is to solder”; “Technology is knowing how to connect cables”; “*Technology is another word for strategy, e.g. a precise football technique or a skill”*.

5. Application: Focus on benefits or harms
“*Technology is something that makes life easier“*.

6. General, rather vague descriptions often attributed by a value.
„Technology is something beautiful.“

Looking at the distribution of the answers in the different categories, one clearly sees that most students have rather vague conceptions about technology. Simple descriptions are often associated with a value, e.g. “technology is complicated”; they dominate the answers. If the students have more precise conceptions they are thinking of technical systems or technical objects. They also quite often associate technology with positive or negative effects or with actions, skills or strategies, while only a few of the explanations focus on technological production of goods or functional processes of technology which for engineers are predominant.

Between girls and boys interesting differences can be found, cf. table 1.



Main categories	Sub categories	girls in %	boys in %
1 Artifacts, Technical objects/Technical Systems	1.1 Technical objects/systems general	16.9	13.3
	1.2 specific technical objects/systems***	**41.5**	**54.3**
	1.3 Electronics	10.8	13.3
	1.4 Mechanics	7.7	2.9
	1.5 Electricity, Current, Energy	14.6	14.3
	1.6 Concepts, Theories, Entities***	**8.5**	**1.9**
2 Function/Functional Processes	2.1 Simple	39.5	44.2
	2.2 Differentiated	**47.4**	**46.5**
	2.3 Complex, abstract	13.2	9.3
3 Production	3.1 Product orientation	12.5	35.0
	3.2 Process orientation***	**87.5**	**65.0**
4 Technical actions, skills, strategies	4.1 technical actions***	31.7	48.3
	4.2 Skills, competencies, strategies***	**68.3**	**51.7**
5 Purpose, Application, Benefits	**5.1 Helps, Makes life easier*****	**51.3**	**35.0**
	5.2 Uses	27.5	38.8
	5.3 Potential Uses	21.3	26.2
6 Descriptions, Evalations	**6.1 Descriptions of characteristics without values**	**52.6**	**54.9**
	6.2 Descriptions of characteristics with values	47.4	45.1

Table 1: Students’ conceptions of technology. Categories and subcategories. In red: girls > boys; in green: boys>girls.

Boys are rather “function and product oriented.” They consider technology in a more specific way and associate it often with technical actions. Girls, on the other hand, have rather general conceptions, they show an orientation toward processes and useful applications and associate with technology competencies, skills and strategies.

Comparing the statements before and after the technology teaching unit, we can see that after the EXRETU-Teaching students have expanded their conceptions, they see technology more as technical action, skill or strategy and focus more on beneficial aspects. This is probably due to their own experiences in producing a technological product.

From this study we can conclude that there is a great variation in students’ conceptions of technology. Most of the students have not had very precise and elaborate conceptions of technology and circumscribe the term technology with loose associations. The finding that students relate technology mostly to artifacts, technical objects or technical systems and not to function or production could be explained by the fact that students have not had much opportunity to experience technical functions or see how technical products are built in today’s world. Concerning the effects of EXRETU-lessons, we can find that after participating in technology teaching units, significantly more students in the experimental group see technology as technical action or technical skill or associate it with developing strategies. This leads us to believe that some of the typical activities of the EXRETU-teaching model like developing problem-solving strategies and doing technology are broadening the students' understanding of the term.

Results II: Affinity for technology

This study was the main part of the Swiss National Science Foundation research project EXRETU - 'Explicit, Reflective Technology Education' and was undertaken by Ms. Karin Güdel within her PhD thesis.

The term 'Affinity for Technology' is used for the collection of attitudes, individual interest, self-efficacy and career aspirations in the field of technology following theoretical models of these psychological constructs elaborated by Bandura (1997), Herzog (2006), Krapp & Prenzel (2011) and Todt (2010), cf. Fig. 3.

Fig. 3: Situating 'Affinity for Technology' in the person-technology relationship. Theoretical construction after Krapp & Prenzel (2011).

The following research questions were considered:

Q1: What specific interest, self-efficacy and career aspiration in technology do young people at lower secondary school level have?

Q2: How do students perceive this new approach of technology education?

Q3: How does technology education influence interest, self-efficacy and career aspirations?

As mentioned above, the main research instrument was a written survey with three measuring points, cf. Fig. 2. In addition the quantitative data were completed by qualitative data from guided interviews and the analysis of students' documents such as working journals.

Concerning the effects of the intervention with EXRETU technology education, we found a very positive response of the students to the teaching model. More than 75 percent of the students did like the technology teaching. There was no difference in the positive answers between boys and girls and no differences between different academic school levels. We did find differences between the assigned three activities (chocolate, light/lamp,light-vehicle), but we cannot tell what they were caused by. The qualitative data indicate a strong influence by the teacher's personality.

Further our findings show that most students of 7th and 8th grade have a more positive attitude towards technology (mean = 3.2 in a scale of one to four) than they have an interest in dealing with technology in specific contexts, topics and activities (mean = 2.6-2.7). The interest in working in specific fields of application of technology is even smaller (mean = 2.1). Thus we find a decrease from a general to a very specific interest in technology.

Investigating the interest in technical activities that relate to a design and construction processes, interesting differences show up, cf. Fig. 4.

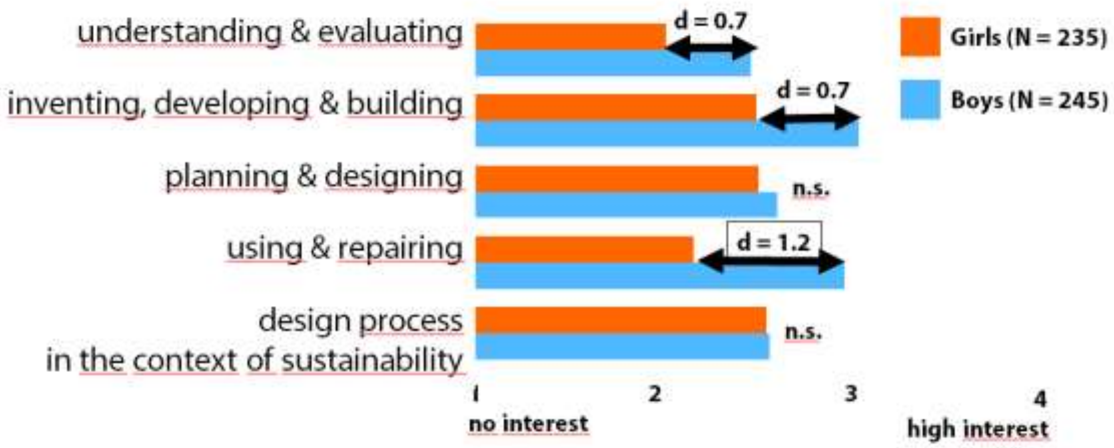


Fig. 4: Interest in activities of design and production processes.

The highest interest can be found in the creative activity of 'inventing, developing and building' while the interest in the cognitive activity like 'understanding and evaluating' is significantly lower. In addition, significant differences between males and females can be found in most categories, except the categories of 'planning and designing' and 'design processes within the context of sustainability'. Here the girls show the same interest, cf. Fig. 4.

Similar gender differences show up looking at the perceived self-efficacy in technical tasks, cf. Fig. 5.

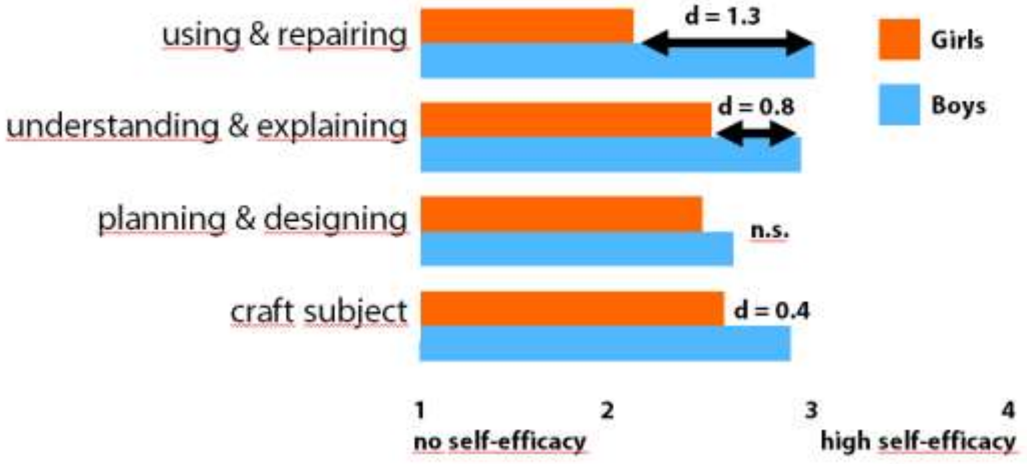


Fig. 5: Gender Differences in the perceived self-efficacy in technical tasks. N = 480. Effect size: Cohen’s d.

The perceived self-efficacy of girls is lower in most technical activities than the boys’ self-efficacy, especially in “using and repairing.” In this area, girls don’t feel confident. However in “planning and designing” the girls show the same self-efficacy as the boys and that is the activity the girls show most interest in (cf. Fig. 4). Thus the correlations between the activity-scales of interest and self-efficacy are great.

Not all girls have a low self-efficacy concerning technical activities and all boys show a strong technical interest. That’s why we had a closer look at the specific gender role orientation. And we could show an interesting connection between rather traditional gender role orientations versus rather open orientations. Girls with open gender role orientations have a higher self-efficacy in technical tasks, show more interest in technology regarding future jobs and show more specific and general interest in technology, while the opposite could be found for boys, cf. Fig. 6.

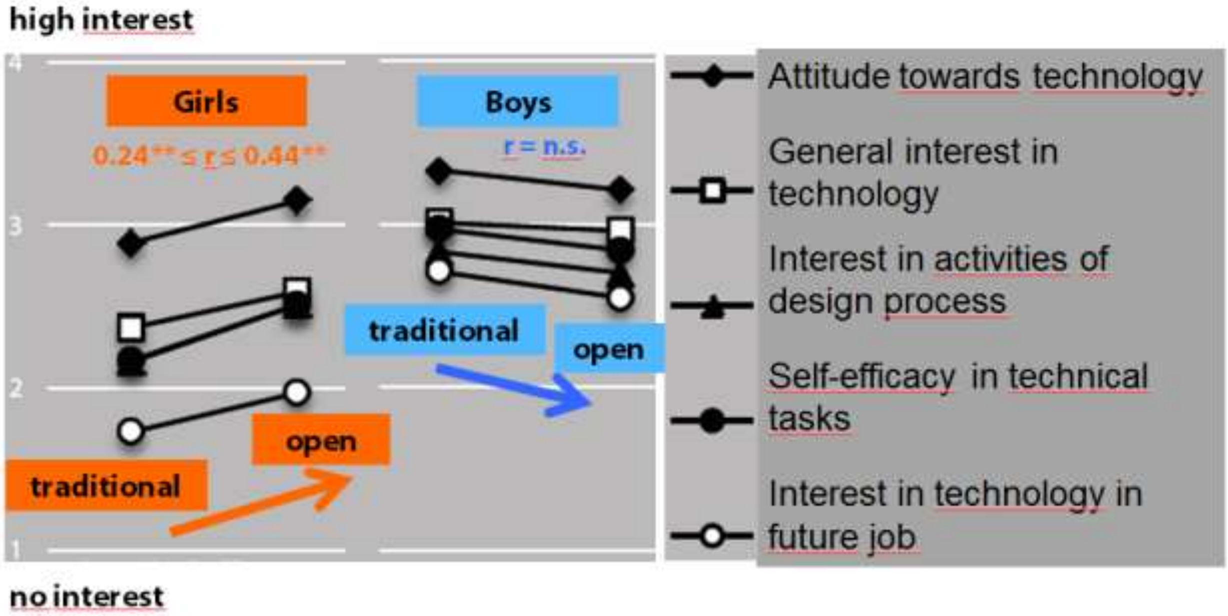


Fig. 6: Influence of the gender role orientation on attitudes, interest and self-efficacy towards technology. R = correlation coefficient (Spearmans rho).

These findings show that there is no such thing as “THE” affinity for technology. One has to look at different aspects of technology (topics, activities, contexts) and at different aspects of the construct of affinity (attitude, interest, self-efficacy) to draw conclusions. We can say that the general interest of the students is higher than specific interest, which seems logical with the kids usually not having had technical experiences in specific contexts. We find big differences between the different subgroups; sex and gender role orientation seem to be important factors. There are other factors that seem to be important for raising the affinity to technology. For example, students of the lowest academic level responded better to the intervention. This might be due to the practical approach of doing technology. Also, girls responded better, perhaps because during the intervention cooperative learning and creativity were given a special focus. And we also found better responses within the classes with a good classroom climate where the “basic needs” (autonomy, experience of competency and social involvement) were fulfilled (Decy & Ryan (1993), cf. Fig. 7.

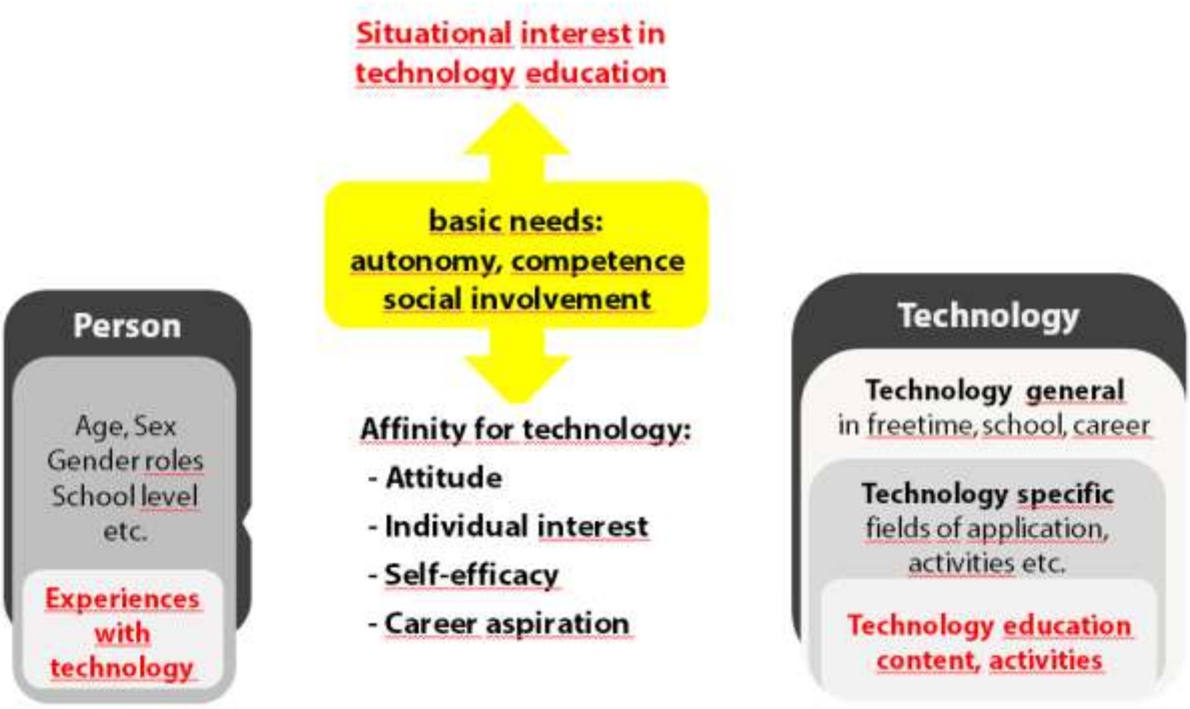


Fig. 7: Multiple factors are influencing the affinity to technology. Factors in red are those that can be easily controlled in the classroom.

General Conclusions

We can conclude from these studies that to augment students' affinity to technology the following factors have to be considered:

- By offering technological activities for students, it is possible to evoke girls' and boys' situational interest in technology. The practical, engineering based approach of the EXRETU – teaching model has proven to be useful for that, especially also for different academic levels.
- Interest in technology and self-efficacy are strongly interdependent. School has to provide the possibility of multiple experiences with technology.
- Considering the different interests of girls and boys, appropriate fields and practical approaches must be chosen. Girls can be motivated by designing and planning processes.
- To get more girls interested in technology, it is important to build up their feelings of self-efficacy and their gender role consciousness towards a rather open gender role.
- Students do not have very elaborate conceptions of technology. An interaction with manifold aspects of technology and 'doing technology' with practical works allows students to broaden their concepts. A special focus has to be given to processes that involve production and function.

From our experiences during the preparatory in-service courses with teachers, we can say that it is not only the students who need more self confidence, but the teachers too. Most teachers are not prepared for technology education, so there is also a need to offer examples, knowledge and the possibility to gain experience in this field. In this sense we consider the teaching model EXRETU as a first step to a possible teacher education too.

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Preliminary Analysis of Ph.D. Perceptions of Technology Education Professions

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Introduction

The vibrancy of professional organizations in the US has declined (Martin, 2007). Some attribute these declines to the economic downturns caused by 9/11 and the 2008 recession, while others pinpoint the declines to societal changes where individual and family relationships rank above work-related responsibilities (Half, 2014). Careers linked to professional organizations were once viewed as avenues for career development where participation and serving in leadership roles could assist with career advancements. This was particularly true for higher education faculty, where state and national service was an important factor leading to promotion in rank. However, the academy has placed increasingly higher worth on securing research funding and publications than it does upon association service roles at research universities.

The root causes to the decline of faculty participation in professional organizations are complex and many. One effect might be how one is mentored in their preparation to becoming a faculty member (Paglis, Green, & Talya, 2006). If doctoral students observe and discuss the university work environment, and follow the career development of their faculty mentors, they see and hear what is judged as important in the academy. Teaching and research are weighted more heavily when one seeks tenure and promotion at research universities.

This background led the researchers to study what doctoral students, those who have graduated with degrees in the past five years and those who are currently enrolled in doctoral preparation, believe will occur in the future in K-12 technology and/or engineering education programs and the technology and/or engineering education professions that represent this school subject.

Research Problem

This study seeks to identify and provide a better understanding of the perspectives of newly graduated doctoral students, and those currently seeking the doctoral degree, on the future of the K-12 school subject of technology and engineering education and the professions that aid in guiding practice. It was guided by the following research objectives:

> RQ_1: What are doctoral students/graduates opinions concerning the focus of content to be learned in K-12 technology and engineering education?
>
> RQ_2: How do these scholars believe technology and engineering teachers will be prepared in the near future?
>
> RQ_3: What is the commitment level of these scholars to their technology and engineering teaching professions?
>
> RQ_4: What do these populations expect to occur in the future to the technology and engineering teaching professions?

Review of Literature

The preparation of future faculty involves learning through classroom and research experiences. Individuals that they come into contact as students or early in their careers as they enter their professions influence their professional development. Many times they learn from others’ points of view when they are exposed to new ideas, through reading professional publications, attending professional development meetings, interacting with fellow students, and/or being exposed to others who work outside their field of technology and engineering education, that often affect their philosophies as they settle into a career pathway (Austin, 2002).

University faculties perform a major role in the development of new education doctors (Blackburn & Lawrence, 1995). These are the people who students have focused contact with as they learn the knowledge of their subject and how best to teach and assess this content. Faculty aid students in developing their philosophy through the knowledge they share and the emphasis they place on it and how it should be transferred to learners through technology and engineering education. Graduate students also learn the importance of research from these and other faculty. The background and values of faculty often determines what doctoral students learn and how they should prepare for their professional life. In a doctoral student's academic preparation, do faculties stress the importance of publishing and presenting at professional conferences? Do faculties stress the importance of joining and being active contributing members in professional organizations (Anderson, 2011)? Is the future of the profession discussed and is the leadership role that new doctoral students should seek in professional organizations explained? These are some of the many interactions and philosophical points that may lead graduate students in selecting their future professional directions.

In education, professional communities, as represented through professional organizations, exist and they aid in developing knowledge structures related to their professions and making recommendations on how this knowledge should be taught to others. Professional communities

> serve to shape knowledge practices and strategies in certain ways, by providing a referential context within which practitioners relate to knowledge and engage in professional conduct. In this way they are also constitutive of the knower. Practitioners are shaped, and learn to see the world, through the qualities and lenses of their knowledge culture, and its technical and social arrangements form the basis for introducing newcomers to the professional domain. (Jansen, Lahn, & Nerland, 2012, p. 26)

University faculty and members of professional associations are influential in the development of philosophical views of those who participate in professional communities (Blackburn & Lawrence, 1995). In the US there are few select research universities that provide doctoral education in the study of technology and/or engineering education. There are also few professional associations to guide practices in these professions. The researchers were interested in uncovering the perceptions of new doctoral graduates and currently enrolled students' views on the future of technology and/or engineering education and the role they may take in guiding the professions into the future.

Research Design

The researchers utilized the survey method as the research design for their two separate and individually administered studies. Clark and Creswell (2010) described survey research designs as procedures "for administering a survey or questionnaire to a small group of people (called the sample) in order to identify trends in attitudes, opinions, behaviors, or characteristics of a large group of people (called the population)" (p. 175). Gall, Gall, and Borg (2010) referred to survey research as a "systematic collection of data about participants" (p. 212) while using "standardized measures" (p. 212) (e.g., questionnaires and interviews). Mertler and Charles (2011) stated that a "cross-sectional survey collects data across different segments of the population at a particular time" (p. 113), while Creswell (2012) noted the advantage of cross-sectional survey designs is they have the "advantage of measuring current attitudes or practices" (p. 377).

Procedure

Using electronic survey delivery systems, the researchers administered a structured 12-question survey, which included additional demographic questions. The first survey was administered in October 2012, while the second survey was administered in October 2013. In the letter of invitation to participate, the researchers assured the invitees that their participation was (a) "voluntary," (b) "their response to each question will be aggregated with the responses from all of the participants," (c) "no one individual's responses will be identifiable by name of the individual, so there is minimal risk to you in participating," and (d) "there are also no direct benefits to you for participating in this study." When invitees responded with their expressed interest to participate in the study, they were sent a URL to complete the survey. A total of 33 invitees participated in the first study. The second study had a total of 34 participants.

The researchers made several assumptions prior to commencing their study. First, the invited participants were capable of identifying the focus of content to be learned in K-12 technology and/or engineering education? Second, they were capable of identifying the way technology and/or engineering teachers will be prepared in the near future. Third, they were capable of expressing their commitment level to their technology and engineering teaching professions. And fourth, they were capable of identifying what they believe will occur in the future to the technology and/or engineering teaching professions? (For purposes of this study, "future" was identified as the year 2025.)

Findings

The sample size for the first study was *N* = 33. This group consisted of (a) recent graduates in technology and/or engineering education that had completed their doctoral degrees within the past five years (the authors shall refer to this sample as Group A). The sample size for the second study was *N* = 34. This group consisted of (b) graduate students who are currently pursuing their doctoral degrees in technology education/engineering education (the authors shall refer to this sample as Group B). Lead professors at their universities nominated participants in both studies. Participating institutions for Group A were Colorado State University, North Carolina State University, Old Dominion University, The Ohio State University, The University of Georgia, Utah State University, and Virginia Polytechnic Institute and State University. Participating institutions in Group B were North Carolina State University, Old Dominion University, The University of Georgia, Utah State University, and Virginia Polytechnic Institute and State University.

Data were collected and analyzed from participants' responses to a 12-question survey. The following narrative reports data in frequencies and percentages from selected survey questions. At this time, no attempt has been made to determine if statistically significant differences exist between responses of Group A and Group B to selected survey questions. The reported data are aligned to the same categories used in the survey – Part 1, Part 2, and Part 3. Data reported in Part 1 focus on Research Question 1, while data reported in Part 2 focus on Research Questions 2, 3, and 4 of the study. Part 3 includes demographic data.

Part 1

Part 1 of the survey contained questions that focused exclusively on Research Question 1. In one question, the participants were instructed to identify what should be the *focus of content* taught in formalized kindergarten (primary) through high school (secondary) technology and/or engineering education programs. In addition, the participants were instructed to "select all that apply" from a menu containing five choices: (a) technological literacy, (b) workforce education, (c) design technology/engineering design, (d) STEM integration, and (e) "other". Group A's response to this question revealed that technological literacy (*n* = 25; 73.5%) and STEM integration (*n* = 24; 70.6%) were the most often selected foci for content in technology and engineering education. This group also gave attention to design technology/engineering design (*n* = 20; 58.8%) and to a lesser extent, workforce education (*n* = 14; 41.2%). A review of Group B's response to this question revealed that STEM integration was selected most often (*n* = 27; 79.4%), followed by design technology/engineering design (*n* = 23; 67.6%), and technological literacy (*n* = 21; 61.8%). In addition, workforce education was selected nine times (26.5%). No Group A or Group B participant selected "other" as their preferred choice.

A preliminary analysis of Group A and Group B responses to what should be the focus of content taught in a formalized kindergarten (primary) through high school (secondary) technology and/or engineering education programs indicates that both groups give attention to the importance of technological literacy, STEM integration, and design technology/engineering design. However, a further analysis also reveals the differences in the importance they consider the focus of content of these three areas. Group A gives equal importance to technological literacy (*n* = 25; 73.5%) and STEM integration (*n* = 24; 70.6%). Group B clearly believes the content focus should be on STEM integration (*n* = 27; 79.4%). Both groups recognize the importance of workforce education, but there appears to be a clear distinction of its importance between participants who already have been awarded the doctorate (Group A) and those who are currently pursuing the doctorate (Group B). See Table 1.

A second survey question also focused on Research Question 1. Identifying the *primary* audience of a formalized instructional program in technology and/or engineering education has been debated within the US profession for decades. Data collected from the participants in Group A and Group B indicated the debate would continue. The survey question instructed participants to identify the primary audience for a formalized instructional program in technology and/or engineering education. In addition, participants were instructed to "select only one" possible primary audience from the following list: (a) elementary aged/primary grade students, (b) middle grades (6-8) aged students, (c) high school students, (d) secondary students (middle grades and high school), (e) post-secondary students, and (f) "all of the above identified populations".

The majority of the participants in Group A believe the primary audience is inclusive of all the elementary through postsecondary grades as the choice of "all of the populations" (*n* = 18; 53.9%) had the highest frequency response rate. Similarly, the majority of the participants in Group B clearly believes the primary audience is inclusive of all the elementary through postsecondary grades (*n* = 20; 58.8%). Within Group A, however, a number of participants (*n* = 16; 47.1%) believe the primary audience for a formalized instructional program should be directed at very specific grades levels. In fact, these participants do not concur that the primary audience is "all the above populations" but should be elementary school students (*n* = 1; 2.9%), middle grade students (*n* = 2; 5.9%), high school students (*n* =3; 8.8%), and secondary school students (*n* = 10; 29.4%). No participant within Group A thought the primary audience should be postsecondary students. Several Group B participants (*n* = 14; 41.2%) believe the primary audience for the instructional program should be directed at specific grades and not be inclusive of the total grade spectrum. Data collected from the participants who believe the primary audience of the instructional program should <u>not</u> be "all the above populations" indicated the audience should be elementary students (*n* = 1; 2.9%); middle grade students (*n* = 5; 14.7%), high school students (n = 1; 2.9%), secondary students (*n* = 6; 17.8%), and postsecondary students (*n* = 1; 2.9%). It is clear that participants in Group A and Group B who selected specific grades as the primary audience of the instructional program gave little credence to the value of offering the instructional program to an audience that includes only elementary students, high school students, and postsecondary students. It is also clear that there is some interest in the primary audience being directed only to secondary students (middle grades and high school) but the majority of participants in Group A and Group B believe the primary audience is "all of the above populations". The primary audience debate that started in the US decades ago may continue for several more decades. See Table 1.

Table 1

Content Focus for Technology and Engineering Education

		Group A		Group B	
		Number	Percentage	Number	Percentage
Content	Technological Literacy	25	73.5	21	61.8
	STEM Integration	24	70.6	27	79.4
	Design Technology/ Engineering Design	20	58.8	23	67.6
	Workforce Education	14	41.2	9	26.5
Primary Audience	All Populations	18	53.9	20	58.8
	Elementary/Primary Grades	1	02.9	1	02.9
	Middle School Grades	2	05.9	5	14.7
	High School Grades	3	08.8	1	02.9

Secondary School Grades	10	29.4	6	17.8
Post-Secondary Students	0	00.0	1	02.9

Part 2

The next question to be explored focused on Research Question 2. The profession has a long history of investing human and financial resources in professional development, although the service providers of professional development have undergone significant changes over the past few decades. The researchers sought to determine whom the participants thought would be providing professional development for technology and/or engineering educators (classroom teachers, supervisors/ administrators, teacher educators). The participants were provided several different professional development providers from which to choose and they were instructed to select "all that apply" where appropriate. The professional development providers were (a) national/regional/district supervisors, (b) commercial vendors, (c) professional associations, (d) teacher education institutions, (e) distance learning providers, and (f) other. Group A's participants to this question included 33 invitees and all 34 invitees in Group B responded to this question.

Group A believes that teacher education institutions will continue to play a major role in providing professional development (*n* = 23; 69.7%), followed by national/regional/district supervisors (*n* = 17; 51.5%) and state professional associations (*n* = 15; 45.5%). Data from Group B show similar results as teacher education institutions are recognized as the prime professional development providers (*n* = 26; 76.5%), followed by professional associations (*n* = 67.6%) and national/regional/district supervisors (*n* = 17; 50%). With the declining number of teacher education institutions in the US, it will be a challenge for those remaining teacher education institutions to fulfill the professional development needs of this population of educators. A clear difference exists in the role members of Group A and Group B sees in distance learning providers in professional development. Less than half of Group A's participants (*n* = 11; 33.3%) see distance learning providers providing a key role in professional development while more than half of Group B's participants (*n* = 18; 53%) see a key role for distance learning providers. Commercial vendors were not viewed as significant professional development providers by Group A (*n* = 9; 27.3%) and Group B (*n* = 10; 29.4%). Interestingly, however, commercial vendors have a very important presence at the conferences of organizations where they host professional development activities on the convention floor and in special pullout workshops.

Another question in the survey focused on addressing Research Question 3. A challenge to all professionals is making a commitment to extend the body of knowledge in their discipline. The researchers attempted to determine the participants' level of involvement by seeking to know their plans to publish in scholarly professional journals. Specifically, the survey question provided several possible choices and the participants were instructed to "select all that apply". The choices were (a) *Technology and Engineering Teacher*, (b) *Journal of Technology Education*, (c) *Journal of Technological Studies*, (d) *International Journal for Technology and Design Education*, (e) *Australasian Journal for Technology Education*, (f) *Design and Technology Education: An International Journal*, and (g) *Prism Magazine/Journal of Engineering Education*. (Since the survey for Group B was also designed for an international audience, the *Design and Technology Education: An International Journal* was not included in the choices for Group A.) The two journals that received the highest response rate from the participants in Group A were *Technology and Engineering Teacher* (*n* = 22; 73.3%) and *Journal of Technology Education* (*n* = 26; 86.7%). Group B participants share a similar interest as Group A as they also selected the *Technology and Engineering Teacher* (*n* = 27; 79.4%) and *Journal of Technology Education* (*n* = 27; 79.4%) as publications they plan to submit manuscripts to for publication. One of the international journals, *International Journal for Technology and Design Education*, received attention from Group A (*n* = 12; 40.0%) and Group B (*n* = 11; 32.4%).

The final survey question covered in this paper addresses Research Question 4. The researchers sought to determine the participants' best projection for what the profession would look like in 2025. Participants were instructed to select "only one of the following" statements: (a) the profession will look very similar to what it looks like today, (b) the profession as we know it today will be integrated